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THE IMPACT OF JOINT LAND TITLING: EVIDENCE FROM VIETNAM

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ABSTRACT

In Vietnam, Land-Use Right Certificates (henceforth referred as LURCs) can be issued to either individuals or households. If the land and asset are defined as common property of husband and wife, both have the right of land use or asset ownership. In this study, we assess the impact of land use rights on household welfare using Vietnam Household Living Standard Surveys 2004 and 2014. We find a strong effect of jointly-titled LURCs of residential land on formal and informal credit. Having jointly-titled LURCs increases the amount of formal credit by 35.1% and informal credit by 18.9%. We also estimate the effect of having jointly-titled LURCs on per capita expenditure. Jointly-titled LURCs of agricultural land and residential land help households increase per capita expenditure by 1.6% and 2.5%, respectively.

KEY WORDS

land titling, gender, poverty, impact evaluation, Vietnam

JEL CODES

Q15, R14, O12, O15

1 INTRODUCTION

A positive correlation between gender equality and economic development is well documented (Appiah and McMahon, 2002; Duflo, 2012; Diebolt and Perrin, 2013; Bertay et al., 2020). Policy-makers as well as researchers have long been interested in policies, which can reduce gender inequality (e.g., Grown et al., 2005; Eswaran, 2014; Grown et al., 2016; Sharma and Tarp, 2018). In many countries, especially in low-income countries, women are found to have less legal rights to property than men, (e.g., Rao, 2005; Izumi, 2007; Roy, 2015; Chigbu, 2019; Deere and León, 2022). Land is an important form of property that serves as a resource for increasing production, improving access to credit, and reducing vulnerability (Roy and

Tisdell, 2002; Campus, 2016; Meinzen-Dick et al., 2019). There is an influential argument that having land rights can help women increases their power in the decision-making process (Agarwal, 1994; Izumi, 2007; Menon et al., 2017; Meinzen-Dick et al., 2019). An important question is whether joint land titling for both men and women can increase household welfare.

In this study, we examine whether having jointly-titled land-use right certificates (LURCs) can increase living standards of households in Vietnam. We estimate the effect of both joint titling of agricultural land as well as residential land using district fixed-effect regression and data from Vietnam Household Living Standard Surveys (henceforth referred as VHLSS) in 2004 and 2014. The empirical results show beneficial effects of joint land titling. Having jointly-titled LURCs of agricultural land and residential increased increase per capita expenditure by 1.6% and 2.5%, respectively. A mechanism through which joint land titling increase household expenditure is through raising loans, both informal and formal sources, and nonfarm income.

Our study is expected to contribute empirical findings on the effect of joint land titling to the literature on gender equality and economic development. There are several studies that focus on the role of ensuring legal rights in women's empowerment (Datta, 2006; Field, 2007; Wiig, 2013; Newman et al., 2015; Menon et al., 2017; Widman and Hart, 2019; Cherchi et al., 2019). However, most studies look at the outcomes of woman empowerment. There is little evidence on the effect of joint land titling on aggregate measures of living standards of households. An exceptional study is Menon et al. (2017), which also examine the effect of joint land titling on per capita expenditure in Vietnam using VHLSSs 2004 and 2008. Compared with Menon et al. (2017), we use more recent data, i.e., the 2014 VHLSS, and we investigate the role of joint titling of not only agricultural but also residential land. In addition, we show that increasing formal and informal credit is one of channels through which joint land titling increase household's expenditure. To our knowledge, our study is one of the first attempts to look at the effect of joint land titling on credit of households.

Vietnam is an interesting case to look at. The country has achieved significant success in improving gender equality and empowering women. Compared to other countries with similar levels of economic development, Vietnam has higher gender development indexes (United Nations, 2008). However, there is still significant inequality with regard to gender in both perception and economic conditions. Nguyen and Tran (2017) find that families continue to have children until they produce a male child. According to the 2016 VHLSS, monthly wages of women are 18 percent lower than men. It is estimated that the overall lifetime prevalence rate for physical violence against women by husbands in Vietnam is 31.5 percent (GSO, 2010).

Land-holding is the most common form of property for families, especially in Vietnam – a country with a high proportion of rural and agricultural households. The Marriage and Family Law of Vietnam states that properties that are purchased during marriage belong to both husband and wife. The Vietnamese Government's Decree No. 70, effective since October 2001, also regulates that all documents indicating the ownership of properties must be in the names of both spouses. A LURC must have the names of both husband and wife. The 2003 Land Law also requires that names of both husband and wife be written explicitly on LURCs. The LURCs issued since 2003 often contain the names of both spouses, but LURCs issued before 2003 might contain the name of only one spouse, and that is usually the husband. As a result, lands have been disproportionately controlled by men in Vietnam. If a land plot is "defined as common property" of the husband and wife, both have the right of land use even though one of them may not be named on the LURC. However, World Bank (2008) shows that a woman does have more power in decision-making processes in her family if her name is written explicitly in the LURC.

In Vietnam, there have been several studies on the role that LURCs play in the lives of women. Except for Menon et al. (2017),

which is discussed above, most studies rely on qualitative methods. These studies have shown that when women are not named in LURCs, they tend to have less economic power in the family. Greig et al. (2006) conducted a survey of 82 female business owners. According to these women, a main reason why women are less likely to access formal capital than men is that their names are not on LURCs. Ethnic minority women tend to receive less land than men in divorce and inheritance (Do and Hoang, 2005; Nguyen, 1999). When husbands are absent from the home or do not give consent, women cannot use LURCs to obtain loans from a bank (World Bank, 2008). Without land use rights, women are more economically dependent on their husbands. They are more afraid of divorce and suffer more domestic violence (World Bank, 2008). Razavi (2003) and Tinker and Summerfield (1999) indicate that LURCs can improve decision-making power of women and sustainably reduce gender inequality.

This paper is structured into 5 sections. Following the introduction section, the second section describes data sets and analytical methods used in this study. The third section presents the descriptive analysis of land and land titling in Vietnam. The fourth section discusses the empirical results from the impact of joint titling of LURCs on household welfare. The fifth section summarizes the conclusions of the study and discusses policy implications.

2 DATA AND METHODOLOGY

Data for the study comes from VHLSSs in 2004 and 2014. The sample household size of the 2004 and 2014 VHLSSs is 9,188 and 9,388, respectively. These VHLSSs are representative for the national, rural and urban, and regional levels. The VHLSSs were conducted by the General Statistics Office of Vietnam (GSO) with technical support from the World Bank. Although VHLSSs have been conducted every two years since 2002 by GSO, only the 2004 and 2014 VHLSS contain a special module on land and do contain information on land area as well as land titling of both agricultural and residential lands. This is the main reason why we use these two surveys in this study. The VHLSSs contain detailed information on households and household members. Individual-level data on individuals include demography, education, health care, and employment. Household-level data include assets, land holdings, production activities, access to credit, social protection programs , income and expenditure.

The most challenging is how to estimate the impact of land joint titling on outcomes of and households. We examine the effect of having land use right or having name on LURCs on household outcomes as follows:

$$Y_{j,t} = \beta_0 + \text{Joint}_{j,t}\beta_1 + X_{j,t}\beta_2 + \\ + T_t\beta_3 + v_j + u_{j,t}, \quad (1)$$

where $Y_{j,t}$ is an outcome of interest of household j in year t. The outcome variables include loans from different sources, share of income from different sources in total income, and per capita expenditure. $\text{Joint}_{j,t}$ is a dummy variable indicating household j has a joint titling of LURCs. The reference group is households who have LURCs but with only a single name on LURCs. It means that households without LURCs are excluded. In addition, we also exclude households, in which LURCs is held by a single person (who is unmarried, divorced or widowed). In other words, we compare married couples with joint-titled LURCs with married couples with LURCs held by only a husband or a wife. Model (1) is estimated using the household-level data from VHLSSs. $X_{j,t}$ is a vector of explanatory variables which consist of household-level variables. T_t is a set of year dummies. v_j denotes time-invariant variables of districts, and $u_{j,t}$ denotes unobserved variables on households.

A problem in estimating the above equations is the selection or endogeneity bias of LURCs. Individuals who have LURCs and households with joint land titling can be different from other households. To address this problem, we control for a number of observed variables including ethnicity, age, gender, education, household composition, and land areas. In Vietnam, LURCs are issues by district authorities. Thus we also control for dummies of districts, v_j. District variables can affect obtaining LURCs and at the same time the outcomes of individuals and households. Failure to control district variables can lead to biased estimates.[1] Using district fixed-effects regression, we expect to mitigate the selection bias, therefore being able to measure the effect of joint land titling.

3 LAND TITLING IN VIETNAM

3.1 Use of Land without LURCs

In this study, both agricultural land and residential land is analyzed. The agricultural land consists of annual cropland, perennial cropland, forestry land, and aquaculture surface. However, separate analysis of all agricultural land types is not presented in consideration of the breadth of material. Instead, the analysis for annual cropland and the remaining agricultural lands are grouped into "other agricultural land". Annual cropland is more important and common than other agricultural land. The main annual crops in Vietnam include rice, corn, potato, cassava, tomato, and other vegetable.

Fig. 1 reports the percentage of households using or managing lands, and the average land areas of these households. The percentage of household using and managing agricultural land decreased over time. In 2014, 48.2 percent of households used or managed annual cropland, and 22 percent of households used or managed other agricultural land. The average area of annual cropland (computed for households with annual cropland) and the other agricultural land (computed for households with these lands) was 4,794.5 and 10,361.4 square meters, respectively.

In VHLSS, residential land consists of house area and surrounding area. It should be noted that data on residential land are available in VHLSS 2004 and 2014. The percentage of households using or managing residential lands was 88 percent in 2014. This means that 12 percent of total households shared residential land with other households. It is fairly common in Vietnam that parents are living with their adult children in the same area, but they are counted as two or more households. The average residential area decreased from 711 to 455 square meters during the period 2004–2014. This decrease reflects the fact that population increased over time, while the total residential land area did not increase.

LURCs can be issued to individuals (male only or female only) or households (husband and wife).[2] If a LURC is granted to one or many persons, only the persons named on the certificate have the right of land use or ownership of properties attached to land. A LURC that is "issued to a household" often contains the name of one representative house-

[1] Two better estimation strategies (when randomization is not possible) are instrumental variables regression and household fixed-effects regression. Instrumental variable regression requires an instrument that is correlated with LURCs but not outcomes. This study was unable to find such an instrument. For example, the study used the proportion of joint-titled LURCs of provinces as the instrument for the joint-titled LURCs of households. However, this instrumental variable does not work well. The first-stage is strong, but the coefficients are extremely large (more than 10 times of OLS coefficients). This suggests that this instrumental variable is correlated with the error terms. Household fixed-effects regression control for time-invariant household variables using panel data. Since panel data are not available, this method cannot be used in this study.

[2] LURCs are issued by local authorities (provincial-level and district-level People's Committees). LURCs can have different names such as land use right certificate, land tenure certificates, certificate of ownership of residential houses and land use rights, certificates of land use rights, ownership of houses and other assets attached to land. They can be referred to as red book and pink book.

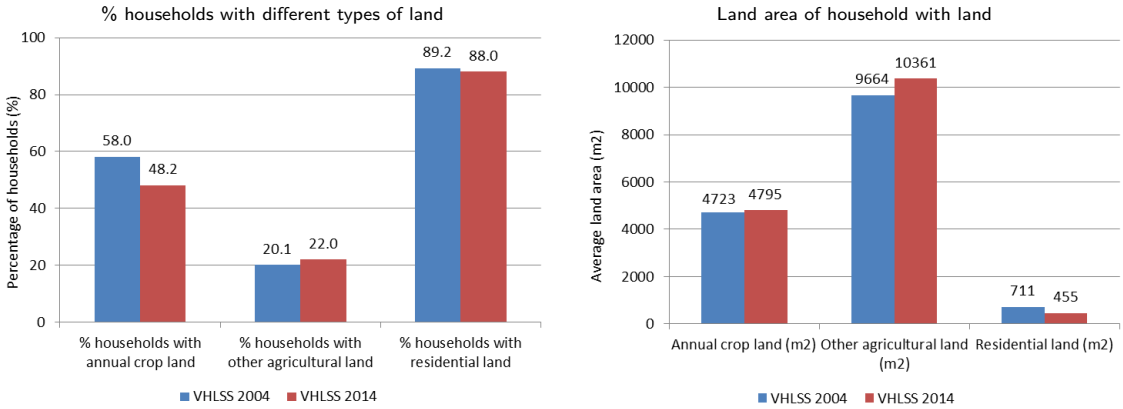


Fig. 1: Households using land and average land area (estimation from VHLSS 2004 and 2014)

hold member (usually the household head). In this case, ownership and use rights to the land and property stated on the LURC belong to all persons named in the household registration book, regardless of whether they are named in the certificate. It means that a person still has ownership and use rights to a land plot even if his or her name is not written in a LURC.

Tab. 1 presents the percentage of land area without LURCs by different characteristics of households. The percentage of annual cropland area without LURCs increased slightly from 26 percent to 30.5 percent during the period 2004 to 2014. However, the percentage of other agricultural land without LURCs decreased from 30.1 percent to 24.6 percent during the same period. The percentage of residential lands without LURCs also decreased from 22.6 percent in 2004 to 17.8 percent in 2014.

The proportion of land area without LURCs differs across regions and for different types of land. For example, Central Highlands has the highest rate of not having LURCs of annual croplands, but South Central Coast has the highest rate of not having LURCs of other agricultural lands. Regarding residential lands, the incidence of households without LURCs is highest in North West.

Tab. 1 also presents the proportion of land area without LURCs by gender and age of household heads. In 2014, female-headed households were more likely to have LURCs than male-headed households, especially for annual cropland. In 2014, 31.7 percent of annual cropland area of male-headed households did not have LURCs, while this rate for female-headed households was 22.6 percent.

In the 2014 VHLSS, various reasons emerge why households do not have LURCs. For annual croplands, 39.4 percent of land area without LURCs is due to the process of obtaining LURCs. Reclamation is responsible for 32.9 percent of cropland area without LURCs (Fig. 2). And about 17.9 percent of cropland area does not require LURCs by households. A small proportion of cropland area in dispute or conflict also has no LURCs. The reasons for not having LURCs for other agricultural land are rather similar to those for annual cropland. For residential land, the main reason is in the process of obtaining LURCs, accounting for 64.4 percent not having LURCs while another 15.7 percent of residential land does not need LURCs.

3.2 Land Titling by Gender

In the following analysis of titling by gender of holders, the discussion will focus on LURCs held by only male, only female or both (i.e., joint titling). Land area without LURCs is not considered in this particular analysis. As noted, there is a category of LURCs that are granted to households, but only a household head is named in this type of LURC. There is no information in VHLSS on individual-type or household-type of LURCs. Thus, LURCs that are granted to households would be defined as

Tab. 1: Percentage of land area without LURCs, 2014 (estimation from VHLSSs 2004 and 2014)

	Annual cropland		Other agricultural land		Residential land	
	2004	2014	2004	2014	2004	2014
Total	26.0	30.5	30.1	24.6	22.6	17.8
Region						
Red River Delta	28.9	45.3	32.2	22.1	29.1	17.3
North East	18.9	29.4	25.6	31.3	17.4	18.0
North West	51.2	50.6	12.3	24.4	23.9	29.1
North Central Coast	28.5	37.2	44.7	12.2	25.3	12.4
South Central Coast	34.8	40.5	34.5	43.4	18.1	16.3
Central Highlands	55.7	56.3	49.7	34.6	23.1	16.3
Southeast	39.4	22.1	35.0	25.2	25.7	24.4
Mekong River Delta	8.7	10.0	17.7	15.3	17.3	17.6
Gender of household head						
Male	26.3	31.7	29.9	24.7	22.2	18.3
Female	24.6	22.6	31.4	22.9	24.2	16.1

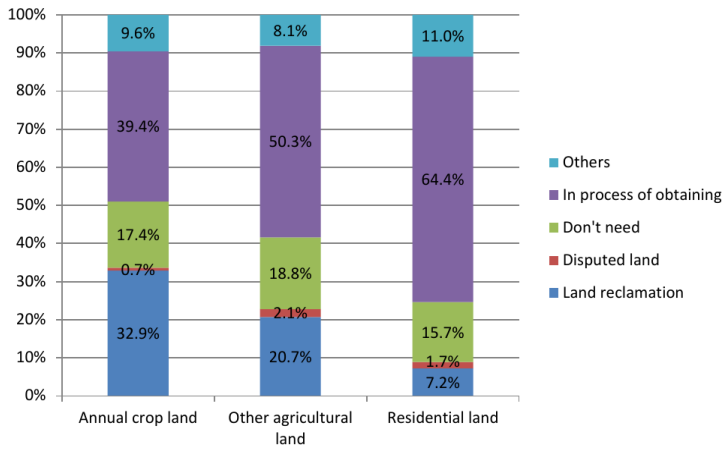


Fig. 2: Distribution of land area by reasons for not having LURCs, 2014 (estimation from VHLSS 2014)

single-titled LURCs since these LURCs contain the name of only one representative household member.

Tab. 2 shows a remarkable increase in the joint titling of LURCs over time. The left panel of the table presents the distribution of all LURCs ("whole sample") by joint titling status. In 2004, only 11.6 percent of LURCs of annual cropland area was joint-titled. In 2014, the proportion of joint-titled LURCs of annual cropland increased to 38.3 percent. The percentage of joint-titled LURCs of other agricultural land and residential land also increased significantly over the same period. Clearly, the legal regulation in Land Law 2013 has been effective and contributed to the success in issuing joint-titled LURCs in Vietnam.

The percentage of LURCs held by only female was quite stable over time, while the percentage of LURCs held by only male decreased significantly because of increasing joint-titled LURCs. However, the proportion of LURCs held by only male is still remarkably higher than that held by single female. In 2014, 46 percent of LURCs of annual cropland were held by only male, while 15.7 percent of LURCs were held by only female. For residential land, males are also more likely to have LURCs than female.

Tab. 2: Distribution of LURCs by gender of holders (estimation from VHLSSs 2004 and 2014)

	Only male	Joint	Only female	Total
Annual cropland				
VHLSS 2004	70.9	11.6	17.5	100
VHLSS 2014	46.0	38.3	15.7	100
Other agricultural land				
VHLSS 2004	71.2	13.9	14.9	100
VHLSS 2014	45.2	41.4	13.3	100
Residential land				
VHLSS 2004	64.7	15.7	19.7	100
VHLSS 2014	34.5	44.6	20.9	100

Gender inequality lies not only in titling of LURCs but also in the size of land holdings. Fig. 3 shows that the average land area (both agricultural and residential land) with LURCs held by only female is smaller than that with LURCs held by only male. Moreover, residential land with LURCs held by only male is larger than land with joint-titled LURCs or only female-titled LURCs. Simply looking at the distribution of LURCs by holders' gender does not reflect the full picture of the gender inequality in land use rights.

Finally, we use regressions to examine multivariate correlation between land titling and characteristics of households in the 2014 VHLSS. Tab. 7 in the Annex presents these results. The sample consists of plots of agricultural and residential lands. The dependent variables include a dummy indicating whether a land plot is titled and a dummy indicating whether a land plot is jointly titled. Overall, residential lands are more likely to be jointly titled, then perennial crop lands and annual crop lands. Residential lands which have a higher area are more likely to be titled but less likely jointly titled. Households with older and more-educated heads are more lily to have titled lands and joint-titled lands than households with younger and less-educated heads. Households with higher expenditure tend to have a higher proportion of titled lands as well as jointly-titled lands.

4 THE IMPACT OF LAND JOINT TITLING

Since land is important collateral for borrowing in Vietnam, land use rights have a positive effect on households by increasing access to credit (World Bank, 2008). The role of credit in increasing household production and reducing poverty has been well documented (e.g., Khandker, 2005; van Rooyen et al., 2012). In Vietnam, micro-credit as well as credit from informal sources can have a direct effect on poverty reduction (e.g., Nguyen, 2008; Swain et al., 2008; Lensink and Pham, 2012; Nguyen and van den Berg, 2014). With land use rights, women also have better access to credit and, as a result, can increase their opportunities for employment and give stronger voice to decision-making in their households. Qualitative research from World Bank (2008) find that "women feel they have more freedom in making decisions to take and use loans when their names are listed on the LTCs".

Fig. 4 and 5 show the important role of LURCs on access to formal credit. As shown in Fig. 4, the average amount of formal credit of households having agricultural land with only female-named LURCs was 7,090,000 VND in 2014. The formal credit for households with joint-titled LURCs was 6,429,000 VND. Households without LURCs and households with only male-named LURCs had remarkably lower amounts of formal credit at 4,433,000 and 3,885,000 VND, respectively.

Similarly, households with joint-titled LURCs of residential land also had larger amounts of formal credit than other households (Fig. 5). Informal credit and microcredit differed slightly among households with different titling status of LURCs since these types of credit do not depend largely on collateral. This estimate is also consistent with the estimate of the percentage of households using lands as collateral for borrowing. In the 2014 VHLSS, there is a question with regard to whether households have used lands as collateral to obtain loans. Around 12 percent households reported that they had used

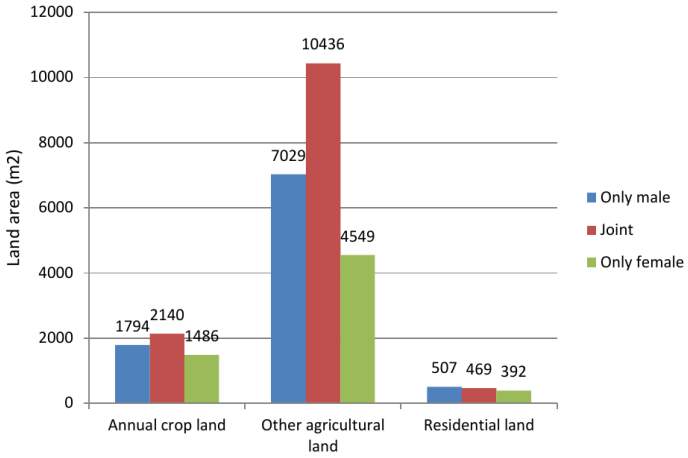
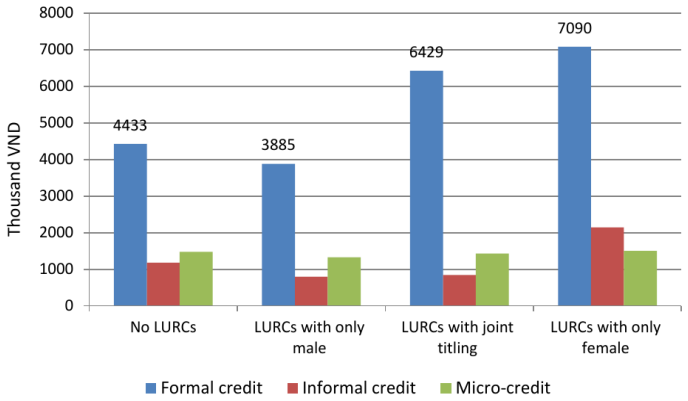


Fig. 3: The average land area by LURC titling, 2014 (estimation from VHLSS 2014)



Note: The credit sources are defined based on questionnaires of VHLSS 2014. In this study, formal credit includes loans from banks and other credit institutions. Informal credit consists of loans from private lenders, credit groups, friends, and relatives. Micro-credit is loan from Vietnam Bank for Social Policies.

Fig. 4: Average loan of households by titling status of agricultural land LURCs, 2014 (estim. from VHLSSs 2004, 2014)

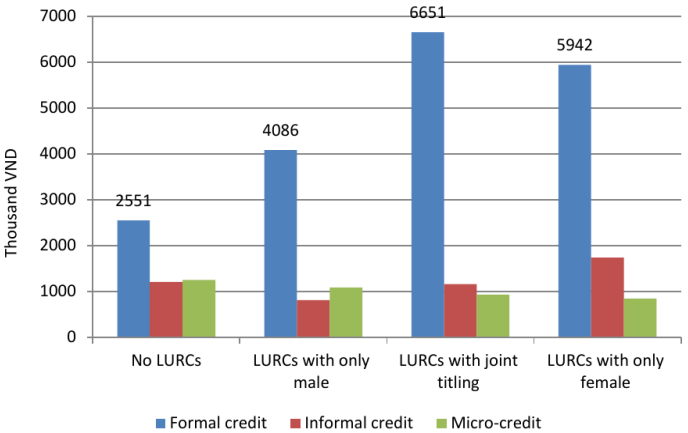


Fig. 5: Average loan of households by titling status of residential land LURCs, 2014 (estim. from VHLSSs 2004, 2014)

agricultural lands as collateral to obtain loans. This rate does not differ for households with and households without joint-titled LURCs on agricultural land. The rate of households using residential lands as collateral to obtain loans is higher; this rate differs between households with and household without joint-titled LURCs. Around 22 percent of households with joint-titled LURCs used residential lands as collateral to obtain loans, while this rate for households without joint-titled LURCs on residential land was 17 percent.

Fig. 4 and 5 do not represent causality of LURCs on credit access. Households with different titling statuses of LURCs can be different in other characteristics, which can also affect credit access. The regression method is used in this study to control for the differences in several characteristics that can affect the titling statuses of LURCs.

In Tab. 3 and 4, we run regression of households' access to credit and other household outcomes on joint land titling and control variables. The statistics of household variables is presented in Tab. 5 and 6 in the Annex. The impact evaluation of land joint titling for this study compares the outcomes of households with joint-titled LURCs and the outcomes of households with single-titled LURCs. Unlike the study by Menon et al. (2017), which use households without LURCs as the comparison group, this study drops households without LURCs. Households without LURCs often rent a house or land; they differ from households with joint-titled LURCs and account for a small proportion of households. Therefore, households with single-titled LURCs are used as the comparison group. Moreover, this group will be the targeted households for the policy of joint-titled LURCs. Control variables include age, gender, and education of household heads, ethnicity, urban dummy, household composition, land area, and district dummies. The reason why the study controls for district dummies (or also called district fixed-effects regression) is because that district People's Committees are responsible for issuing LURCs.

Tab. 3 and 4 present the coefficients of LURCs in regressions. The full regressions are reported in Tab. 8 and 9 in the Annex. It shows that the most direct effect of LURCs is on access to credit. Again, a regression was run on loan sizes from different sources on joint-titled LURCs of agricultural land (Tab. 3) and of residential land (Tab. 4). There are no significant effects of joint-titled LURCs of agricultural land. However, there are strong effects of joint-titled LURCs of residential land on formal and informal credit. Specifically, having joint-titled LURCs increases the amount of formal credit by 35.1 percent and informal credit by 18 percent.[3] The coefficient of micro-credit has a negative sign and is not statistically significant. This is expected since micro-credit does not require collateral. Our finding is consistent with qualitative study from World Bank (2008), which shows that LURCs can help households to be more likely to borrow and also help women feel more confidence in decision-making process.

A possible reason why the effect of joint-titled LURCs of residential land on loan is larger than the effect of joint-titled LURCs of agricultural land is that residential land values are higher than agricultural land values. According to the 2014 VHLSS, the average value of residential land of households is around 665 million VND, which is twice as much as the average value of agricultural land. In addition, there are no term limits for LURCs of residential land while the term of LURCs of annual cropland and perennial cropland is 20 and 50 years, respectively.

Having joint-titled LURCs of agricultural land does not affect the income structure of households. However, having joint-titled LURCs of residential land increases the share of non-farm business by 1.8 percentage points. This implies an increase in loans used in non-farm business. Finally, the study estimates joint-titled LURCs of agricultural land and of

[3]The coefficient of variable 'joint titling of residential land' in the regression of log of formal credit is 0.3008. The difference in log of formal credit between households with and households without joint titling of residential land is: $\log(\text{Credit1}) - \log(\text{Credit0}) = 0.3008$, or $\log(\text{Credit1}/\text{Credit0}) = 0.3008$. Thus $\text{Credit1}/\text{Credit0} = \exp(0.3008) = 1.351$. It means that the amount of formal credit of households with joint titling of residential land is around 35.1 percent higher than that of households without joint titling of residential land.

Tab. 3: Regression of household-level dependent variables on joint titling of agricultural land

Explanatory variables	Log of formal credit (thousand VND)	Log of informal credit (thousand VND)	Log of micro-credit (thousand VND)	Share of farm income in household total income	Share of non-farm income in household total income	Share of wage income in household total income	Share of income from other sources in household total income	Log of per capita expenditure
Joint titling in agricultural land	0.1091	−0.0193	−0.0579	0.0032	0.0037	−0.0086	0.0018	0.0161*
	(0.1136)	(0.0825)	(0.0843)	(0.0061)	(0.0053)	(0.0061)	(0.0045)	(0.0097)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	5.2382	1.8836	1.9689	−0.4542***	0.3408***	0.9412***	0.1722***	7.3992***
	(3.9408)	(2.8643)	(2.9246)	(0.0446)	(0.0388)	(0.0452)	(0.0331)	(0.0716)
Observations	11,121	11,121	11,121	21,558	21,558	21,558	21,558	21,558
R-squared	0.265	0.241	0.277	0.599	0.327	0.440	0.420	0.769

Notes: Robust standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The full regression results are reported in Tab. 8 in the Annex. Source: Estimation from VHLSS 2002, 2004, 2008 and 2014.

Tab. 4: Regression of household-level dependent variables on joint titling of residential land

Explanatory variables	Log of formal credit (thousand VND)	Log of informal credit (thousand VND)	Log of micro-credit (thousand VND)	Share of farm income in household total income	Share of non-farm income in household total income	Share of wage income in household total income	Share of income from other sources in household total income	Log of per capita expenditure
Joint titling in residential land	0.3008***	0.1733**	−0.0843	0.0041	0.0177**	−0.0153	−0.0064	0.0247**
	(0.1062)	(0.0799)	(0.0798)	(0.0074)	(0.0090)	(0.0101)	(0.0062)	(0.0122)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	6.8456***	1.1266	1.1375*	0.0780	−0.0140	0.8563***	0.0797	8.5186***
	(1.2965)	(0.9931)	(0.6846)	(0.2322)	(0.0893)	(0.2233)	(0.0706)	(0.6145)
Observations	9,648	9,648	9,648	9,648	9,648	9,648	9,648	9,648
R-squared	0.255	0.227	0.261	0.542	0.289	0.387	0.379	0.796

Notes: Robust standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The full regression results are reported in Tab. 8 in the Annex. Source: Estimation from VHLSS 2002, 2004, 2008 and 2014.

residential land increase per capita expenditure by 1.6 percent and 2.5 percent, respectively.

Notably, although the regression method controls for observed variables, including district dummies, it can be biased if households with dissimilar LURC tiling statuses are found to be different in not only observed but also unobserved characteristics. Without randomization of LURCs, it is challenging to estimate the causal effect of LURCs. Thus, the findings from the impact evaluation should be interpreted with discretion.

5 CONCLUSIONS AND POLICY RECOMMENDATIONS

Provision of joint land title for both men and women is important to ensure gender equality. In Vietnam, the 2003 Land Law requires joint-titled LURCs for married couples. As a result, there has been a remarkable increase in the joint-titled LURCs since 2004. For instance, the proportion of joint-titled LURCs of annual cropland increased from 11.6 percent in 2004 to 38.3 percent in 2014. The proportion of joint-titled LURCs of other agricultural land and residential land also increased significantly.

Using the 2004 and 2014 VHLSSs and district fixed-effect regression, we find several positive effect of joint-titled LURCs. The most direct effect of LURCs is on the access to credit. We find that joint-titled LURCs increased the amount of formal credit by 35.1 percent and informal credit by 18.9 percent. This finding is consistent with qualitative study from World Bank (2008), which shows that LURCs can help households to be more likely to borrow and also help women feel more confidence

in decision-making process. Compared with previous quantitative studies, our study is one of the first attempt which find a positive effect of joint land titling on credit.

The increase in credit is translated into an expansion of nonfarm production, resulting in an increase in the share of nonfarm income of households with joint-titled LURCs. As a result, consumption is increased. We find that joint-titled LURCs of agricultural land and residential land increases per capita expenditure of households by 1.6 percent and 2.5 percent, respectively. The positive effect of joint land titling is also found in Menon et al. (2017). Thus, together with Menon et al. (2017), our study provides the supportive evidence for the hypothesis that joint land titling can improve the living standards of households.

Our study suggests several policy implications. The Government should have policies to re-issue single-titled LURCs as joint-titled LURCs. Even for LURCs that are provided to households under the name of households should be revised. Not only household heads but also their spouses should be named on LURCs. To further gain the benefits from joint land titling, there is an opportunity to enhance joint-titled LURCs. It is important to strengthen communication and the enforcement of women's land rights, especially in rural and remote areas with high concentration of ethnic minority groups. The provincial authorities should incorporate tasks of raising awareness of women's land rights and benefits of joint titling in communication programs of local mass organizations, such as the Farmers' Association, the Youths' Union, and notably the Women's Union. Content should be provided in local language and should not only refer to the Land Law but to other related laws such as the Inheritance Law and the Law on Marriage and Families. Provincial authorities should provide assistance in the preparation of paperwork needed for obtaining joint-titled LURCs.

Finally, it should be noted that there is a limitation in estimation method in our study. Although we are seeking to estimate the causal effect of joint land titling, we are fully aware of selection bias. Households with and those without joint-titled LURCs can differ for unobserved variables such as cultural, legislation or linguistic factors. Although we tried to control for a large number of observed variables and district dummies, these unobserved variables might still cause biases. Thus the causal effect of joint land titling in this study should be interpreted with caution. Solving the selection bias requires better methods such as randomized control trials. Addressing this problem is out of scope of our study, but certainly important for the future study.

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8 ANNEX

Tab. 5: Household welfare indicators by LURCs of agricultural lands in 2014 (estimation from VHLSS 2014)

Household welfare indicators	No LURCs	LURCs with only male	LURCs with joint titling	LURCs with only female	Total
Loan from formal bank (thousand VND)	4433.2	3884.7	6428.8	7089.5	5017.7
Loan from informal sources (thousand VND)	1184.3	792.2	845.8	2143.7	982.3
Loan from Bank for Social Policies (thousand VND)	1475.0	1322.6	1434.3	1501.0	1415.5
Share of farm income in total income (%)	37.9	41.6	44.1	31.8	40.9
Share of nonfarm income in total income (%)	14.3	12.6	11.3	14.2	12.8
Share of wages in total income (%)	36.5	33.1	32.8	42.7	34.4
Share of other income in total income (%)	11.3	12.7	11.8	11.3	11.9
Real per capita expenditure (thousand VND)	7188.0	8007.5	8510.1	8676.2	7929.4
Poverty rate (%)	21.2	14.9	14.2	10.1	16.6

Tab. 6: Household welfare indicators by LURCs of residential lands (estimation from VHLSS 2014)

Household welfare indicators	No LURCs	LURCs with only male	LURCs with joint titling	LURCs with only female	Total
Loan from formal bank (thousand VND)	2551.3	4085.6	6651.2	5941.8	4868.8
Loan from informal sources (thousand VND)	1215.3	813.0	1170.6	1742.9	1100.6
Loan from Bank for Social Policies (thousand VND)	1260.2	1097.0	936.2	854.0	1059.3
Share of farm income in total income (%)	27.6	30.8	25.9	12.7	27.2
Share of nonfarm income in total income (%)	17.1	15.8	18.8	22.4	17.7
Share of wages in total income (%)	45.4	39.9	42.8	52.9	43.0
Share of other income in total income (%)	9.8	13.6	12.5	12.0	12.1
Real per capita income (thousand VND)	9264.3	10397.1	11870.1	13350.0	10861.0
Real per capita expenditure (thousand VND)	8484.5	9291.7	11107.0	11202.4	9938.3
Poverty rate (%)	18.6	12.0	9.2	5.4	12.2

Tab. 7: OLS regression of land titling

Explanatory variables	Dependent variable is 'land plot with titling' (estimated using the full sample of land plots)			Dependent variable is 'land plot with joint titling' (estimated using the sample of land plots in households with married household heads)		
	All land plots	Agricultural land plot	Residential land plot	All land plots	Agricultural land plot	Residential land plot
Annual crop land (yes = 1, no = 0)	Reference					
Perennial crop land (yes = 1, no = 0)	0.0366**	0.0209		0.0222	0.0023	
	(0.0161)	(0.0163)		(0.0213)	(0.0231)	
Forestry land (yes = 1, no = 0)	−0.0707***	0.0102		−0.0712**	−0.1140***	
	(0.0224)	(0.0235)		(0.0284)	(0.0297)	
Aquaculture surface (yes = 1, no = 0)	−0.1425***	−0.1570***		0.0477	0.0410	
	(0.0244)	(0.0233)		(0.0342)	(0.0347)	
Residential land (yes = 1, no = 0)	0.0875***			0.1106***		
	(0.0114)			(0.0158)		
Ethnic minorities (yes = 1, Kinh = 0)	−0.0213	0.0108	−0.0644***	0.0709*	0.0863**	0.0144
	(0.0213)	(0.0248)	(0.0214)	(0.0367)	(0.0434)	(0.0319)
Gender of household head (male = 1, female = 0)	0.0077	−0.0013	0.0073	0.0506*	0.0454	0.0566**
	(0.0125)	(0.0179)	(0.0126)	(0.0282)	(0.0448)	(0.0253)
Age of household head	0.0234***	0.0236***	0.0207***	−0.0090	−0.0131*	−0.0020
	(0.0027)	(0.0037)	(0.0028)	(0.0056)	(0.0076)	(0.0051)
Age of household head squared	−0.0002***	−0.0002***	−0.0001***	0.0001*	0.0001*	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0000)
Head with less than primary education	Reference					
Head with primary education	0.0453***	0.0412**	0.0471***	−0.0099	−0.0021	−0.0231
	(0.0152)	(0.0194)	(0.0152)	(0.0277)	(0.0342)	(0.0247)
Head with lower-secondary education	0.0428***	0.0320	0.0584***	0.0035	0.0272	−0.0305
	(0.0156)	(0.0201)	(0.0162)	(0.0292)	(0.0362)	(0.0258)
Head with upper-secondary education	0.0438*	0.0425	0.0555**	−0.0228	−0.0174	−0.0295
	(0.0225)	(0.0309)	(0.0217)	(0.0381)	(0.0490)	(0.0333)
Head with technical degree	0.0289	−0.0064	0.0789***	−0.0143	−0.0273	−0.0164
	(0.0210)	(0.0299)	(0.0208)	(0.0384)	(0.0529)	(0.0321)
Head with post-secondary education	0.0829***	0.0342	0.1206***	0.0622	0.0902	0.0255
	(0.0249)	(0.0488)	(0.0232)	(0.0451)	(0.0837)	(0.0369)
Log of per capita expenditure	0.0671***	0.0688***	0.0534***	0.0506**	0.0580**	0.0361*
	(0.0117)	(0.0165)	(0.0107)	(0.0200)	(0.0272)	(0.0187)
Proportion of older people in household	0.0378	0.0053	0.0694***	−0.1483***	−0.1897***	−0.0817*
	(0.0252)	(0.0347)	(0.0243)	(0.0503)	(0.0642)	(0.0462)
Proportion of children in household	−0.2166***	−0.2626***	−0.1495***	0.0836	0.0896	0.0631
	(0.0358)	(0.0482)	(0.0347)	(0.0603)	(0.0794)	(0.0541)
Household size	0.0283***	0.0269***	0.0295***	−0.0082	−0.0085	−0.0067
	(0.0040)	(0.0052)	(0.0039)	(0.0071)	(0.0088)	(0.0064)
Log of land areas	0.0018	−0.0437***	0.0520***	0.0250***	0.0414***	−0.0160*
	(0.0039)	(0.0053)	(0.0056)	(0.0059)	(0.0086)	(0.0088)
Urban areas (urban = 1, rural = 0)	−0.0350**	−0.0151	−0.0106	0.0428*	−0.0077	0.0429*
	(0.0146)	(0.0245)	(0.0148)	(0.0258)	(0.0416)	(0.0236)
Red River Delta	Reference					
North East	0.1963***	0.2371***	0.0891***	−0.0432	−0.0195	−0.0853**
	(0.0212)	(0.0266)	(0.0191)	(0.0396)	(0.0476)	(0.0333)
North West	0.1263***	0.1958***	0.0015	−0.2334***	−0.2422***	−0.1921***
	(0.0349)	(0.0396)	(0.0350)	(0.0562)	(0.0640)	(0.0529)
North Central Coast	0.0741***	0.0973***	0.0452**	0.0940**	0.1010**	0.0928***
	(0.0239)	(0.0318)	(0.0207)	(0.0391)	(0.0505)	(0.0330)
South Central Coast	0.0854***	0.1482***	−0.0079	−0.0246	−0.0362	0.0032
	(0.0236)	(0.0300)	(0.0225)	(0.0389)	(0.0498)	(0.0337)
Central Highlands	0.0516*	0.1281***	0.0228	0.1842***	0.1925***	0.1787***
	(0.0273)	(0.0373)	(0.0266)	(0.0396)	(0.0557)	(0.0359)
Southeast	0.0700***	0.2623***	−0.0020	0.0044	0.0399	−0.0467
	(0.0220)	(0.0359)	(0.0233)	(0.0367)	(0.0612)	(0.0362)
Mekong River Delta	0.1381***	0.3484***	−0.0023	−0.1891***	−0.1901***	−0.2213***
	(0.0177)	(0.0255)	(0.0183)	(0.0319)	(0.0444)	(0.0291)
Constant	−0.9371***	−0.6820***	−0.8630***	−0.0113	−0.0991	0.3165
	(0.1382)	(0.1905)	(0.1369)	(0.2535)	(0.3460)	(0.2359)
Observations	24,811	15,963	8,848	14,543	9,153	5,390
R-squared	0.100	0.122	0.103	0.064	0.064	0.060

Note: Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Tab. 8: Regression of household-level dependent variables on joint-titled LURCs of agricultural land

Explanatory variables	Log of formal credit (thousand VND)	Log of informal credit (thousand VND)	Log of micro-credit (thousand VND)	Share of farm income in household total income	Share of non-farm income in household total income	Share of wage income in household total income	Share of income from other sources in household total income	Log of per capita expenditure
Joint titling in agricultural land	0.1091	−0.0193	−0.0579	0.0032	0.0037	−0.0086	0.0018	0.0161*
	(0.1136)	(0.0825)	(0.0843)	(0.0061)	(0.0053)	(0.0061)	(0.0045)	(0.0097)
Household head is male	0.2782	−0.2076	−0.1168	0.0548***	0.0203***	−0.0481***	−0.0271***	−0.0136
	(0.1784)	(0.1297)	(0.1324)	(0.0075)	(0.0065)	(0.0076)	(0.0056)	(0.0120)
Age of household head	0.0048	−0.0657***	0.0125	0.0031***	−0.0020**	−0.0052***	0.0041***	0.0112***
	(0.0264)	(0.0192)	(0.0196)	(0.0010)	(0.0009)	(0.0011)	(0.0008)	(0.0017)
Squared age of household head	−0.0001	0.0005***	−0.0002	−0.0000***	0.0000	0.0000***	−0.0000	−0.0001***
	(0.0003)	(0.0002)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Household head is married	−5.5814	1.9514	0.1047	0.0040	0.0122	−0.0131	−0.0032	−0.0132
	(3.8593)	(2.8051)	(2.8642)	(0.0326)	(0.0284)	(0.0330)	(0.0242)	(0.0523)
Head with less than primary education	Reference							
Head with primary education	−0.0002	−0.0593	−0.0807	−0.0162***	0.0131***	−0.0047	0.0078**	0.0935***
	(0.1198)	(0.0871)	(0.0889)	(0.0050)	(0.0043)	(0.0050)	(0.0037)	(0.0080)
Head with lower-secondary education	0.0738	−0.1305	0.0651	−0.0348***	0.0171***	0.0062	0.0114***	0.1559***
	(0.1350)	(0.0982)	(0.1002)	(0.0056)	(0.0049)	(0.0057)	(0.0042)	(0.0090)
Head with upper-secondary education	0.3414*	−0.0800	−0.0347	−0.0632***	0.0353***	0.0101	0.0178***	0.2220***
	(0.1864)	(0.1355)	(0.1383)	(0.0078)	(0.0068)	(0.0079)	(0.0058)	(0.0125)
Head with technical degree	0.5682***	−0.3746***	0.1009	−0.1220***	0.0336***	0.0451***	0.0433***	0.3030***
	(0.1827)	(0.1328)	(0.1356)	(0.0082)	(0.0072)	(0.0084)	(0.0061)	(0.0132)
Head with post-secondary education	0.2136	0.0666	−0.2760	−0.1531***	−0.0290**	0.1437***	0.0384***	0.4232***
	(0.3190)	(0.2318)	(0.2367)	(0.0141)	(0.0122)	(0.0142)	(0.0104)	(0.0226)
Spouse with less than primary education	Reference							
Spouse with primary education	−0.0761	−0.0771	−0.0269	−0.0093*	0.0097**	−0.0093*	0.0089**	0.0617***
	(0.1170)	(0.0850)	(0.0868)	(0.0049)	(0.0043)	(0.0050)	(0.0037)	(0.0079)
Spouse with lower-secondary education	0.0201	−0.0667	−0.1529	−0.0079	0.0193***	−0.0138**	0.0023	0.1095***
	(0.1392)	(0.1012)	(0.1033)	(0.0059)	(0.0051)	(0.0059)	(0.0044)	(0.0094)
Spouse with upper-secondary education	0.0774	−0.2065	−0.1707	−0.0356***	0.0435***	−0.0083	0.0004	0.1737***
	(0.2148)	(0.1561)	(0.1594)	(0.0089)	(0.0078)	(0.0090)	(0.0066)	(0.0143)
Spouse with technical degree	0.2002	−0.3578**	−0.3499**	−0.1346***	−0.0020	0.1208***	0.0157**	0.3081***
	(0.2307)	(0.1677)	(0.1712)	(0.0102)	(0.0089)	(0.0103)	(0.0076)	(0.0164)
Spouse with post-secondary education	0.5688	−0.2904	−1.1611***	−0.1590***	−0.0568***	0.2367***	−0.0209*	0.4569***
	(0.3530)	(0.2566)	(0.2620)	(0.0156)	(0.0136)	(0.0158)	(0.0115)	(0.0250)
Urban area	−0.2825*	−0.1002	−0.2873**	−0.0759***	0.0737***	0.0077	−0.0055	0.0873***
	(0.1678)	(0.1219)	(0.1245)	(0.0094)	(0.0082)	(0.0096)	(0.0070)	(0.0152)
Ethnic minorities	−0.3600**	−0.2039	0.3192**	0.0339***	−0.0462***	0.0068	0.0055	−0.2338***
	(0.1824)	(0.1326)	(0.1354)	(0.0086)	(0.0075)	(0.0087)	(0.0064)	(0.0138)
Household size	0.1059***	0.0651***	0.0179	−0.0210***	0.0084***	0.0273***	−0.0147***	−0.0720***
	(0.0296)	(0.0215)	(0.0220)	(0.0012)	(0.0011)	(0.0012)	(0.0009)	(0.0020)
Proportion of children below 15	−0.1373	−0.1761	−0.0085	0.0925***	−0.0128	−0.1001***	0.0203**	−0.5185***
	(0.2626)	(0.1909)	(0.1949)	(0.0108)	(0.0094)	(0.0110)	(0.0080)	(0.0174)
Proportion of people above 60	−0.9013***	−0.5059***	−0.6851***	0.0321***	−0.0281***	−0.1774***	0.1735***	−0.1398***
	(0.2585)	(0.1879)	(0.1918)	(0.0112)	(0.0098)	(0.0114)	(0.0083)	(0.0180)
Log of agricultural land areas	0.2341***	−0.0692**	−0.0974***	0.1243***	−0.0298***	−0.0749***	−0.0197***	0.0779***
	(0.0455)	(0.0330)	(0.0337)	(0.0020)	(0.0018)	(0.0020)	(0.0015)	(0.0032)
Constant	5.2382	1.8836	1.9689	−0.4542***	0.3408***	0.9412***	0.1722***	7.3992***
	(3.9408)	(2.8643)	(2.9246)	(0.0446)	(0.0388)	(0.0452)	(0.0331)	(0.0716)
Observations	11,121	11,121	11,121	21,558	21,558	21,558	21,558	21,558
R-squared	0.265	0.241	0.277	0.599	0.327	0.440	0.420	0.769

Notes: Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Source: Estimation from VHLSS 2002, 2004, 2008 and 2014.

Tab. 9: Regression of household-level dependent variables on joint-titled LURCs of residential land

Explanatory variables	Log of formal credit (thousand VND)	Log of informal credit (thousand VND)	Log of micro-credit (thousand VND)	Share of farm income in household total income	Share of non-farm income in household total income	Share of wage income in household total income	Share of income from other sources in household total income	Log of per capita expenditure
Joint titling in residential land	0.3008*** (0.1062)	0.1733** (0.0799)	−0.0843 (0.0798)	0.0041 (0.0074)	0.0177** (0.0090)	−0.0153 (0.0101)	−0.0064 (0.0062)	0.0247** (0.0122)
Household head is male	0.0734 (0.1366)	−0.0855 (0.1086)	−0.0807 (0.0912)	0.0467*** (0.0082)	0.0095 (0.0130)	−0.0421*** (0.0140)	−0.0141* (0.0078)	−0.0015 (0.0169)
Age of household head	−0.0029 (0.0251)	−0.0315* (0.0167)	0.0081 (0.0186)	0.0057*** (0.0019)	0.0006 (0.0020)	−0.0074*** (0.0023)	0.0011 (0.0017)	0.0078*** (0.0030)
Squared age of household head	−0.0000 (0.0002)	0.0001 (0.0001)	−0.0001 (0.0002)	−0.0001*** (0.0000)	−0.0000 (0.0000)	0.0001*** (0.0000)	0.0000 (0.0000)	−0.0001* (0.0000)
Household head is married	−6.2921*** (1.0541)	1.3148 (0.8396)	0.3746 (0.3952)	−0.1356 (0.2257)	0.3344*** (0.0674)	−0.2418 (0.2128)	0.0431 (0.0557)	−0.2400 (0.6086)
Head with less than primary education	Reference							
Head with primary education	0.0698 (0.1353)	-0.2304** (0.0978)	-0.1090 (0.1030)	-0.0101 (0.0104)	0.0371*** (0.0097)	-0.0156 (0.0112)	-0.0113 (0.0075)	0.0888*** (0.0145)
Head with lower-secondary education	0.0129 (0.1500)	-0.3143*** (0.1115)	-0.0452 (0.1170)	-0.0259** (0.0111)	0.0285** (0.0113)	0.0036 (0.0127)	-0.0062 (0.0082)	0.1563*** (0.0162)
Head with upper-secondary education	0.1435 (0.1874)	-0.1746 (0.1470)	-0.1978 (0.1356)	-0.0651*** (0.0134)	0.0602*** (0.0164)	-0.0028 (0.0173)	0.0078 (0.0108)	0.2671*** (0.0209)
Head with technical degree	0.1594 (0.1874)	-0.3738*** (0.1414)	0.0825 (0.1388)	-0.1228*** (0.0125)	0.0426*** (0.0145)	0.0941*** (0.0163)	-0.0139 (0.0106)	0.3026*** (0.0204)
Head with post-secondary education	0.0930 (0.2270)	-0.3594** (0.1711)	-0.2499* (0.1475)	-0.1081*** (0.0142)	-0.0761*** (0.0184)	0.2233*** (0.0206)	-0.0392*** (0.0127)	0.4261*** (0.0265)
Spouse with less than primary education	Reference							
Spouse with primary education	−0.1221 (0.1316)	0.0357 (0.0936)	−0.0376 (0.0999)	0.0037 (0.0097)	0.0040 (0.0096)	−0.0022 (0.0109)	−0.0055 (0.0072)	0.0709*** (0.0144)
Spouse with lower-secondary education	−0.0736 (0.1525)	−0.0116 (0.1125)	−0.2536** (0.1154)	−0.0012 (0.0108)	0.0109 (0.0117)	−0.0039 (0.0130)	−0.0058 (0.0083)	0.1147*** (0.0168)
Spouse with upper-secondary education	0.0972 (0.2063)	−0.2321 (0.1535)	−0.2219 (0.1487)	−0.0366*** (0.0135)	0.0464** (0.0182)	−0.0081 (0.0191)	−0.0017 (0.0112)	0.1992*** (0.0237)
Spouse with technical degree	−0.0521 (0.2060)	−0.1378 (0.1696)	−0.4710*** (0.1565)	−0.0876*** (0.0130)	−0.0321* (0.0171)	0.1329*** (0.0190)	−0.0133 (0.0123)	0.2929*** (0.0240)
Spouse with post-secondary education	0.0262 (0.2450)	−0.3804** (0.1812)	−0.6853*** (0.1550)	−0.0902*** (0.0141)	−0.0899*** (0.0199)	0.1967*** (0.0225)	−0.0166 (0.0133)	0.3861*** (0.0290)
Urban area	−0.1945 (0.1530)	0.0449 (0.1000)	−0.3831*** (0.1002)	−0.1527*** (0.0103)	0.1357*** (0.0125)	0.0027 (0.0130)	0.0143* (0.0077)	0.1336*** (0.0162)
Ethnic minorities	−0.5204** (0.2205)	−0.2522* (0.1517)	0.4266** (0.1731)	0.0938*** (0.0152)	−0.0962*** (0.0134)	−0.0046 (0.0159)	0.0070 (0.0094)	−0.2845*** (0.0219)
Household size	0.1292*** (0.0328)	0.0397* (0.0238)	0.0273 (0.0234)	−0.0081*** (0.0022)	−0.0004 (0.0024)	0.0321*** (0.0028)	−0.0237*** (0.0018)	−0.0746*** (0.0036)
Proportion of children below 15	−0.2853 (0.2750)	0.0643 (0.2120)	−0.2289 (0.2052)	0.0469** (0.0189)	0.0285 (0.0224)	−0.0958*** (0.0245)	0.0204 (0.0147)	−0.4972*** (0.0306)
Proportion of people above 60	−0.9904*** (0.2293)	−0.1081 (0.1492)	−0.5499*** (0.1667)	−0.0111 (0.0194)	−0.0382** (0.0190)	−0.1364*** (0.0219)	0.1856*** (0.0193)	−0.2345*** (0.0308)
Log of residential land areas	0.1866*** (0.0490)	−0.0320 (0.0346)	−0.0274 (0.0336)	0.0590*** (0.0034)	−0.0301*** (0.0038)	−0.0291*** (0.0041)	0.0002 (0.0025)	0.0516*** (0.0055)
Constant	6.8456*** (1.2965)	1.1266 (0.9931)	1.1375* (0.6846)	0.0780 (0.2322)	−0.0140 (0.0893)	0.8563*** (0.2233)	0.0797 (0.0706)	8.5186*** (0.6145)
Observations	9,648	9,648	9,648	9,648	9,648	9,648	9,648	9,648
R-squared	0.255	0.227	0.261	0.542	0.289	0.387	0.379	0.796

Notes: Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Source: Estimation from VHLSS 2004 and 2014.

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CONSUMERS' ACCEPTANCE OF ONLINE GROCERY SHOPPING IN A PANDEMIC SITUATION: AN EXTENDED TECHNOLOGY ACCEPTANCE MODEL PERSPECTIVE

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ABSTRACT

This study aims to understand the mechanisms of consumers' online grocery shopping (OGS) acceptance in the current COVID-19 pandemic. Through this perspective, an extended technology acceptance model is employed by including the fear of COVID-19 factor to reveal the extent of the Turkish consumers' acceptance of OGS. We have tested the proposed research model on 455 survey participants living in various cities of Turkey. Structural equation modeling is employed to test the eleven research hypotheses. The results indicate that perceived ease of use, perceived usefulness, and attitude are valid predictors of OGS acceptance. Besides, the fear of COVID-19 negatively moderates these relationships. By revealing these empirical results, this study provides some useful insights into our understanding of the acceptance mechanisms of OGS processes in a pandemic situation. We hope to pinpoint the underlying reasons for the vast expansion of OGS among Turkish customers in pandemic times.

KEY WORDS

online grocery shopping, technology adoption, technology usage, e-TAM, fear, COVID-19

JEL CODES

M10, M31

1 INTRODUCTION

The online grocery shopping (OGS) market has been growing steadily on a global scale, particularly within the last decade and has reached USD 134.998 billion in 2019 (Globe Newshire, 2020). According to the same report, the main reason for this growth stems mainly from increasing technological advances, convenience to shopping online, product variety availability, and saving in cost and time. According to recent Nielsen data, on a global scale, half of the online consumers believe that choosing online channels for grocery shopping is

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convenient and saves time (Singh, 2017). Apart from these reasons for consumers to prefer OGS, several other research perspectives have been adopted to understand consumer OGS behavior, including the theories of Reasoned Action and Planned Behavior (Hansen et al., 2004; Hansen, 2005), Motivation-Opportunity-Ability Model (Van Droogenbroeck and Van Hove, 2017), the technology acceptance model (TAM) (Sreeram et al., 2017; Loketkrawee and Bhatiasevi, 2018; Driediger and Bhatiasevi, 2019) and the Attitude Theory (Brand et al., 2020). These research perspectives explain consumer behavior regarding OGS with sound theoretical foundations. However, literature also suggests that situational factors (such as developing health problems) also play a role as a trigger for buying groceries online (Robinson et al., 2007; Hand et al., 2009). As an emerging actor, we consider the novel COVID-19 outbreak as a potential situational factor, which creates a research gap that needs to be addressed. Accordingly, we used an extended technology acceptance model (e-TAM) as the theoretical foundation for understanding the consumers' adoption of OGS technology. These constructs need to be understood thoroughly to gain better consumer insights and their OGS behavior.

Although many recent studies in OGS behavior used TAM as their theoretical framework (Loketkrawee and Bhatiasevi, 2018; Bauerová and Klepek, 2018; Driediger and Bhatiasevi, 2019), none of them included fear of COVID-19 construct in their research model due to the timing of the pandemic. Therefore, the current study offers a unique perspective on the recent OGS behavior under the conditions of the COVID-19 outbreak. There are many sound reasons for us to adopt the COVID-19 effect (particularly Fear of COVID-19) to be an influential factor in understanding consumers' OGS behavior. Firstly, the COVID-19 outbreak has been affecting people's lives on a global scale in various ways. As the World Health Organization declared COVID-19 a pandemic as of March 2020, many countries practiced various restrictions like lockdown, travel restrictions, closure of businesses and schools, all of which negatively affected the global economy. The economic damage is driven mainly by a fall in consumer demand, which is expected to lead to a 4.5% decrease in the global GDP (Statista, 2020). Therefore, many sectors are negatively affected by the COVID-19, such as tourism, automotive, transportation.

However, the consequences of economic contraction have not been experienced negatively for all industries. Remarkably, the grocery shopping market could be regarded as one of these rare sectors. There was even a temporary supply problem in certain products such as toilet paper due to consumers' stockpiling behavior. Simultaneously, there has been an increasing shift in consumer behavior from store visits to online shopping, aiming to reduce face-to-face interaction to prevent viral infection (UN, 2020). Consequently, it is seen that online channel preferences in grocery shopping particularly have increased significantly during the COVID-19 period, mostly due to the safe characteristics of online channels to meet basic human needs (Gorman, 2020).

The situation for the Turkish market is similar to global trends. In the first period of 2020, Turkey's e-commerce volume has risen 64% compared to the same period of 2019 by reaching USD 14.2 billion (Şahin, 2020). Significant growth was experienced in grocery shopping by far apart from all the other online retailing branches. According to the Turkish Ministry of Commerce data, OGS increased by 434% in the first six months of 2020 by reaching USD 244.90 million (Yağcı, 2020). Even local grocery shops started to operate their online channels after the pandemic began, which is entirely new for the Turkish market. Considering it is a current situation, it might be regarded as an opportunity for marketing professionals to understand the mechanisms of consumers' OGS behavior and create valuable consumer insights.

Before the COVID-19 era, although in a much lower percentage, OGS was already steadily growing in the Turkish market. Online grocery brands target mostly young, educated, tech-friendly customers who do not have sufficient time to visit the shops (Retail Türkiye, 2019). Today those businesses are offering their services to a much wider range of consumers.

This situation can also be regarded as another research gap considering the extraordinary situation caused by COVID-19. Additionally, Studies in the literature regarding OGS have been conducted in different countries. However, as Driediger and Bhatiasevi (2019) stated in their study, most of the studies subjected to OGS have been conducted in the context of western countries, and there is much need to be done to create insight in terms of consumers' OGS behavior for developing markets, which represent another research gap for our study. Thus, to understand the novel situation and develop a better perspective, the topic needs to be further investigated. Adopting this perspective, this study explores the OGS behavior of Turkish consumers in the COVID-19 era using an e-TAM. In this context, the variables Trust in Retailers and COVID-19 fear were included in the TAM to obtain a better consumer insight. Researching Turkish consumer behavior in the Covid era also has other benefits, such as providing valuable information to grocery business leaders for setting the possible future direction of their industry and changing customer preferences. Fear of COVID-19 construct would also be interesting to study and assess further in future studies.

2 THEORETICAL BACKGROUND AND HYPOTHESES DEVELOPMENT

This study has used an e-TAM to propose a research model for understanding the mechanisms of OGS acceptance in Turkey within the COVID-19 era, as illustrated in Fig. 1.

The research hypotheses and their background arguments have been provided in the following paragraphs.

2.1 Technology Acceptance Model

One of the broadly cited theoretical models in the literature is the TAM by Davis (1989). The model explains individual technology adoption and usage behavior coherently and concisely; that is, it has high explanatory power with a few variables. Hence, it has been popular and cited thousands of times by scholars from various research fields. According to the original model, our technology adoption attitudes are a function of two antecedents as perceived ease of use (PEU) and perceived usefulness (PU), that jointly form our positive or negative attitudes toward specific technologies that in turn shape our intentions to use or not use those technologies (King and He, 2006).

TAM is constructed on the Theory of Reasoned Action (TRA) by Ajzen and Fishbein (1980). TAM's two main antecedents are also rooted in Rogers' Technology Diffusion Theory (Rogers, 1983). TRA and TAM are belief-based theoretical structures that pose a causal relationship between our beliefs – attitudes and intentions – behaviors. Attitude is the outcome of our subjective beliefs for particular behavior as well as the results of our given importance to such beliefs (Moreno-Agudelo and Valencia-Arias, 2017). TAM and TRA aim to explain as well as predict our particular behaviors in a wide variety of contexts which can easily be applied to many research settings and is a well-recognized theoretical framework across different contexts and cultures (Gefen et al., 2003). TAM has been recently applied to numerous research domains such as acceptance of online travel products (Sevim et al., 2017), e-commerce (Dash and Saji, 2008), mobile commerce (Zamil et al., 2020), and online banking (Onyiriuba, 2016). Besides, according to the literature, TAM is found to be the strongest predictor to influence OGS behavior, compared to other independent variables (Loketkrawee and Bhatiasevi, 2018). Thus, we adapted an extended version of the TAM as the theoretical lens for this research.

2.1.1 Perceived Ease of Use and Perceived Usefulness

PEU is defined as users' self-assessment of interacting and using a particular system that would be effortless to use (Davis, 1989). PU

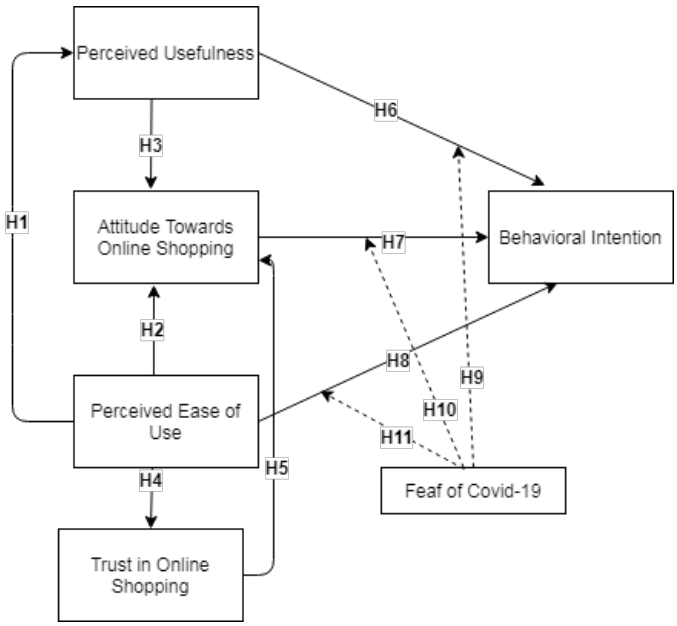

Fig. 1: Research model and hypotheses

means the users' subjective chances of adopting the system in question that would enhance their job performance (Davis et al., 1989). PEU has its roots in intrinsic motivation research. Ease of use is effective when both browsing websites as well as entire Information Systems Use (Chin and Goh, 2017). If a web shopping site is perceived as easier to use by customers, they will probably return to that website for further shopping (Dash and Saji, 2008). Thus, we suggest the following hypothesis.

H_1: PEU positively affects individuals' PU in OGS.

2.1.2 Perceived Ease of Use and Attitude Toward OGS

Attitudes are shaped by our behavioral beliefs, and behavioral beliefs are expected outcomes of our major underlying beliefs like Perceived Usefulness and Perceived Ease of Use. Our positive attitudes coupled with greater and positive intentions will lead us to do online grocery shopping (Bezirgani and Lachapelle, 2021). PEU can easily influence potential and current customers' attitudes to shop and re-shop from a particular online shopping website. In fact, there is a positive association between the PEU of a particular website, especially with online shopping (Zamil et al., 2020). Also, the perceived simplicity of an online shopping website can easily affect how it has been adopted (Pratyaksa, 2015). Therefore, our second hypothesis is:

H_2: PEU positively influences individuals' attitudes toward OGS.

2.1.3 Perceived Usefulness and Attitude Toward OGS

The Internet can easily be regarded as a useful tool, especially for online shopping (Davis, 1989). With online shopping, customers would be relieved from carrying groceries that they bought, looking for a parking space at the supermarkets, waiting in the long queues in front of the cashiers (Kaur, 2018), resulting time, money, and effort savings in the process. The utility has been presented as a most critical construct influencing customers' intentions to shop online (Hausman and Siekpe, 2009; Belanche et al., 2012), which leads us to propose the following hypothesis.

H_3: PU beliefs positively affect individuals' attitudes toward OGS.

2.1.4 Perceived Ease of Use and Trust Toward OGS

Trust can be defined as "the expectation that the trusted party will accomplish the task reliably" (Sitkin and Roth, 1993). Lack of trust in a technical system (i.e., OGS) can act as a potential barrier to the use of the channel (Dahlberg et al., 2003). In the literature, it is emphasized that trust in online channels is even more important in matters that physically affect consumers such as grocery shopping (Citrin et al., 2003), and in this respect, the role of the online retailer in its success is critical (Toufaily et al., 2013). Also, PEU is hypothesized to positively affect trust in the literature (Chinomona, 2013) that in turn significantly plays vital importance in online shopping behavior through our attitudes. Jared Hansen et al. (2018) also found a strong correlation between PEU affecting trust constructs. Therefore, our fourth hypothesis has been proposed as the following:

H_4: PEU positively affects trust in OGS.

2.1.5 Trust and Attitude Toward OGS

In online shopping, establishing trust is an important and necessary prerequisite for successful progress and finalization of real online shopping behavior, given unfortunate cases of customer swindling in some of the past instances. Most consumers feel the need to trust websites before revealing and submitting their financial and credit card information. Hence, we believe that the feeling of trust is much integrated into OGS customers' behavior, and it is one of the most important prerequisites of the progress of OGS. Shadkam et al. (2013) stated that trust is a key element steering users to utilize online shopping platforms. Virtual stores pose greater risks than online stores when considering OGS. Especially existence of online secure payment processing and receiving systems are a must for the trusted and secure online shopping experience.

If customers form trust in a particular website in online shopping, they would indeed develop affirmative attitudes toward that specific site. In several studies, perceived trust has been defined as an important variable influencing attitude (Chen and Tan, 2004; Kim et al., 2008; Ha and Stoel, 2009). Besides, it has been widely acknowledged that trust positively influences individual attitudes toward online shopping. As a result, we offered the following claim with our fifth hypothesis.

H_5: Trust positively affects attitude toward OGS.

2.1.6 Perceived Usefulness and Behavioral Intention

Starting from the original TAM study by Davis (1989), there are many researchers who have been investigated and proved positive and significant effects of PU on the behavioral intention of technology users. Studies of Ha and Stoel (2009), Venkatesh et al. (2003), and Shih (2004) have shown that a relationship could hold true in online shopping, leading to our sixth hypothesis. Perea y Monsuwé et al. (2004) argued that usefulness is the customer's recognition of online shopping and customer's intention to shop online. Davis (1989) indicated that if a specific innovation is helpful, they will form positive perceptions about the system or online platform (Ruangkanjanases et al., 2021). PU is about mostly how innovations could enhance our lives. Hence, we propose that:

H_6: PU positively influences individuals' behavioral intention toward OGS.

2.1.7 Attitude and Behavioral Intention Toward OGS

Intentions are the basis for us to determine people's individual actions, especially in using or not using a particular technology. Individuals commonly use and adopt technologies toward which we have positive attitudes and vice versa for other technologies. Davis (1989) clearly outlined this relationship in his article. Therefore, our seventh hypothesis proposes that:

H_7: Attitude positively affects behavioral intention toward OGS.

2.1.8 Perceived Ease of Use and Behavioral Intention Toward OGS

TAM has roots in two theoretical variables, defining behavioral intention of individuals as PEU and PU in online shopping (Pavlou, 2003; Ahn et al., 2004). PEU influences directly and indirectly via our attitudes to personal

intentions to shop online. Considering this information in the literature, we posit that;

H_8: PEU perceptions of individuals positively affect their behavioral intention toward OGS.

2.2 The Moderating Role of Fear of COVID-19

Fear (Lyon, 2003) and health concerns (Kim and Park, 2012) have certain effects on individuals' consumption behaviors. In a similar vein, it has been known that the COVID-19 outbreak deeply affects the consumption behavior of people by inflicting fear and health concerns. Due to the restrictions and health concerns, consumers have increasingly been looking for safer ways to buy their groceries (Pantano et al., 2020), leading to a dramatic increase in online shopping activities (Chang and Meyerhoefer, 2020). Moreover, the online shopping market is sensitive to the effect of the COVID-19 era to the extent that there was even a correlation between the pandemic's intensity and the increase of online shopping preferences (Grashuis et al., 2020). Within this context, it is essential to consider the fear of COVID-19 in consumers' acceptance of OGS to obtain further insights into the OGS acceptance in the pandemic period. Considering the issue in terms of OGS acceptance, it would normally be reasonable to expect fear of COVID-19 to increase OGS acceptance. However, when the subject is considered in terms of the variables in question when fear of COVID-19 is included in the equation as an important situational factor, it can be expected to make other factors relatively unimportant. Thus, in this study, we consider the fear from COVID-19 as such an important situational factor that might influence the structure of our research model. As we proposed above, attitude, PEU, and PEU are all potentially effective factors in accepting OGS. However, we consider consumers' fear of COVID-19 as a "game-changer," and we expect that it plays a moderating role in a negative way between the behavioral intention and its specified antecedents. We expect that the consumers' health concerns might play a bigger role in our context, and the inclusion of the COVID-19 factor into the equation would make the specified antecedents less important. Consequently, we offer the following hypotheses:

H_9: Consumers' fear of COVID-19 negatively moderates the relationship between PU and behavioral intentions toward OGS. When the fear of COVID-19 is low, the link is positive. However, as the fear of COVID-19 increases, the association becomes negative.

H_{10}: Consumers' fear of COVID-19 negatively moderates the relationship between attitude and behavioral intention toward OGS. When the fear of COVID-19 is low, the link is positive. However, as the fear of COVID-19 increases, the association becomes negative.

H_{11}: Consumers' fear of COVID-19 negatively moderates the relationship between PEU and behavioral intentions toward OGS. When the fear of COVID-19 is low, the link is positive. However, as the fear of COVID-19 increases, the association becomes negative.

3 METHOD

3.1 Sampling and Data Collection Procedures

We gathered the data from the individuals living in Turkey above the age of 15 and shop their groceries by themselves regularly, either using online or offline channels. Research data were collected in the period of October-November 2020 when pandemic restrictions were strictly enforced in Turkey. A questionnaire link was disseminated via the authors' social media networks. Three voucher gifts have been allocated based on a random lottery. We determined the study sample size according to the requirements for the structural equation model (SEM), similar to Wang et al. (2019). The research model in the study had 20 parameters which required a samples size of 400 (20×20). We restricted the questionnaire to be filled only once from the same IP to prevent multiple participation.

All participants who agreed to fill out the questionnaire were included in the database. 455 usable questionnaires (35 were discarded due to inconsistency issues) were obtained, exceeding the recommended minimum sample size requirement.

3.2 Instrument

The online survey method was used in this study to reach the maximum number of participants, considering the extraordinary situation caused by the pandemic. The questionnaire had four main parts. The first part began with a brief explanation containing the research aim, information about the lottery that will be held among the participants, and the average time that the questionnaire was expected to take. The second part consisted of two questions to learn whether the participants had done OGS earlier and, if yes, how often. The next part consisted of Likert-type questions to make it possible to test the research hypotheses. Lastly, the fourth part consisted of questions regarding the demographics of the participants.

3.3 Measurement

All the measures used in this study were drawn from previous research, which of all were quite robust in terms of reliability and validity (see Tab. 2). The 5-point Likert scales were used to measure all of the scale items (1 – Strongly disagree & 5 – Strongly agree). The moderator Fear of COVID-19 was measured using the seven items adapted from Ahorsu et al. (2020). For the components of e-TAM; PEU (4 items) and behavioral intention (4 items) were adapted from Driediger and Bhatiasevi (2019), while PU (2 items) were taken from Davis (1987). As the measures for the other components of e-TAM, while attitude toward OGS (3 items) was adopted from Bauerová and Klepek (2018), trust in OGS (4 items) were adopted from Lee and Turban (2001). The questionnaire form was designed in English and then translated into Turkish by two academics fluent in both languages by following the method outlined by Brislin (1970) through the back-translation procedure.

3.4 Common Method Bias

Because of the self-reported characteristic of the survey, method variance could be a potential problem. Therefore, the common method bias issue was attempted to be minimized by the authors. Firstly, the questionnaire was designed by adhering to the suggestions of MacKenzie and Podsakoff (2012). In this regard, a pilot test was conducted with 28 academics to see whether they were experiencing any problems understanding the questions. The questionnaire was reassessed accordingly, also by discussing with the translators. The questionnaire was also divided into different parts to reduce the single source bias, as Podsakoff et al. (2003) suggested.

Moreover, to reduce the effects of social desirability, an introduction section was added to the questionnaire to enable the respondents to understand the research purposes clearly. Lastly, to test common method bias, Harman's (1967) test of one-factor was performed as a further post hoc test by SPSS. The results indicated that the first factor explained 33.7% of the variance in the data, which was lower than the suggested 50% cutoff criteria, which reveals a lack of common method bias (Podsakoff et al., 2003).

4 DATA ANALYSIS AND RESULTS

4.1 Sample Characteristics

Tab. 1 present the main demographic characteristics of the study sample. The sample of 455 participants is nearly equally composed of males (50.5%) and females (49.5%). There are more than 90 people for each age group, except the participants more than 51 years old, representing heterogeneity for the age distribution of our sample. More than 53% of the participants are below the age of 30, and most of the respondents (61%) have at least one

bachelor's degree. Also, more than 22% have graduate degrees. Lastly, more than half of the respondents (60%) stated that they live with three or more people in a family.

Tab. 1: Demographic characteristics of participants ($N = 455$)

Respondent characteristics		Frequency	Percent
Age	15–20 years	105	23.1
	21–30 years	135	29.7
	31–40 years	90	19.8
	41–50 years	106	23.3
	51+ years	19	4.1
Gender	Male	230	50.5
	Female	225	49.5
Education	Secondary School	39	8.6
	High School	97	21.3
	College	42	9.2
	Bachelors	175	38.5
	Postgraduate	102	22.4
Living/w	Alone	35	7.7
	1 person	60	13.2
	2 people	88	19.3
	3 people	129	28.4
	4+ people	143	31.4

Additionally, the results of the two questions asked to reveal the participants' OGS experiences in detail have revealed that 72% of the respondents had already used OGS at least once before. While 51% of them stated that they had started using OGS before the pandemic, 21% started to use it only after the pandemic began. It seems OGS has been common among our Turkish sample, yet a quite significant number of participants started to use OGS the first time after the pandemic.

4.2 Measurement Model

We run the confirmatory factor analysis (CFA) with AMOS 21 to determine the validity and reliability scores of the research constructs. The measurement model demonstrates an acceptable-good fit: $\chi^2/\text{df} = 2.203$, $p < 0.01$; root mean square error of approximation (RMSEA) = 0.051; goodness of fit index (GFI) = 0.932; comparative fit index (CFI) = 0.969; Tucker-Lewis index (TLI) = 0.962; based on the suggestions in the literature (Browne and Cudeck, 1993; Hu and Bentler, 1999; Hair et al., 2010). Regarding CFA results, the AVE and CR values were above the threshold levels (0.5 and 0.7, respectively). The CR of the constructs ranged from 0.856 to 0.913, while the AVE values ranged from 0.647 to 0.753, as shown in Tab. 2. Additionally, the item loadings ranged from 0.748 to 0.931, all statistically significant at the 0.99 level ($p < 0.01$ for all the items), hence we can ensure the variables' convergent validity (Hair et al., 2010).

Discriminant validity was assessed adopting the perspective of Fornell and Larcker (1981). As represented in Tab. 3, all the AVE values are larger than the MSV (maximum shared variance) values. Also, all AVE values are bigger than the square of latent variables' correlations, ensuring the discriminant validity of variables. Results establish the soundness of the measures used in this study, thus enabling their usage in the stage of hypothesis testing.

4.3 Main Effect Analysis

A structural equation modeling (SEM) was undertaken using AMOS 21 to test direct effects. The proposed model had an acceptable fit ($\chi^2/\text{df} = 2.736$, $p < 0.01$; CFI = 0.967, TLI = 0.958, GFI = 0.933, RMSEA = 0.062).

Tab. 4 presents the analysis results of the research hypotheses. We can see that consumers' PEU significantly affects their PU of OGS ($\beta = 0.458$, $p < 0.01$), thus supporting H_1. Also, PEU was found to be positively affecting attitude toward OGS – at a 90% significance level ($\beta = 0.563$, $p < 0.01$), "partially" supporting H_2. PEU also positively affects attitude ($\beta = 0.089$, $p < 0.10$) and trust in OGS ($\beta = 0.556$, $p < 0.01$), supporting H_3 and H_4. Additionally, trust is found to positively affect attitude toward OGS ($\beta = 0.312$, $p < 0.01$), supporting H_5. Lastly, the PU of OGS ($\beta = 0.187$, $p < 0.01$), attitude toward OGS ($\beta = 0.556$, $p < 0.01$), PEU of OGS usage ($\beta = 0.158$, $p < 0.01$) all were found to have significant positive effects on the behavioral intention of OGS, supporting the hypotheses H_6, H_7, and H_8.

Tab. 2: Summary of the measurement model

Construct	Statements	Factor loadings
Fear of COVID-19	I am afraid most from Corona Virus.	0.82
AVE = 0.65; CR = 0.88	I feel uncomfortable in thinking coronavirus.	0.82
MSV = 0.54; $\alpha = 0.89$	I am afraid to lose my life because of coronavirus.	0.79
	When seeing news and stories on coronavirus on social media, I feel stress and worried.	0.79
Trust in Online Shopping	Internet shopping is secure.	0.82
AVE = 0.73; CR = 0.91	In general, Internet shopping sites hold their promises.	0.80
MSV = 0.38; $\alpha = 0.91$	Internet shopping is reliable without any uncertainty.	0.85
	Internet shopping is a secure experience.	0.93
Perceived Ease of Use of OGS	Doing OGS is/might be easy.	0.88
AVE = 0.65; CR = 0.88	Getting experienced in OGS is/might be easy.	0.71
MSV = 0.50; $\alpha = 0.89$	Following the procedures in OGS is/might be easy for me.	0.77
	In general, I believe that doing OGS is easy.	0.87
Attitude	Doing grocery shopping over the web seems attractive for my daily life.	0.87
AVE = 0.75; CR = 0.90	Doing online grocery shopping over the web is/would be pleasant.	0.87
MSV = 0.50; $\alpha = 0.90$	Using a website for grocery shopping is/would be a good idea.	0.86
Perceived Usefulness of OGS	Online grocery shopping enables me to save my time.	0.92
AVE = 0.75; CR = 0.86	Using the website for grocery shopping makes it easier to do my shopping.	0.81
MSV = 0.23; $\alpha = 0.85$		
Behavioral Intention	Whenever possible, I intend to use OGS to purchase groceries.	0.75
AVE = 0.67; CR = 0.86	I intend to use OGS when there is free home delivery.	0.87
MSV = 0.27; $\alpha = 0.85$	I intend to use OGS when the price is competitive.	0.83

Notes: AVE = Average Variance Extracted; CR = Composite Reliability, MSV = Maximum Shared Variance; α = Cronbach's Alpha

Tab. 3: Correlation matrix for the constructs of the study

	1	2	3	4	5	6
1 Fear of COVID-19	1					
2 Trust	0.002	1				
3 Ease of Use	0.048	0.331	1			
4 Behavioral Intention	0.054	0.096	0.259	1		
5 Attitude	0.033	0.381	0.497	0.273	1	
6 Perceived Usefulness	0.047	0.094	0.234	0.139	0.082	1

Note: Values in the table represent the square of latent variables' correlations.

Tab. 4: Structural model hypothesis test results

Hypothesis	β	t-value	Result
Direct effects			
H_1	0.458***	8.674	Supported
H_2	0.563***	9.547	Supported
H_3	0.089*	1.803	Partially Supported
H_4	0.556***	12.213	Supported
H_5	0.328***	6.496	Supported
H_6	0.187***	3.398	Supported
H_7	0.312***	4.672	Supported
H_8	0.158***	2.140	Supported
Moderating effects			
H_9	−0.166***	−4.093	Supported
H_{10}	−0.120**	−3.164	Supported
H_{11}	−0.110**	−2.465	Supported

Note: * = $p < 0.10$; ** = $p < 0.05$; *** = $p < 0.01$.

4.4 Moderation Analysis

We assessed the moderating effects of Fear of COVID-19 using PROCESS macro, considering this method is more sophisticated in terms of operationalization of moderating-mediating effects compared to SEM (Hayes et al., 2017) via IBM SPSS 21. Based on the results, it was seen that consumers' fear of COVID-19 moderates the relationships between PU and behavioral intentions toward OGS: $F(3, 451) = 28.627$, $\Delta R^2 = 0.031$, $\beta = -0.166$, $p < 0.01$ supporting H_9; attitude and behavioral intention toward OGS: $F(3, 451) = 46.886$, $\Delta R^2 = 0.017$, $\beta = -0.120$, $p = 0.02$ supporting H_{10}; and lastly, PEU and behavioral intention toward OGS: $F(3, 451) = 34.221$, $\beta = -0.110$, $\Delta R^2 = 0.011$, $p = 0.014$ supporting H_{11}. Hence, all moderating relationships have been statistically supported.

5 DISCUSSION

Explaining the adoption of online shopping using TAM is a popular research field in the marketing literature. However, only a few studies specifically focused on the acceptance of OGS (e.g., Loketkrawee and Bhatiasevi, 2018; Driediger and Bhatiasevi, 2019). This study supports the idea of using the e-TAM framework to explain the acceptance of OGS. Adopting this perspective, we extended the TAM by including two variables to the research model, which are trust and fear of COVID-19. The inclusion of trust into the TAM is well supported in the literature (e.g., Dhagarra et al., 2020). It is also known from the literature that situational factors might also have an effect on the acceptance of OGS. This study includes an emerging situational factor, fear of the COVID-19 variable as a moderator in the acceptance of OGS. Since the day it was first seen over a year ago, COVID-19 has caused significant changes in people's consumption habits, as in many other issues. One of these significant changes has been observed in OGS with an excessive preference over store visiting. This situation creates a research opportunity to understand the pandemic process, which is thought to play an important role in accepting OGS by consumers. Adopting this perspective, this study's main objective was to empirically reveal the consumers' OGS acceptance mechanisms in the pandemic era using the e-TAM as a theoretical lens. To reach this objective, eleven hypotheses were proposed and tested via aSEM. The results obtained are discussed below respectively.

The current study is also among the first studies in Turkish literature to contribute OGS behavior of individuals by employing the TAM framework under COVID-19 pandemic conditions. Also, we incorporated the fear of COVID-19 in our empirical model that is also among one of the few studies in international OGS literature that we know of. Hence, we introduce unique perspectives from southeast Mediterranean customers and shed light on Turkish customers' novel shopping habits and preferences in emerging online shopping areas under pandemic conditions with the addition of a less used construct of fear of COVID-19. Hence, we hope the insights gained from this current study would provide valuable feedback

to politicians as well as managers of respective organizations in setting up their strategies, policies and directions for the industry as well as the particular firms.

The certain positive influence of consumers' PEU on PU toward OGS (H_1) is supported in this study, meaning that consumers who think that OGS is easy to use also perceive it as useful. Although there are studies in the literature that propose a reverse relationship between those two constructs (Loketkrawee and Bhatiasevi, 2018), the results we obtain in this study are congruent with the original TAM model (Davis, 1987), which is also supported in other studies (Bauerová and Klepek, 2018).

The positive effect of PEU on attitude toward OGS is also supported (H_2). This result suggests that consumers who consider OGS to be easy also gain positive attitudes toward it. There are contradictory findings in the literature regarding this relationship. While some studies reveal a significant relationship between two variables (Chien et al., 2003; Loketkrawee and Bhatiasevi, 2018), some did not (Bauerová and Klepek, 2018). Our findings empirically support the positive relationship between the two constructs in the context of OGS.

The relationship between PU and attitudes showed a significant effect, thus supporting H_3. This result suggests that consumers who consider OGS as a useful instrument also gain positive attitudes toward it. Yet, it seems natural for us to shop online in the pandemic era rather than mere performance enhancement or time and effort gains, which is also consistent with the literature (Chien et al., 2003; Loketkrawee and Bhatiasevi, 2018).

The positive effect of PEU on trust is supported (H_4), meaning consumers who find OGS easy to use, also develop trust in it. The relationship between trust and attitude also presented a positive effect, which verifies H_5. This result suggests that consumers who developed trust toward OGS also gain positive attitudes toward it. Considering that there is no research found in the literature investigating these relationships in the OGS context, these results contribute to the literature by revealing these effects between the OGS antecedents.

Lastly, the positive effects of PU (H_6), attitude (H_7), and PEU (H_8) on the behavioral intention of OGS are all supported. These results suggest that consumers who found OGS useful and easy to use and grew positive attitudes toward it tend to use it in their OGS. Especially, PU was found to be the most influential variable on behavioral intention, with its mean value of 4,39 out of 5, which further supports the findings in the literature (Driediger and Bhatiasevi, 2019).

Overall, the results highlight that the components of the e-TAM are capable of explaining the acceptance of OGS technology similar to the earlier studies (Chien et al., 2003; Loketkrawee and Bhatiasevi, 2018; Driediger and Bhatiasevi, 2019).

5.1 Moderating Effects

It is suggested in the literature that situational factors also needs to be taken into account in the acceptance of OGS (Hand et al., 2009). Adapting this suggestion, the current study examines the effect of COVID-19 on the acceptance of OGS by including the people's fear of COVID-19 to the research model as a moderator. The period that the data had been collected was deliberately selected as between 1 and 25 November 2020 after the Turkish government's reintroduction of restrictions, when the effect of the pandemic was still severely experienced by the consumers. The mean level for the participants' pandemic fear was 2,99 out of five, which is above the average. According to the results, significant effects of certain e-TAM antecedents on behavioral intention toward OGS are significantly weaker after adding the interaction effect of consumers' fear from COVID-19, supporting the hypotheses H_9, H_{10} & H_{11}. These results suggest that the more people are afraid of COVID-19, the less e-TAM is capable of explaining the consumers' acceptance of OGS by itself since we should consider an important and significant external variable of fear of COVID-19. However, by integrating the fear of the COVID-19 construct into our TAM model, we can enhance the predictive power of the model remarkably.

6 CONCLUSION

6.1 Theoretical Implications

This study further supports the idea of using the e-TAM theory to explain consumers OGS acceptance. The research results also emphasized the importance of situational factors in the TAM structure once again. SEM found all the twelve proposed hypotheses as significant and thereby providing further support to existing TAM relationships, especially with the inclusion of an important situational factor, fear of COVID-19. The addition of the COVID-19 fear construct would be a recent and unique contribution of this study in TAM and OGS literature. As the pandemic is still raging worldwide, it seems logical to argue that we will talk about COVID-19 for a considerable time more.

6.2 Practical Implications

The findings in the literature that indicates; PU, attitude, and PEU as significant antecedents of OGS (Driediger and Bhatiasevi, 2019) have also been empirically supported in this research, which suggests further evidence for the retailing managers in terms of understanding the mechanisms of OGS acceptance.

This study also reveals the fear of pandemics as a significant factor in the acceptance of OGS. As we all know, this is not the first pandemic that humanity has faced. However, since a pandemic of this magnitude has been experienced for the first time in the near future, businesses operating in many markets, especially retail, have been caught unprepared for the epidemic. It is also clear that there is a great possibility that new outbreaks will occur in the future (Iserson, 2020). For these reason, retail managers should learn from this crisis and prepare their online channels for a possible upcoming pandemic. In this study, especially PEU emerged as the most influential variable in OGS acceptance. Thereby, one of the most important preparations that retailers can implement will be to transform their online channels into a more user-friendly form.

6.3 Limitations of the Study and Possible Future Undertakings

The current study has some limitations, some of which might provide possible future research challenges. First, mainly due to the pandemic restrictions, this study adopted a convenience sampling methodology for the data gathering process, which could somewhat decrease the generalizability of our findings. Future scholars may replicate this study by using actual data from the retailers operating an online trade channel. Second, this study focuses exclusively on grocery shopping retailers with online channels. Hence, the findings of this study might not be valid for other types of retailers, which would also give some reasoning for future studies.

It is understood from the results of this study that for the people with a high-level fear of a pandemic, the effects of the predictors for the acceptance of OGS decrease. This might be interpreted as a signal for future researchers to examine some other antecedents to understand better the acceptance of OGS in extraordinary situations like the pandemic era. Also, considering the empirical evidence represented in this study regarding the effects of pandemic fear, in future research, scholars can also examine the effects of different aspects of the pandemic on the acceptance of OGS like decreases and changes in purchasing patterns as well as types of supplies. Besides, comparative studies among different OGS venues and other countries with Turkish samples could also bear fruitful and interesting results.

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DETERMINANTS OF TECHNOSTRESS: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Technostress as an academic domain has evolved significantly since year 1984. Based on the systematic literature review (SLR), eight determinants of technostress were identified which were classified into individual and organizational categories. Individual determinants were further divided into demographic, psychographic and cognitive categories. Outcome of the SLR was the development of a comprehensive framework of technostress. This study can facilitate the top management and the HR managers of organizations to adopt appropriate change management interventions while implementing and augmenting new technologies.

KEY WORDS

computer literacy, determinants, information and communication technology, personality type, self-efficacy, stress, specialization, technology engagement, technostress

JEL CODES

D23, O33, D83, L86, M15, O14

1 INTRODUCTION

Information and communication technology (ICT) has become an inseparable part of modern personal and professional lives. This technological engagement is not only confined to organizational boundary but affects personal spheres too due to massive penetration of internet, apps and smart gadgets. Rapid changes of technologies from personal computers to smart phones and internet, enable the information access in just a single click. However, it keeps individuals under constant pressure to acquire and learn new skills, knowledge and creativity (Lee, 2010). This pressure of acquainting with new technologies creates a feeling of anxiety, fear and stress among the users.

This fear results from feeling of insecurity of losing their jobs, as they might be replaced by technology, automation or digitalization. This

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often takes the form of negative emotions such as nervousness, decreased confidence, increased anxiety and apprehension in using computer (Abdul-Gader and Kozar, 1995; Marcoulides, 1989). Stressful working conditions can adversely affect both employees and employers (Ganster, 2008). These factors lead to creation of stress among the users and is referred as technostress (Brod, 1984; Weil and Rosen, 1997).

As a result of economic development or technological advances, organizations are compelled to restructure, which changes an employee's roles and employment status, creating new and increased demands on employees and their wellbeing (Le et al., 2020). In technology-led reengineering of business processes; new power, authority and decision-making structures are created. These factors induce stress among the individuals, resulting into decreased productivity and performance in organizations (Sinha and Sinha, 2012; Tarafdar et al., 2007).

In this paper, authors carried out an in-depth study of research papers related to technostress from year 1984 to 2020 to identify relevant factors causing technostress. The primary aim of the paper was to integrate and synthesize the findings of existing research papers related to technostress. Based on the systematic literature review; individual determinants: age, gender, self-efficacy, personality type, computer literacy, field of specialization; and organizational determinants: technology engagement and organization climate have been identified as major determinants of technostress. It was followed by the development of a comprehensive framework of technostress. Managerial implications of technostress have also been highlighted in the end. Paper concludes with the limitations and scope for future research.

2 BACKGROUND OF TECHNOSTRESS

Craig Brod was the first author to introduce the term "technostress" in the year 1984. According to him, "technostress was a modern disease of adaptation caused by an inability to cope with the new computer technologies in a healthy manner". Authors Clark and Kalin (1996) were of the opinion that technology was not the problem but human's adverse response to new innovations was the problem. According to Wang et al. (2008), "technostress is negative effect on human attitude, thoughts, behaviors and psychology that directly or indirectly results from technology". They opined that the psychology and attitude of people resisting the change were the major causes of technostress.

Technology has become an indispensable part of modern human life. Business Dictionary defines technology as the purposeful application of information in the design, production, and utilization of goods and services, and in the organization of human activities. ICT encompasses all hardware (including communication technologies like cell phone), networking devices, software applications and systems that enable individuals and organizations to communicate and transact with each other for various purposes. With rapid development and spread of Industry 4.0 technologies like artificial intelligence, machine learning, IOT, Cloud, big data and analytics; radical shift is getting witnessed in every sector and across the globe in recent years.

Due to faster pace of life, rising customers' expectations, growing competition, exceeding regulatory pressures etc.; organizations need to invest in state-of-the-art technologies. Rapid obsolescence of technology necessitates this investment on a regular basis. While this puts pressure on the management of companies in terms of procurement and deployment of IT resources, this affects employees also to a great extent as they need to learn, unlearn and re-learn newer technologies and associated business processes to remain competitive.

Numerous studies, agencies and experts have predicted that in coming years; millions of jobs will be threatened due to this fourth industrial revolution including IoT, Analytics and artificial intelligence technologies. These disruptive technologies compel organizations to reinvent their business model, philosophy, and processes.

As organization strive for survival and growth, individuals cannot remain complacent. However, everyone in organization does not possess requisite competence and agility to cope up with fast-paced technological changes taking place in environment, leading to technostress.

McKinsey Global Institute (2019) survey indicated that by year 2030, 75 million to 375 million workers will switch occupational categories. This shift may make many jobs redundant at one hand; on other hand, may create new jobs in production process, business, and service delivery mechanism. With the exponential changes in technologies, higher-value jobs will be created that would require altogether different skill sets and result in likely job losses in developed and developing countries including India (World Economic Forum, 2017).

World Bank report indicated that the proportion of jobs threatened by industry 4.0 technologies in India is 69 percentage year-on-year (Business Today, 2017). Ganesh (2018) in his paper referred Job Buzz survey, which highlighted that about 70 percentage of the Indian employees were suspicious of their jobs getting away due to automation and only 20 percentage feel their jobs getting better due to Industry 4.0 technologies. Mehta (2018) in his study referred a FICCI (2017) report, which indicated that there will be decline in routine, lower and middle level jobs and consequent increase in high skill jobs.

3 RESEARCH METHODOLOGY

Authors followed the review method suggested by Akosah-Twumasi et al. (2018) for this paper. Time-period for review was year 1984 (when the term was coined) to year 2020. Authors began this paper by searching various online databases such as Google Scholar, Ebsco Host, Emerald, Jstor, Taylor and Francis and Wiley to identify research papers published on the theme of technostress. Although the number of relevant papers received on these databases was found to be sufficient, search was also performed in other databases like sage, psychnet etc. However, many of the papers were found to be the same, therefore, further search on these databased was not carried out. At initial stage, keywords used were technostress, stress theories, information and communication technology, technology engagement and social networking sites.

In the second stage, experts' opinion was sought to find the new keywords relevant to the subject. Additional identified keywords were social networking service fatigue, teleworking, IT affordance, knowledge workers, digitalization etc. Although, this study attempted to include all the relevant articles on technostress, authors do not claim that the databases included are complete or exhaustive in nature. Fig. 1 summarizes the process mentioned above.

Sankey diagram connecting the three nodes i.e., journal, author(s) and publication year is presented in Fig. 2. It is a visualization tool that depicts the flow of one set of values to another and where the width of the arrow is proportionate to the flow rate. First and last node represent number of papers published in particular journal and year, while node two shows the number of papers published by particular author(s).

Based on the secondary research, authors have identified various determinants which have relevance with technostress or can result into technostress. These factors include age, gender, computer literacy/knowledge/experience, field or area of specialization, personality type, self-efficacy, technology engagement and organization climate. Summary of relevant literature on these determinants, classified into individual and organizational determinants, is presented in Tab. 1.

Sankey diagram connecting the determinant (streams), author(s) and publication year is presented in Fig. 3.

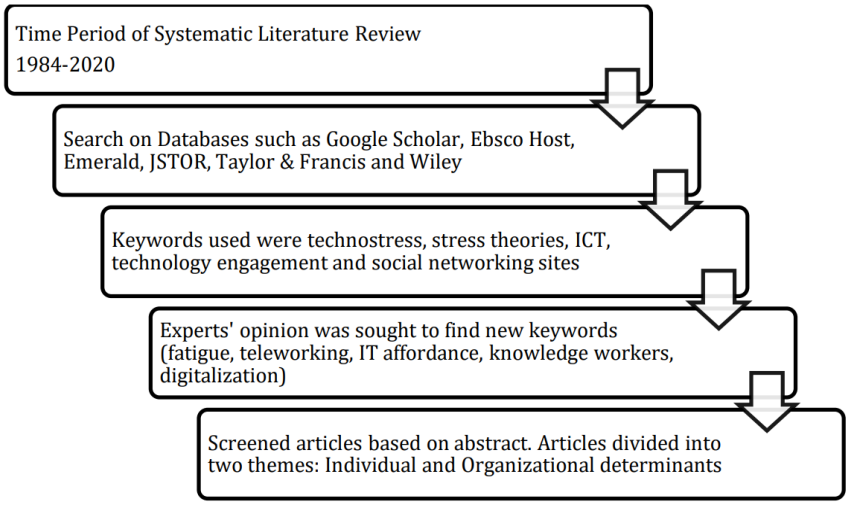

Fig. 1: Literature Review Process

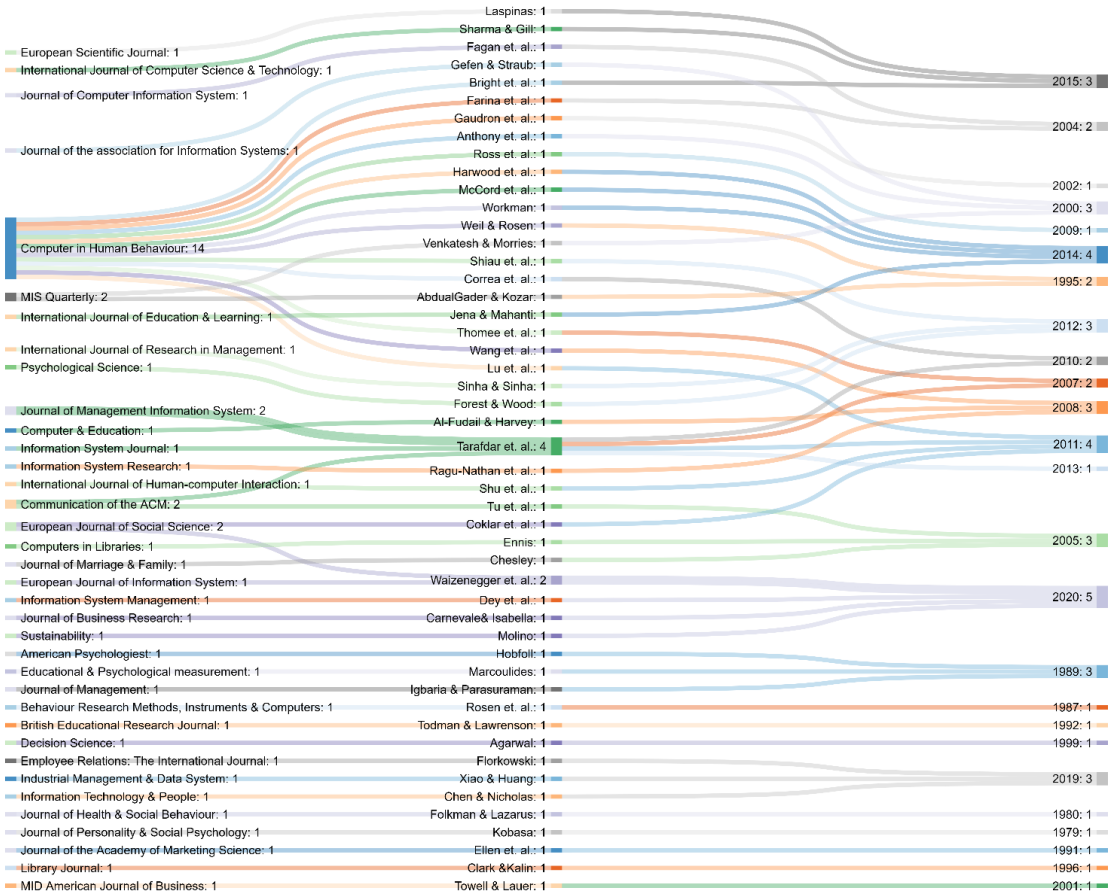

Fig. 2: Sankey Diagram (Journal – Author – Year)

Tab. 1: Streams of Researches on Determinants of Technostress

Determinants	Articles	References
Individual (27) – includes Demographic (11), Psychographic (5), Cognitive (11)		
Age (D)	7	Sharma and Gill (2015); Ragu-Nathan et al. (2008); Tu et al. (2005); Weil and Rosen (1995); Todman and Lawrenson (1992); Rosen et al. (1987); Howard and Smith (1986)
Gender (D)	4	Çoklar and Şahin (2011); Tarafdar et al. (2011); Gefen and Straub (2000); Weil and Rosen (1995)
Personality Type (P)	2	Anthony et al. (2000); Fariña et al. (1991)
Self-Efficacy (P)	3	Shu et al. (2011); Fagan et al. (2004); Ellen et al. (1991)
Computer Literacy/Knowledge (C)	9	Jena and Mahanti (2014); Tarafdar et al. (2011); Gaudron and Vignoli (2002); Agarwal and Prasad (1999); Brosnan (1998); Weil and Rosen (1995); Fariña et al. (1991); Igbaria and Parasuraman (1989); Howard and Smith (1986)
Field of Specialization (C)	2	Towell and Lauer (2001); Rosen et al. (1987)
Organizational (12)		
Technology Engagement	7	Al-Fudail and Mellar (2008); Thomée et al. (2007); Chesley (2005); Raitoharju (2005); Ennis (2005); Valcour and Hunter (2005); Gant and Kiesler (2001)
Organization Climate	5	Sharma and Gill (2015); Jena and Mahanti (2014); Wang et al. (2008); Tarafdar et al. (2007)

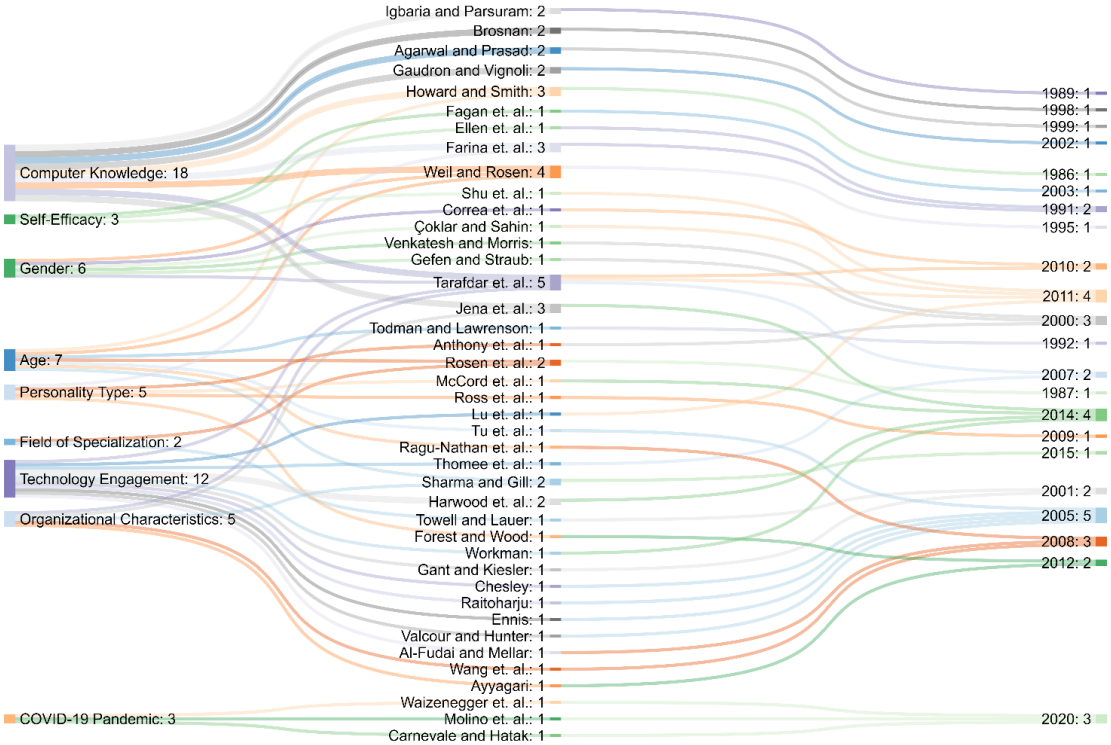

Fig. 3: Sankey Diagram (Determinants – Author – Year)

Under this backdrop, this research aims to broaden the understanding of technostress domain by addressing following research questions:

- RQ_1: What are the main determinants of technostress at individual and organizational levels?
- RQ_2: How can we illustrate technostress in a comprehensive manner?

4 LITERATURE REVIEW OF TECHNOSTRESS DETERMINANTS

Identified determinants of technostress have been classified in two categories:

- Individual Determinants: Demographic (age, gender), Psychographic (self-efficacy, personality type) and Cognitive (computer literacy, knowledge, experience; field of specialization of work).
- Organizational Determinants: Technology Engagement, Organization Climate.

Next section discusses eight determinants given above.

4.1 Individual Determinants

4.1.1 Demographic Determinants

Demographic variable age's impact on technostress has been studied by various researchers. Research conducted by Rosen et al. (1987) among the university students revealed that computer anxiety was correlated with age as older students experienced more anxiety than younger students. A study conducted on school children (9 years old) and university students (First-year Psychology students) concluded that university students had higher levels of computer anxiety than school children (Todman and Lawrenson, 1992). In China, employees older than 35 years witnessed more technostress. It might be because of their rigid thinking and their convenience with conventional work settings and procedures (Tu et al., 2005). Similar study by Sharma and Gill (2015) reveals that senior employees find it more difficult in adopting the technological changes as compared to the younger employees. However, some studies show that younger people are more techno-stressed than their senior counterparts. Weil and Rosen (1995) in their study conducted in 23 countries, found that in the sample of Mexico and Czechoslovakia, computer anxiety was negatively correlated with age. In other words, older students had less technological anxiety. This might be due to their maturity which led them to better handle stressors (Ragu-Nathan et al., 2008). Howard and Smith (1986) found that age did not have significant correlation with computer anxiety.

As per authors' review, gender affects computer related anxiety of a user. A study of Weil and Rosen (1995) concluded that gender and computer anxiety were related. Males showed more computer anxiety than females in the samples of 23 countries. Particularly, it was visible in sample from Italy, Thailand and Kenya while in Israel and Hungary, female respondents had high computer anxiety. It might be because usage of computers at the time of study was relatively less at workplaces in these countries, unless it was compulsory. Gefen and Straub (2000) in their study on academicians found that male academicians' experienced higher technostress compared to women academicians because women used technology only when they required it while men used technology very often. Study of social network users in Turkey revealed that female users experienced more stress than their male counterparts (Çoklar and Şahin, 2011). However, Tarafdar et al. (2011) concluded that gender did not have any significant relationship with technostress.

4.1.2 Psychographic Determinants

Self-efficacy is an individual's belief that he or she is capable of performing a task (Robbins and Judge, 2013). As per the social cognitive theory, computer self-efficacy had a negative relationship with technostress. Study of Fagan et al. (2004) also revealed similar results. Ellen et al. (1991) concluded that people with lower self-efficacy oppose technological changes compare to those having higher self-efficacy. Shu et al. (2011) reaffirmed that people with lower computer self-efficacy and higher technology dependence were found to be more techno-stressed than others with opposite behavioral traits.

Personality is defined as enduring characteristics that describe an individual's behavior (Robbins and Judge, 2013). Research on 176 South African university students by Anthony et al. (2000) was intended at finding correlation

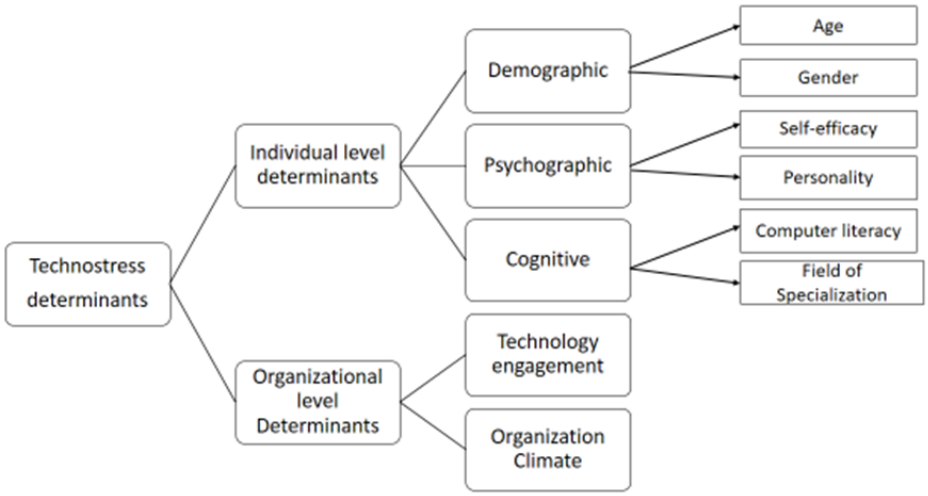

Fig. 4: Technostress Determinants

between dimensions of personality (Openness to experience, Extraversion, Agreeableness, Conscientiousness and Neuroticism) and technophobia. Result of their study indicated that neuroticism correlated positively with computer anxiety. On the other side, openness was inversely correlated with computer anxiety. Chen and Roberts (2019) in their study of social networking site (Facebook) users – undergraduate student from Public American University found that agreeable individuals might be driven by compliance mentality and became addicted to SNSs. Extroverts became addicted to SNSs to enhance pleasure and excitement. Neurotic individuals tend to use SNSs to cope with negative emotions or feelings of deficiency.

4.1.3 Cognitive Determinants

Study by Howard and Smith (1986) did not find significant relationship of computer anxiety with computer knowledge. However, they found an inversely significant relationship between computer anxiety and technology experience. Fariña et al. (1991) concluded that respondents with more computer experience had less anxiety towards the computer. Based on research conducted in 23 countries, Weil and Rosen (1995) found that less experienced students from 17 countries exhibited higher anxiety about computer operation. Negative attitude towards ICTs uses also created nervousness and agitation among computer users (Brosnan, 1998; Gaudron and Vignoli, 2002) while professionals with greater confidence in computers experienced less technostress because of their own competence to manage the technical challenges (Tarafdar et al., 2011).

Educational qualification was generally considered to be inversely related with technostress. Assumption behind this proposition was that educated users had less anxiety compared to less educated users (Igbaria and Parasuraman, 1989; Agarwal and Prasad, 1999). Jena and Mahanti (2014) in their study of academicians found that those who were highly aware with the technology experienced less technostress as they were more confident in dealing with challenges emanating from technological introduction. Five studies conducted among 450 students, consisting of various nationality and specializations, of a State university in USA concluded that social science and humanities students had much higher computer anxiety and were less inclined towards technology compared with their counterparts from science and business backgrounds. Males in science major and females in a social science major had more computer anxiety. (Rosen et al., 1987). A USA based study conducted by Towell and Lauer (2001) compared computer related stress levels among 239 MBA students. They found that MIS major students experienced higher

technostress compared to other specialization students as they had highest interaction with computer and their grades were also highly dependent on the computer work.

4.2 Organizational Determinants

4.2.1 Technology Engagement and Technostress

Stress can be created by technologies in form of extended working hours and need for employees to remain available 24×7 through internet (Walz, 2012). Modern communication devices such as smart phones, laptops, and other collaborative tools compel the employees to perform multiple tasks simultaneously that create communication overload and information overload which might be difficult for them to handle effectively (Ragu-Nathan et al., 2008). These devices and communication applications provide greater flexibility but affect work-life balance to a great extent causing stress (Chesley, 2005). Mobile communication devices also put the employees "on call" for extended hours for official matters. This increases their working hours and restrict their autonomy resulting into stress (Gant and Kiesler, 2001).

A study by Thomée et al. (2007) found that there was no significant relationship between time spent on email and stress among male participants, but found that time spent on e-mailing causes depression among women. Necessity to use technology in different processes associated with different sectors such as health care (Raitoharju, 2005), education (Al-Fudail and Mellar, 2008) and library studies (Ennis, 2005) resulted in avoidance of technology use due to users' negative disposition and resulted in stress. Virtual presence of people due to advance technology made them to work across different time zones and respond to tasks 24×7 (Valcour and Hunter, 2005), which led to work overload (Chesley, 2005). Suh and Lee (2017) found that technology characteristics (IT presentism and the pace of IT change) and job characteristics (job autonomy and task interdependence) jointly explain the technostress.

Drastic technology usage was witnessed in our daily lives after the outbreak of COVID-19 pandemic. Work from home and remote work options were the vital options to run the organization in this pandemic situation. The lockdown and social distancing forced the organizations to make policy and practices changes. Many employees were forced to work from home with or without any prior experience of technology, which resulted in higher level of stress among them (Waizenegger et al., 2020). Carnevale and Hatak (2020) in their study found that people were in continuous struggle to adapt to the new work platform. Use of technology for work and personal front, blurred the boundary between work and personal lives, resulted into technostress (Dey et al., 2020).

4.2.2 Organization Climate and Technostress

An organization's environment also contributes to technostress among the employees. Tarafdar et al. (2007) propounded that technostress can increase the existing stress due to aspects of individual's role. Wang et al. (2008) concluded that overall technostress is directly proportional to the level of centralization and innovation culture in organization. One of the draw backs of ICTs was information overload in work settings. Individuals may experience stress because of this information overload. But if someone experiences high task technology fit, it lowers his/her stress level (Ayyagari, 2012). Study of Jena and Mahanti (2014) found that organizational tenure of academicians was also related with technostress. Those academicians having greater organizational tenure experienced less technostress due to superior understanding of organization and technologies in use. It may possibly enhance the power of academicians in the institute which might reduce technology related pressure in the academic institute. Technological changes introduced in organization, without involving staff which alter their role, also lead to technostress (Sharma and Gill, 2015)

5 IMPACT OF TECHNOSTRESS

Factors discussed above create technostress which results into psychological, behavioral or physiological strains. Psychological strains can be defined as emotional reactions to stressor conditions. These include dissatisfaction with the job, depression, negative self-evaluation, organizational commitment etc. (Walz, 2012). Behavioral strain is defined as an influence on the action of an individual. Various researches in organizational behavior area described end-users' reactions to ICTs in form of mental stress, anxiety, work pressure etc. Technostress creators on one end decreased the job satisfaction and organizational commitment, while on other end, increased role stress among the individuals that affected the individual's sense of well-being and dedication at the workplace (Tarafdar et al., 2011). Study of Kupersmith (1992) and Tarafdar et al. (2011) showed that utilization of ICTs in libraries had caused technostress among librarians, which reduced their job satisfaction.

Physiological strain can be defined as reactions of human body including the digestive, nervous, endocrine, immune systems etc. to various stressors. Most cited physical symptoms of technostress by librarians were back pain, eye strains, headache, increased heart rate etc., caused by their excessive sitting and computer gazing. (Laspinas, 2015). It also created job insecurity among librarians due to fear of being overtaken by computers (Harper, 2000). Based on the above review, authors have developed following model highlighting various antecedents, determinants (individual and organization) and consequences of technostress.

6 DISCUSSION AND CONCLUSION

This paper contributes to the research on technology induced stress by integrating a large number of research papers causing technophobia, computer anxiety and fatigue. Through systematic literature review, we identified eight determinants of technostress, classified into individual and organizational determinants. Individual determinants have been further divided into demographic, psychographic and cognitive categories. In case of age, majority of studies pointed at positive correlation, however, some studies found negative correlation with age and lack of relationship too. Studies on gender and technostress was also not conclusive. Researches are unanimous about the negative relationship of Computer self-efficacy with technostress. Personality type was found to be a significant predictor of technostress. Studies on relationship between computer literacy/knowledge and technostress produced contradictory results. Similarly, the relationship between the field of specialization and technostress was also not one-sided. At organizational level, technology engagement (nature, application and duration) determined the technostress. Organization climate was also found to be a major determinant of technostress.

Lazarus and Folkman (1984) defined stress as "a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his/her resources and endangering his/her well-being". They mentioned that stress results from an imbalance between demand and resources. This definition focused on two aspects – appraisal and coping. Appraisal means a person acknowledges that something which they have are at stake. These can be in form of their job, goal, values or beliefs (Lazarus, 2001). The mechanism to deal with such cognitive underpinning emotion is coping, which is defined as "the cognitive and behavioral efforts made to master, tolerate or reduce external and internal demands and conflict among them" (Folkman and Lazarus, 1980). This coping mechanism as cognitive efforts (self-efficacy) and behavior (gather computer knowledge and experience), if implemented well, can reduce the demand (technostress).

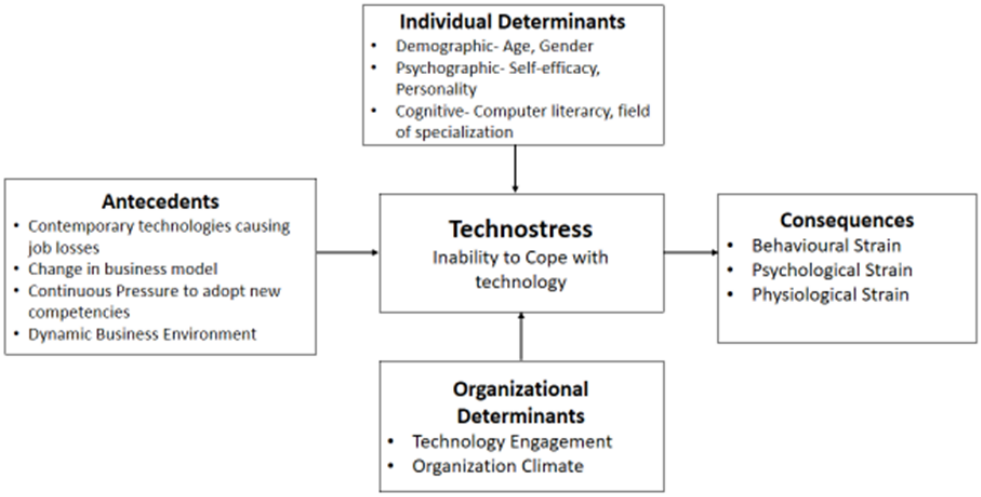

Fig. 5: Technostress Framework: Antecedents, Determinants and Consequences

This research can facilitate the top management of organizations and the HR managers to adopt appropriate change management interventions such as training, coaching, counselling, mentoring, hand-holding etc., while introducing new technologies in their organization. Florkowski (2019) studied the technology's influence on general work attitudes within the HR department and found that top-management support was inversely proportional to technostress. Champions need to be identified by the top management for each SBU, division and department who can create enabling environment and lead their fellow colleagues for technology adoption. Training should be provided in varying duration depending on employees' roles and in phases (awareness building seminar, demonstration followed by actual usage of tools). Training material should be prepared in different languages and should be made available offline and online for ease of access. Online and/or offline support, can also enable smooth adoption of technology (Li and Wang, 2021).

Organizations need to take a pragmatic view involving all segments of employees (based on determinants mentioned above – age, gender etc.) while adopting technology in their organization. Special attention should be given to vulnerable groups who consider technology as intimidating. In operational terms, heterogenous groups can be formed based on age, past knowledge, specialization etc. In other words, there cannot be a 'One Size Fits All' strategy while adopting technology in an organization (Tyler et al., 2020). Additionally; in view of technostress, top management and technology managers should consider technology implementation in pilot mode/stage wise implementation. By this, various technological and behavioral issues can be identified before organization-wide roll out of technology. More involvement of employees at each stage of technology adoption and upgradation is also another mechanism of resolving the technostress.

HR managers need to understand genuine anxieties and fears of employees. For allaying employees' concerns, continuous communication with all stakeholders can play an important role (Nisafani et al., 2020). For smooth introduction and stabilization of technology, suitable reward mechanism can also be explored. IT policy should lay more emphasis on people and process issues (including change management) than technology issues (hardware, software etc.). Lastly, functional managers' role becomes important as technology ultimately gets intertwined with various functional processes, therefore, requires constructive support from them at a regular interval. In technology adoption, top management should lead by example.

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FROM QUALITY TO QUANTITY: HOW CAN DIGITAL SOVEREIGNTY BE PARSED INTO MEASURABLE COMPONENTS?

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ABSTRACT

The use of digital technologies for state-relevant institutions, government organisations and administrations has grown steadily in recent decades. Therefore, the question arises whether the mastery of these technologies has an influence on a state's ability to act and whether state sovereignty is affected. In the European Union, the concept of digital sovereignty of states is being intensively discussed. However, it is unclear what exactly is meant by the term digital sovereignty and how it can be defined. The research gap is the lack of a clear qualitative and quantitative definition of that term, so that the goal of the article is to provide an overview of a qualitative definition. That is the basis for a quantiative model. To achive that goal a hierarchical component model is developed for concretisation. Furthermore, the components are decomposed into subcomponents, each of which is then quantified by suitable metric parameters, which are populated from secondary data sources for states and subjected to selected quantitative analyses. To verify and validate whether the component model and the parameters are suitable and robust for measuring digital sovereignty, a comparative index is formed and compared with existing indices.

KEY WORDS

digital sovereignty, state sovereignty, technology

JEL CODES

N4, N7, O33, O38

1 INTRODUCTION

The social, political and economic relevance of information and communication technology (ICT) is growing, and the associated discussion of digital sovereignty of states is taking place especially in the European Union (EU). The focus is on the question of whether increasing digitalisation influences the sovereignty of states. Various, unspecific and partly contradictory qualitative definitions are used and initiatives are derived whose effectiveness can be described

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qualitatively but not assessed quantitatively (Madiega, 2020). A qualitative uniform understanding does not exist, and there is no possibility of metric classification and comparability or analysis of states about their positioning with digital sovereignty, which describes the research gap. Impulses to make the up to now diversely used term digital sovereignty more accessible from the perspective of the European value system, a model for assessing is needed. This can be used to assess how states can be classified in terms of digital sovereignty and create room for improvement. The aim of the article is to describe the term in a structured, qualitative way, to derive a quantifiable model from it and to prove that the model is suitable for assessing digital sovereignty of states.

2 DATA SOURCES AND METHODS

The qualitative definition of digital sovereignty is derived from historical analysis, through literature review, of the individual terms by deduction and structured through synthesis into a new, composite term. Reference is made to a wide range of literature, which is mainly analysed in an article by the author (Kaloudis, 2021). This analysis is processed in a structured way and a new conceptual proposal for digital sovereignty is derived (cf. 1.1).

The new term is decomposed into qualitative main and sub components based on the structured derivation (cf. 1.2). Then the sub components are quantitatively assessed using metric parameters that are available as secondary data (cf. 1.3).

Secondary data sources on which the analysis is based are:

- World Bank: the World Bank's Open Data database provides a wide range of data, including country-specific data, which is used in this analysis (`www.worldbank.org`),
- OECD (Organisation for Economic Cooperation and Development) statistics: country-specific statistics (`https://stats.oecd.org/`),
- IEA (International Association for the Evaluation of Educational Achievement): network for improving education with data on the educational status of more than 100 countries (`www.iea.nl`),
- GII (Global Innovation Index): index with detailed measurements of 131 countries that rank the degree of innovation of states (`www.globalinnovationindex.org`),
- EUD (EU database): country-oriented database focusing in particular on states of the European Union (`www.ec.europa.eu`),
- PS (Patentscope): patent applications worldwide (`www.patentscope.wipo.int`),
- UND (UN database): database system on UN states maintained by the Department of Economic and Social Affairs (`www.publicadministration.un.org`),
- FS (further studies): selected studies by management consultancies or scientific institutions on special topics (e.g. McKinsey: `www.mckinsey.com`, Cambrian Intelligence: `www.cambrianintelligence.com`, IP Lytics: `www.iplytics.com`, International Institute for Management Development: `www.imd.org`, International Telecommunication Union: `www.itu.int`, Comparitech: `www.comparitech.com`, Leidenranking: Performance from over 1,300 universities worldwide, `www.leidenranking.com`).

The development and evaluation of the model presented in the results closely follows the OECD recommendations for the development of comparative indices. The parameters thus available are analysed and normalised using quantitative methods (OECD, 2020b, p. 13; cf. 1.4). Regression methods are used to evaluate statistical estimators in selected examples (Fahrmeir and Tutz, 2001). Missing data are imputed (cf. 1.4). The weighting of the parameters and their aggregation with suitable procedures is then discussed in various forms (OECD, 2020b; cf. 1.5). Verification and validation of the suggested index is carried out to prove the robustness of the model (Janová et al., 2019; cf. 1.6).

3 RESULTS

3.1 Qualitative Definition of Digital Sovereignty

State sovereignty and economics are closely connected (Kukkola et al., 2019). This is also true in a digital context: discussions about digital sovereignty of a state have arisen due to the criticality of the use of digital technologies and the economic dominance of digital industries of individual countries. The digital dependence on other states that has arisen and the state sovereignty that may be affected as a result, i.e. the influence on the state's desire for autonomy, can basically be countered by two opposing approaches (Pohle and Thiel, 2020; Rhode, 2020).

Through strategic autarky, which attempts through economic and industrial policy to achieve maximum independence in the sense of autarky and thus isolation from other states. Elements that are characteristic of this are strong regulations in the sense of economic promotion of own IT industries such as software, hardware and telecommunication and usage specifications for the industries to be digitised or by building barriers in the sense of protectionism for providers from other states. Examples include the USA, China and Russia.

Through strategic autonomy, which follows the approach of remaining capable of acting at all times in certain administrative and industrial areas that particularly concern state sovereignty (Madiega, 2020). However, this is not achieved through isolation but through active management of a global ecosystem and the use of technologies. The approach is characterised by strategic globalisation. The focus is largely on controllable partnerships. This can take place, for example, through the development of key competencies and key technologies or the use of parallel technologies to reduce dependencies.

Both approaches, i.e. autonomy or autarky, are essential elements of the fundamental (economic) political orientation of a state and are thus closely linked to politics and economics and also historically shaped. By using tools from the social and technology sciences (STS), the complex interdependencies and reciprocal relationships between technological, social and political aspects and actors (multistakeholderism) can be analysed and described (DeNardis et al., 2020). This interdisciplinary approach forms the basis for the analysis of digital sovereignty of a state.

In previous articles by the author, the individual aspects of sovereignty and digitalisation are analysed using methods from STS and an intensive literature search (Kaloudis, 2021, 2022). Selected literature for the aspects of state sovereignty on which the analysis is based include: (Bodin, 1994; Zimmer, 2008, p. 55; Zandonella, 2007; Abbate, 2017; DeNardis et al., 2020; Bublitz, 2014, p. 273; Mohabbat-Kar et al., 2018, p. 189; DeNardis and Raymond, 2013; Cerny, 2010, p. 8; Dahlman, 2009; and Barnett, 2017). For an overview these aspects can be structured as shown in Fig. 1.

The aspects of the term digitalisation are also analysed in the referenced article with the help of the following selected literature: (Kagermann et al., 2011; Tomory, 2016; Mohajan, 2019, p. 383; Juhász et al., 2020, p. 41; Schwab, 2016; Bauernhansl et al., 2014, pp. 14–30; and Wagner et al., 2017). On overview of the aspects is shown in Fig. 2.

From that historically motivated analysis of the understanding of state sovereignty in Europe and synthesis with the emergence of digitalisation, a definition of the composite term digital sovereignty is deducted (Kaloudis, 2021): "(…) A state is digitally sovereign precisely when (1) its sovereignty is preserved in the sense of a Foucauldian approach of 'good governance' based on Europe's democratic and liberal values, i.e. administrative and governmental work must be carried out sovereignly, (2) technological digitization by means of key enabling technologies is defined for the respective state, revised if necessary and generally accepted, and (3) under the aspect of strong data sovereignty, technology sovereignty is also established so that the technologies used by state organisations are understood and can be controlled or replaced at any time if necessary."

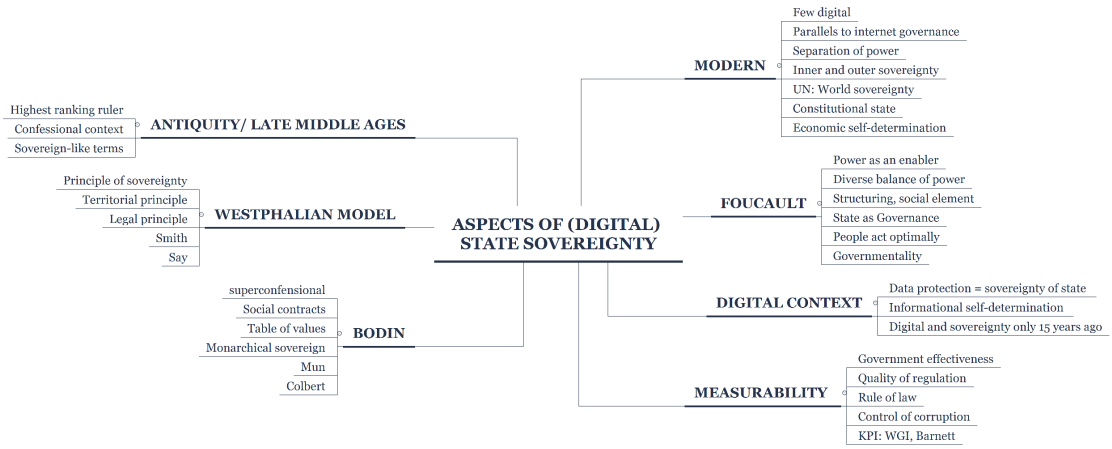

Fig. 1: Literature review: selected, analysed attributes of state sovereignty, adapted from (Kaloudis, 2021)

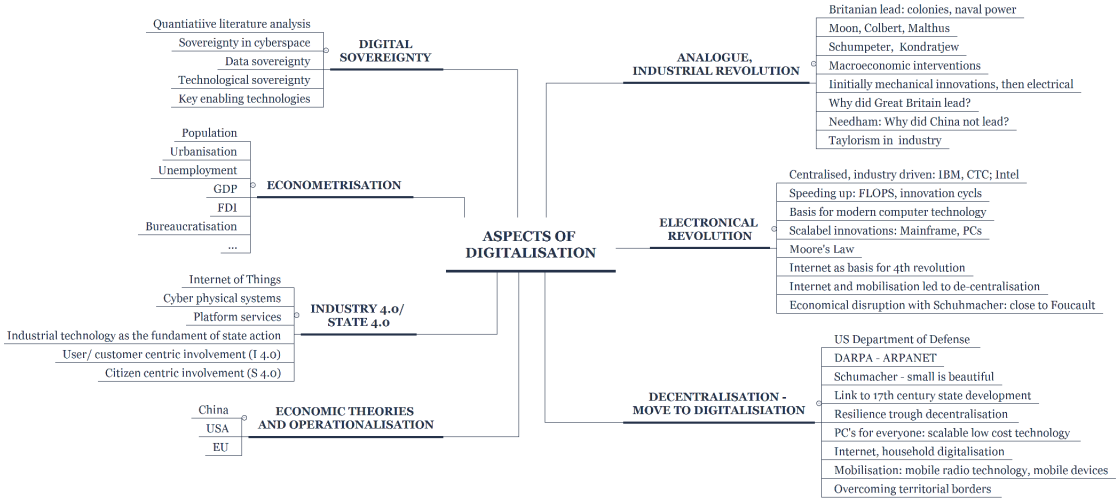

Fig. 2: Literature review: selected, analysed attributes of digitalisation, adapted from (Kaloudis, 2021)

Thus, "good governance", "KETs" and "technological sovereignty" are essential structural elements for digital sovereignty, which will be further defined below.

In order to achieve a common understanding of the variously used term and to generate a basis for further considerations, it is proposed to use the aforementioned definition.

3.2 Component Model

The metric classification of the qualitative definition of digital sovereignty requires a theoretical framework (OECD, 2020b). For the present case, the following hierarchical 3-component model is developed by the author.

The main and sub components are deduced from the definition of the term digital sovereignty in the following structured way.

Main component 1: State sovereignty in the Sense of "good governance"

The classification of state sovereignty in the value context of the EU is relevant because, depending on a state's understanding of sovereignty, it is used to assess how relevant a democratic or (semi-) autocratic state becomes

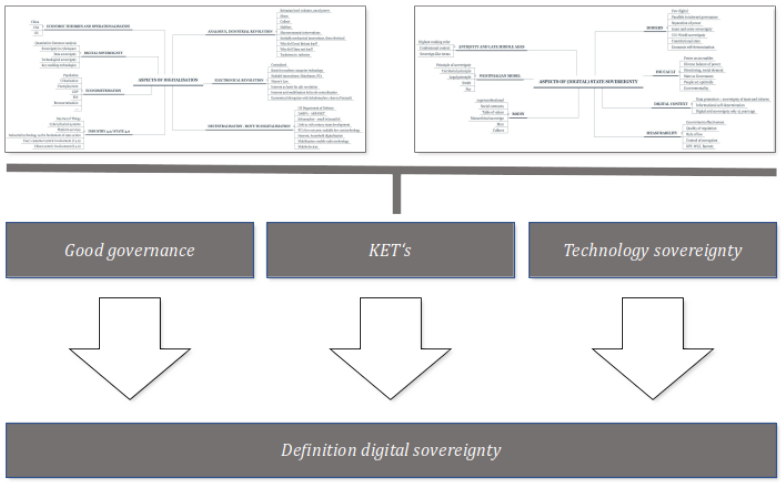

Fig. 3: Conceptualisation, analysis and synthesis digital sovereignty

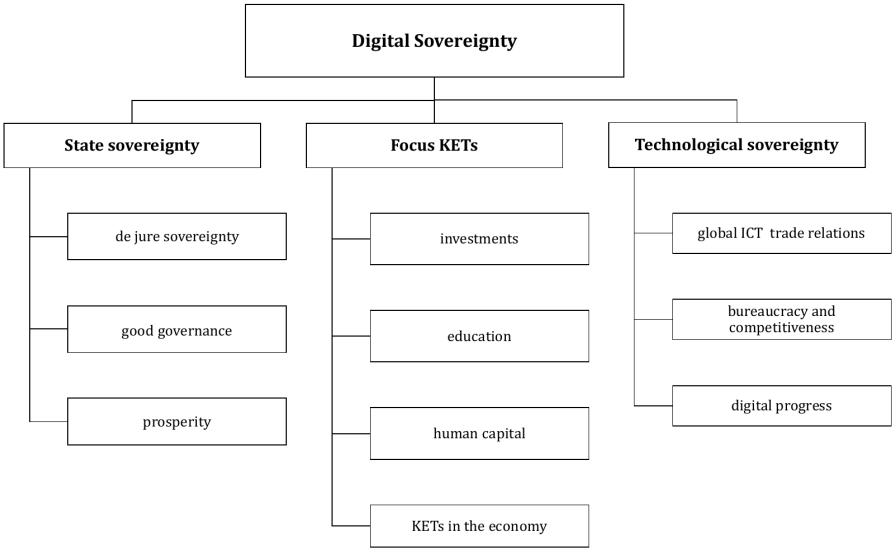

Fig. 4: Component model digital sovereignty

for the quantitative measurement of digital sovereignty.

Sub components of state sovereignty

State sovereignty is guided by elements measuring the quality of governance, through government effectiveness, quality of regulation, rule of law, control of corruption, political stability and participation and freedom of expression. Furthermore, elements of de jure sovereignty are incorporated, and the well-being of a state's citizens is assessed, which is an important indicator of political stability. This is complemented by an assessment of the prosperity of a state, which is directly correlated to "good state sovereignty". This assesses the concept of good governance and "good governmentally".

Main component 2: Focus on key enabling technologies (KETs)

KETs are the focus of the technological consideration of digital sovereignty. Therefore, another main component is a state's assessment

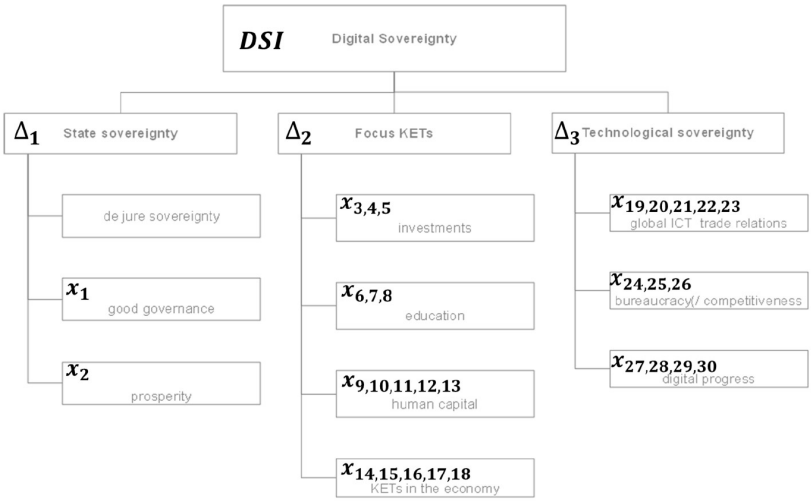

Fig. 5: Classification of parameters in the component model

of how focused key technologies are defined and placed in terms of academic training and economic relevance. Investments, especially in key technologies, also play an important role here.

Sub components KETs

The research, assessment and development of KETs are important influencing factors. These include a state's willingness and ability to develop the (technological) sectors of the economy with and through foreign investment, as well as to promote training of technology assessment specialists through schools and universities and mathematical technical education. Also relevant is a state's ability to mobilise the potential of its citizens in the economy and in the workplace. With the previously mentioned criteria, basic skills emerge to identify which key technologies are relevant for a state and to assess how to deal with them. Another criterion is how successfully countries translate research results into products. However, a uniform understanding of which KETs are really relevant is still lacking among countries (Kaloudis, 2021, p. 7).

Main component 3: Technological sovereignty

Technology understanding and the strategy of increasing strategic autonomy in the sense of technology sovereignty are the focus of the third main component.

Sub components of technological sovereignty

In order to achieve a good understanding of technology, especially with a focus on data sovereignty, i.e., to be able to assess which data are how sensitive and which measures are necessary to keep dependence on third parties at a tolerable level, various indicators can be chosen. The selection is based on the assumption that digital sovereignty in a free, liberal and democratic basic order does not come about through strategic autarky and isolation in the model of autocratic states, but through controllable exchange in an ecosystem of states, i.e., in the sense of global sovereignty. Indicators for this are trade relations with other states with digital services and goods, the evaluation of bureaucratic hurdles to set up a company in a state in order to produce technology with it, the innovative capacity of a state as well as the degree of digitalisation of state institutions or society. Digital competitiveness is also considered, which contributes to remaining "master of technology" relevant to state sovereignty. The sub components will now be assessed with 30 parameters from secondary data, which are described in the following chapter.

3.3 Quantitative Classification and Parameters

Each of those 10 subcomponents can be described by at least one of a total of 30 parameters. For m states, n parameters are collected that describe elements of digital sovereignty of the state. The data is stored in a vector

$$X = X_i = \begin{pmatrix} x_{i1} \\ x_{i2} \\ \vdots \\ x_{ij} \end{pmatrix}, \qquad (1)$$
$$x_{ij} \in \mathbb{R}, \quad i, j \in \mathbb{N},$$

with $j \in \{1, \ldots, m\}$ and $i \in \{1, \ldots, n\}$ and n is a number of parameters collected.

After data collection one obtains a $m \times n$ matrix with $k \leq m \cdot n$ coefficients, since not every parameter is complete for every state. X serves as a basis for further multi-criteria analyses and can be examined for further research as a suitable basis for assessing digital sovereignty of a state.

Parameters for main component 1:
Sovereignty in the sense of "good governance"

Sub component: de jure sovereignty

Whether a state is fundamentally sovereign is assessed using "de jure" sovereignty: only states that are recognised in principle are considered. As a prerequisite, it is assumed that a state is a member of the UN, only then is it a state at all. This interpretation is found in common literature (Dahlman, 2009, p. 28). For the purpose of this article, the degree of recognition is the quotient of the number of states that recognise another in comparison to all UN states, standardised to 100 in each case, i.e. a value of 100 means that all 193 UN states have recognised this state (Barnett, 2017, pp. 62–64).

$$\Theta = \text{De jure sovereignty} \qquad (2)$$

Sub component: good governance

Through the World Governance Index (Kaufmann and Kraay, 2020) has been collecting data from various sources for almost all states since 1996 and quantifying them in six standardised dimensions: "Participation and Accountability", "Political Stability", "Government Effectiveness", "Regulatory Quality", "Rule of Law" and "Control of Corruption". Thus, this approach corresponds to the quantification of good governance in the faucaldian sense (Kaloudis, 2021). Following Barnett, the World Happiness Index is used as a supplement (Barnett, 2017, p. 21).

$$\Xi = \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 + \beta_6 + \lambda \qquad (3)$$

The first parameter is described by the sum of de jure sovereignty and "good governance".

$$x_1 = \Theta + \Xi \qquad (4)$$

Sub component: prosperity

The per capita gross domestic product is used to measure the material prosperity of a state.

$$x_2 = \text{GDP}_{\text{per capita}} \qquad (5)$$

Parameters for main component 2:
Focus on KETs

Sub component: investments

In addition to the effect that essential digital infrastructures must be available for foreign direct investments, without which they would not be able to operate effectively, these investment activities are a characteristic of the ability of states or their industries to interact with global markets. A distinction is made between net inflows and outflows, but both are seen as a positive feature of investment in general and thus also as potential investments in key enabling technologies:

$$x_3 = \text{FDI}_{\text{inflow}} \qquad (6)$$

$$x_4 = \text{FDI}_{\text{outflow}} \qquad (7)$$

In addition, the level of investment in start-ups is used as a parameter to assess a state's ability to also promote new business

$$x_5 = \text{Investment startups} \tag{8}$$

Sub component: education

The qualification of citizens of a state is the basis for (technological) progress (Becker et al., 2011, p. 120; Peters and Jandrić, 2019, p. 14). On the one hand, this pays into the ability of citizens to be digitally sovereign themselves, or to participate as professionals in the digitalisation of the state. Digital capability through education and training assesses a country's ability to produce high-educated citizens. This begins with school education, continues with training and studies, the quality of universities and ends with the number of IT specialists in the labour market.[1] The parameters used are:

$$x_6 = \text{TIMMS} \tag{9}$$

$$x_7 = \text{Assessment in reading, mathematics, and science} \tag{10}$$

$$x_8 = \text{Expenditure on training as a percentage of GDP} \tag{11}$$

Sub component: human capital

The human capital, i.e., the knowledge-based economic power of a country's workforce, is also assessed. The number of employed IT specialists[2] per country represents the amount of ICT know-how that can contribute to the digitalisation of a country. These quantitative data are well recorded for the EU, for other countries only singular sources can be found.

$$x_9 = \text{number of employed IT specialists} \tag{12}$$

In addition, the number of successfully filed patents with an ICT focus is evaluated. It provides an overview of a country's ability to generate new, innovative ideas. Patent submissions are documented worldwide for patent law reasons alone and can be determined. For the present work, the published patents were evaluated in the following categories (included on title page): Cloud, Artificial Intelligence, Quantum, Information Technology and Telecommunication.

$$x_{10} = \text{Number patents} \tag{13}$$

In addition, the quality of universities is included as a key figure. Here, the QS University Ranking is used as a parameter, with the average value of the top three universities.

$$x_{11} = \text{QS university ranking, average score TOP 3} \tag{14}$$

Another question is the extent to which research is transferred to industry. For this purpose, the Leiden Ranking (van Eck, 2021) the indicator for the number of publications in mathematics and computer science in cooperation between universities and industry is used in comparison to all publications with mathematical or information technology content.[3]

$$x_{12} = \frac{\text{Number of publications in Maths \& Computer Science in collaboration with industry}}{\text{Number of publications in Maths \& Computer Science}} \tag{15}$$

The human capital index is used as a complementary factor. The index measures the extent to which a country actually uses the potential of its citizens.

$$x_{13} = \text{Human Capital Index} \tag{16}$$

Sub component: KETs in the economy

As a characteristic of transparency and promotion of data availability for digital processing by an Open Data promoting ecosystem, the index for government support of data use is formed from the characteristics of availability and data accessibility (Lafortune and Ubaldi, 2018; OECD, 2021).

$$x_{14} = \text{Open Data Index} \tag{17}$$

[1] Students reaching the international benchmarks of mathematics achievement.
[2] Persons with ICT education by labour status.
[3] Used parameter calculated independently.

The following parameter is used to assess how key technologies that may be relevant to states are promoted in a state's industries through research and development.

$$x_{15} = \text{Research and development expenses} \tag{18}$$

With a focus on specific KETs[4], it is assessed:

$$x_{16} = \text{Public funding for Quantum} \tag{19}$$

$$x_{17} = \text{Index artificial intelligence} \tag{20}$$

$$x_{18} = \text{Number Blockchain Startups} \tag{21}$$

Parameters for main component 3: Technological Sovereignty

Sub component: global ITC trade relations

To assess the extent to which states trade in digital goods and services, parameters for imports and exports as well as for restrictions and freedoms in the context of trade in digital goods and services are analysed. The selection of parameters focuses on those that describe the trade relations of ICT services or goods.

$$x_{19} = \text{Amount of exported IT services} \tag{22}$$

$$x_{20} = \text{Share of exported IT services in total exports} \tag{23}$$

$$x_{21} = \text{Amount of imported IT goods} \tag{24}$$

$$x_{22} = \text{Amount of imported IT services} \tag{25}$$

In addition, the Services Trade Restrictiveness Index (STRI), which is based on digital aspects of trade freedom, is calculated by the OECD (OECD, 2020d), STRI, the so-called digital STRI (OECD, 2020a) is used.

$$x_{23} = \text{Digital STRI} \tag{26}$$

Sub component: bureaucracy and competitiveness

To assess a state's bureaucracy, the index for assessing the promotion of business activities and the one for assessing digital competitiveness are used.

$$x_{24} = \text{EDBI} \tag{27}$$

$$x_{25} = \text{WDC} \tag{28}$$

Another criterion for competitiveness in the sense of technological sovereignty is the ability of a state to deal with data protection. The EU's assessment of whether a state has an adequate level of data protection is used to measure this. Based on Article 45 of EU Regulation 2016/679, the EU can define whether a country outside the EU offers an adequate level of data protection. If confirmed, this means that data transfers to the country in question are treated the same as data exchanges within the EU. The rating is digital, i.e., 1 if a country is classified accordingly, otherwise 0. In addition, the point rating from the Comparitech study is used and added to the EU data protection rating.

$$x_{26} = \text{EU-GDPR} + \text{Score Comparitech} \tag{29}$$

Sub component: digital progress

The positioning of a state in the ranking of digital capabilities and digital progress and digital openness is formed by the following individual indices.

$$x_{27} = \text{Internet Access Households} \tag{30}$$

$$x_{28} = \text{SIM Cards to Population} \tag{31}$$

The digitalisation of state organisations, ministries and authorities is assessed with the following indices.

$$x_{29} = \text{Government's online service} \tag{32}$$

$$x_{30} = \text{E-Government Rank (EGDI)} \tag{33}$$

Whether the parameters described above are suitable for quantifying digital sovereignty will be examined in the following chapters.

[4]KPIs for KETs can be added or modified for quantification for later research purposes.

3.4 Quantitative Analysis of the Parameters, Normalisation and Imputation

The data (year 2021 of evaluation) of the parameters collected from the aforementioned secondary sources were normalised[5] to 100 for the following analyses and presentations.

Tab. 1: Number, max, min, mean, 25%, 50%, 75% percentiles of parameters, raw data

X_i	Values	Min	Max	Mean	25% perc.	50% perc.	75% perc.
1	121	65.69	100.00	81.23	74.89	79.65	88.53
2	194	0.00	100.00	9.50	1.15	3.72	11.11
3	185	0.00	100.00	13.82	11.74	11.94	12.86
4	167	0.00	100.00	38.35	36.68	36.70	37.14
5	29	0.00	100.00	4.70	0.03	0.20	0.44
6	55	41.85	100.00	82.15	76.51	85.88	89.16
7	76	1.00	100.00	54.59	27.28	55.49	83.69
8	127	0.00	100.00	42.52	32.29	43.75	55.21
9	37	0.00	100.00	6.67	0.25	0.91	2.64
10	10	0.01	100.00	11.25	0.09	0.24	0.96
11	127	24.00	100.00	46.83	24.00	36.00	68.75
12	59	0.00	100.00	35.15	15.99	29.73	50.98
13	187	0.00	100.00	68.81	55.76	73.96	84.29
14	34	0.00	100.00	60.86	52.85	63.57	74.41
15	126	0.00	100.00	7.68	0.71	2.08	7.76
16	14	3.70	100.00	23.05	3.70	15.93	29.63
17	13	16.00	100.00	42.92	33.75	38.00	44.25
18	9	3.99	100.00	18.73	6.40	8.40	12.29
19	200	0.00	100.00	3.39	0.00	0.08	0.90
20	127	0.00	100.00	8.88	1.94	6.20	11.63
21	170	0.00	100.00	4.12	0.14	0.53	2.47
22	127	0.00	100.00	19.60	8.96	16.42	26.49
23	45	0.00	100.00	68.28	50.36	77.23	86.15
24	127	1.00	100.00	50.61	24.85	51.38	75.62
25	62	23.99	100.00	69.73	54.84	69.11	84.11
26	42	56.25	100.00	89.73	87.50	90.63	93.75
27	199	0.27	100.00	52.88	23.64	57.51	82.02
28	195	5.96	100.00	32.22	25.53	32.56	38.70
29	127	38.97	100.00	70.13	54.93	69.95	85.68
30	187	1.00	100.00	51.37	26.00	51.78	76.52

For the further analysis of the data, various normalisation procedures can be applied for appropriate comparison and imputation procedures, since n individual values x_i for all parameters are not available for each state in the sources. The normalisation and imputation procedures become relevant when a composite index is calculated from the parameters (OECD 2020b).

[5] $x'_j = 100 \cdot \frac{x_j}{\max(x_j)}$

To illustrate arbitrarily selected normalisation and imputation procedures, the following are shown graphically in Fig. 1:

1. Raw data, without imputation, as shown in Tab. 1 shown,
2. Raw data, normalised by mean 0, without imputation,
3. Raw data, imputation with k-nearest-neighbours method (kNN),
4. Raw data normalised by mean 0 and standard deviation 1, kNN imputation.

The graphical representation shows the effect of the normalisation and imputation procedures on the raw data. If the data are used further, then the appropriate selection of the right procedure, e.g. in the context of a sensitivity analysis, becomes very important, since the raw data are optimised for further statistical analyses by the procedure combinations, but at the same time are significantly falsified (OECD 2020b).

In order to identify correlations between the parameters, the coefficient of determination R^2 is used as the explained variance and the p-values, which can be determined by (linear) regression (Montgomery et al., 2012, p. 83). Formal prerequisites for efficient regression estimators are normal distribution of the error terms, linearity, no autocorrelation and homoscedasticity. The raw data shown above fulfil the prerequisites only to a limited extent, are heteroskedastic and not normally distributed. Due to the missing preconditions, the estimators of the regression analysis are indeed satisfactory, but no longer efficient (Fahrmeir et al. 2009, 64ff). Suitable methods of general regression can minimise the negative effects, but this is neglected here due to the practical relevance of the data.

Thus, a pairwise comparison of two parameters X_i and Y_i is carried out. The null hypothesis H_0 is then in each case: The dependent variable Y_i is determined by the independent variable X_i by a linear function

$$y_i = \beta_0 + \beta_1 x_i + \varepsilon \tag{34}$$

and can be explained with a significance level of 5% and a coefficient of determination of

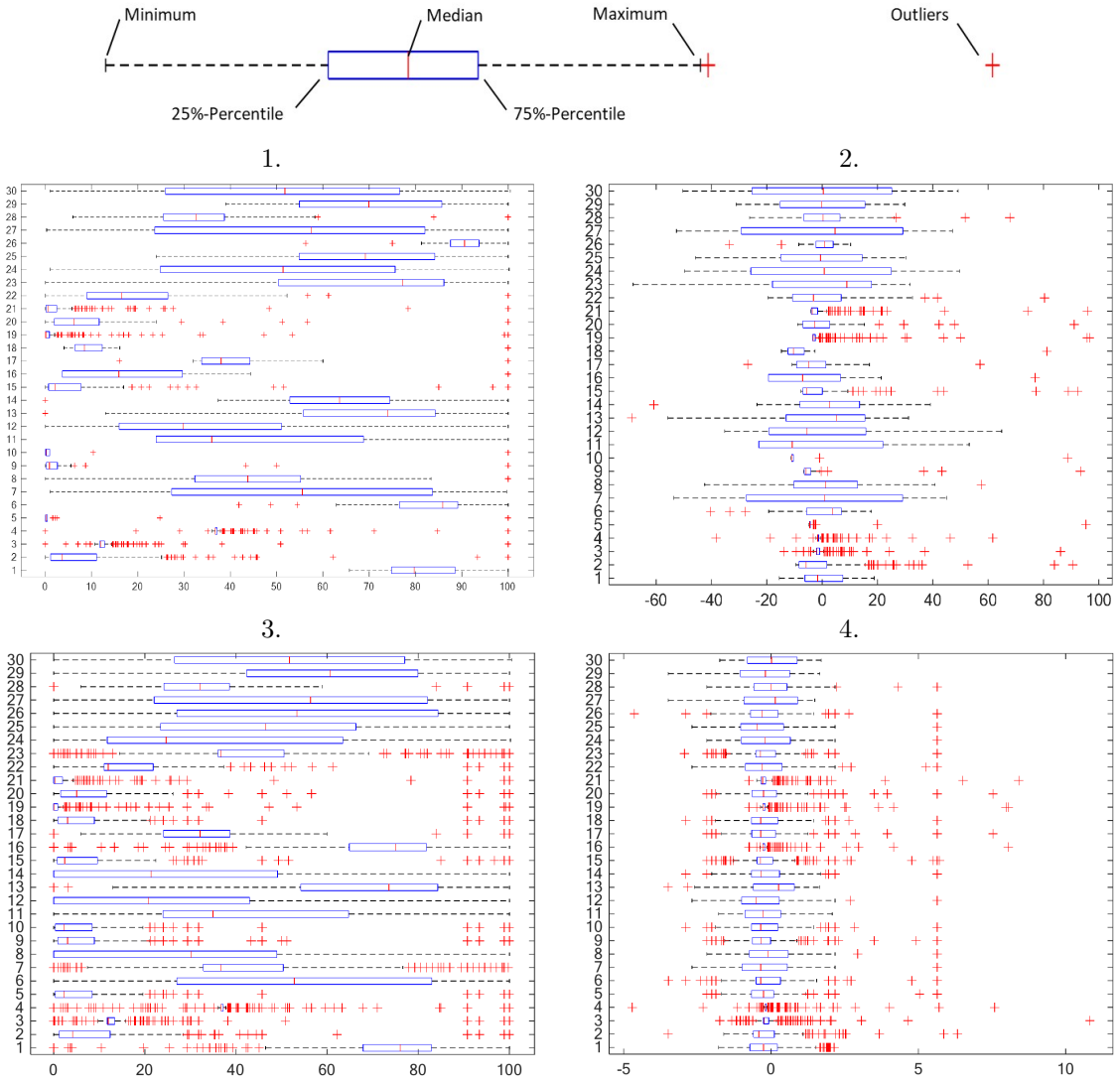

Fig. 6: Normalisation and imputation procedures for raw data

at least 50%. In the following presentation, therefore, only those values are shown for which a coefficient of determination $R^2 \geq 50\%$ and a p-value $< 5\%$ could be determined.

Tab. 2 identifies those parameters that have a high linear correlation, which can also be demonstrated graphically. Since linear regression with two variables is commutative, the matrix is symmetrical. 24 pairs of parameters (5%) can be found whose coefficient of determination $R^2 \geq 50\%$ and $p < 0.05$.

3.5 Weighting and Aggregation

For the present paper, the weighting methods suitable for this application were selected from the possible ones (OECD 2020b, 30). In this case, these are equal weighting (simplicity), Principal Component Analysis (PCA, identifies commonalities of components and corrects for them through weighting) and the Analytic Hierarchy Process (AHP, quantitative support for expert estimators).

Due to the particular relevance of the parameters of main component 1, these are weighted

Tab. 2: Linear regression for X_I and Y_i, outlined in red: $R^2 \geq 0.5$, $p < 0.05$

X_i	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	1.00	.66	.04	.05	.01	.26	.33	.16	.14	.17	.37	.34	.54	.00	.01	.01	.00	.06	.11	.06	.09	.20	.49	.16	.58	.21	.54	.17	.50	.67
2	.66	1.00	.06	.04	.01	.21	.32	.06	.03	.10	.35	.38	.23	.00	.01	.08	.04	.17	.07	.08	.12	.22	.30	.14	.56	.12	.35	.10	.41	.32
3	.04	.06	1.00	.46	.87	.07	.03	.01	.43	.10	.20	.04	.04	.18	.56	.10	.84	.84	.16	.01	.78	.00	.01	.02	.10	.45	.04	.02	.13	.07
4	.05	.04	.46	1.00	.37	.06	.04	.00	.12	.08	.15	.09	.02	.02	.17	.14	.29	.53	.01	.08	.47	.00	.00	.00	.07	.11	.04	.02	.09	.05
5	.01	.01	.87	.37	1.00	.07	.00	.01	.32	.02	.09	.03	.00	.44	.66	.03	.96	.92	.14	.01	.69	.03	.00	.00	.12	.76	.06	.00	.04	.01
6	.26	.21	.07	.06	.07	1.00	.49	.10	.09	.02	.15	.25	.50	.02	.02	.06	.14	.00	.07	.01	.08	.09	.13	.08	.14	.02	.30	.01	.17	.54
7	.33	.32	.03	.04	.00	.49	1.00	.15	.06	.09	.20	.29	.40	.09	.00	.03	.06	.04	.14	.04	.10	.07	.14	.17	.42	.00	.22	.02	.25	.44
8	.16	.06	.01	.00	.01	.10	.15	1.00	.00	.05	.07	.11	.05	.03	.00	.01	.05	.01	.01	.02	.01	.10	.11	.03	.08	.12	.02	.00	.05	.06
9	.14	.03	.43	.12	.32	.09	.06	.00	1.00	.77	.14	.01	.22	.25	.81	.05	.21	.00	.23	.00	.57	.07	.50	.00	.02	.78	.36	.01	.04	.05
10	.17	.10	.10	.08	.02	.02	.09	.05	.77	1.00	.12	.01	.11	.88	.34	.00	.08	.01	.01	.01	.33	.15	.45	.03	.02	.80	.07	.00	.37	.02
11	.37	.35	.20	.15	.09	.15	.20	.07	.14	.12	1.00	.28	.34	.02	.26	.01	.42	.21	.24	.02	.37	.04	.00	.09	.39	.05	.34	.08	.58	.45
12	.34	.38	.04	.09	.03	.25	.29	.11	.01	.01	.28	1.00	.20	.00	.00	.00	.16	.48	.12	.10	.08	.29	.25	.05	.43	.04	.19	.01	.15	.21
13	.54	.23	.04	.02	.00	.50	.40	.05	.22	.11	.34	.20	1.00	.00	.02	.02	.04	.04	.06	.03	.07	.04	.32	.14	.24	.28	.62	.28	.51	.77
14	.00	.00	.18	.02	.44	.02	.09	.03	.25	.88	.02	.00	.00	1.00	.11	.13	.56	.80	.00	.02	.08	.00	.02	.02	.00	.01	.00	.02	.00	.00
15	.01	.01	.56	.17	.66	.02	.00	.00	.81	.34	.26	.00	.02	.11	1.00	.09	.44	.30	.32	.00	.63	.00	.18	.00	.00	.58	.01	.00	.14	.05
16	.01	.08	.10	.14	.03	.06	.03	.01	.05	.00	.01	.00	.02	.13	.09	1.00	.01	.01	.30	.01	.66	.00	.05	.47	.16	.09	.04	.00	.00	.07
17	.00	.04	.84	.29	.96	.14	.06	.05	.21	.08	.42	.16	.04	.56	.44	.01	1.00	.83	.09	.07	.78	.03	.00	.02	.16	.71	.01	.03	.02	.02
18	.06	.17	.84	.53	.92	.00	.04	.01	.00	.01	.21	.48	.04	.80	.30	.01	.83	1.00	.05	.06	.51	.02	.11	.01	.24	.01	.02	.01	.14	.07
19	.11	.07	.16	.01	.14	.07	.14	.01	.23	.01	.24	.12	.06	.00	.32	.30	.09	.05	1.00	.38	.31	.03	.00	.01	.07	.04	.04	.00	.14	.09
20	.06	.08	.01	.08	.01	.01	.04	.02	.00	.01	.02	.10	.03	.02	.00	.01	.07	.06	.38	1.00	.00	.21	.02	.03	.01	.03	.03	.00	.03	.05
21	.09	.12	.78	.47	.69	.08	.10	.01	.57	.33	.37	.08	.07	.08	.63	.66	.78	.51	.31	.00	1.00	.00	.01	.02	.17	.44	.08	.02	.20	.13
22	.20	.22	.00	.00	.03	.09	.07	.10	.07	.15	.04	.29	.04	.00	.00	.00	.03	.02	.03	.21	.00	1.00	.12	.03	.09	.07	.07	.00	.05	.10
23	.49	.30	.01	.00	.00	.13	.14	.11	.50	.45	.00	.25	.32	.02	.18	.05	.00	.11	.00	.02	.01	.12	1.00	.07	.23	.37	.28	.00	.08	.34
24	.16	.14	.02	.00	.00	.08	.17	.03	.00	.03	.09	.05	.14	.02	.00	.47	.02	.01	.01	.03	.02	.03	.07	1.00	.40	.01	.18	.07	.18	.20
25	.58	.56	.10	.07	.12	.14	.42	.08	.02	.02	.39	.43	.24	.00	.00	.16	.16	.24	.07	.01	.17	.09	.23	.40	1.00	.01	.44	.12	.38	.50
26	.21	.12	.45	.11	.76	.02	.00	.12	.78	.80	.05	.04	.28	.01	.58	.09	.71	.01	.04	.03	.44	.07	.37	.01	.01	1.00	.17	.01	.00	.14
27	.54	.35	.04	.04	.06	.30	.22	.02	.36	.07	.34	.19	.62	.00	.01	.04	.01	.02	.04	.03	.08	.07	.28	.18	.44	.17	1.00	.29	.46	.76
28	.17	.10	.02	.02	.00	.01	.02	.00	.01	.00	.08	.01	.28	.02	.00	.00	.03	.01	.00	.00	.02	.00	.00	.07	.12	.01	.29	1.00	.18	.39
29	.50	.41	.13	.09	.04	.17	.25	.05	.04	.37	.58	.15	.51	.00	.14	.00	.02	.14	.14	.03	.20	.05	.08	.18	.38	.00	.46	.18	1.00	.72
30	.67	.32	.07	.05	.01	.54	.44	.06	.05	.02	.45	.21	.77	.00	.05	.07	.02	.07	.09	.05	.13	.10	.34	.20	.50	.14	.76	.39	.72	1.00

1 and under the assumption that all other 28 parameters are identically relevant for the index formation, they receive an identical weighting, namely $\gamma_i = \frac{1}{28}$ independent of normalisation and imputation procedures.

The weights in the PCA and AHP procedures are shown as examples in the Tab. 3.

In order to take into account, the fact that only few secondary data are available for some countries in the index calculation, a country-specific weighting factor α is applied in addition to the parameter-specific weightings γ_i. Since the application of imputation procedures in particular leads to a distortion of the results, this weighting factor takes into account that countries with little raw data are devalued. To simplify matters, three country groups are formed: all parameters are fully weighted if more than 20 raw data are available for a country, a weighting of 0.5 is applied if less than 10 data are available, otherwise a three-quarters weighting is applied. Thus applies:

$$\begin{aligned} \alpha &= 1, \quad |X_i| \geq 20, \\ \alpha &= \tfrac{3}{4}, \quad 20 > |X_i| \geq 10, \\ \alpha &= \tfrac{1}{2}, \quad 10 > |X_i| \end{aligned} \tag{35}$$

Tab. 3: left: maximum loadings PCA, weights (MinMax normalisation, kNN imputation), right: weights using the AHP method

X_i	Max loading	Weight	X_i	Weight
3	0.358	0.042	3	0.021
4	0.182	0.021	4	0.021
5	0.565	0.067	5	0.051
6	0.286	0.034	6	0.040
7	0.162	0.019	7	0.040
8	0.212	0.025	8	0.031
9	0.291	0.034	9	0.048
10	0.293	0.035	10	0.040
11	0.273	0.032	11	0.036
12	0.258	0.031	12	0.035
13	0.386	0.046	13	0.032
14	0.256	0.030	14	0.030
15	0.519	0.061	15	0.032
16	0.238	0.028	16	0.048
17	0.248	0.029	17	0.048
18	0.411	0.049	18	0.048
19	0.216	0.026	19	0.025
20	0.322	0.038	20	0.024
21	0.245	0.029	21	0.024
22	0.262	0.031	22	0.024
23	0.173	0.020	23	0.030
24	0.498	0.059	24	0.050
25	0.273	0.032	25	0.050
26	0.164	0.019	26	0.024
27	0.433	0.051	27	0.026
28	0.474	0.056	28	0.031
29	0.162	0.019	29	0.045
30	0.304	0.036	30	0.045

In addition to the weighting of the parameters, the question of how they are aggregated to create a comparative index must be answered. Aggregation functions are additive, multiplicative or other methods of combining the individual indicators into an aggregated index. Depending on the indicators used in terms of compensability, independence and the standardisation method used, aggregation procedures can be excluded (Bjerre et al., 2019; OECD, 2020b). An additive aggregation function is most frequently used, i.e. the summation with γ_i weighted indicators X (OECD, 2020b, p. 109):

$$\text{Indexvalue} = \sum_i \gamma_i x_i \tag{36}$$

In reality, indicators can cancel each other out, i.e., compensate for each other. The weightings that are considered to be the importance of the indicators can thus also cancel each other out, which can lead to several problems (Greco et al., 2019, pp. 75 ff.). However, the above-mentioned disadvantage of the compensability of the indicators can lead to undesired effects. To avoid this as far as possible, geometric methods can be used:

$$\text{Indexvalue} = \prod_i x_i^{\gamma_i} \tag{37}$$

A multiplicative approach can also have compensatory effects, but these are much smaller (OECD, 2020b, p. 32). Combinations between additive and geometric models are also possible and are used for the present purpose.

The index values determined can then be ranked using a ranking procedure in the sense of a "ranking by points". Non-linear ranking procedures (e.g. according to Condorcet or Borda rules, which carry out pairwise comparisons and lead to a ranking) are not considered in this article (Greco et al., 2019, p. 77).

In order to examine the introduced component model and the parameters for usefulness, a composite index is formed with the help of the weighting and aggregation procedures outlined above, which is used as the basis for the robustness analysis. It is important to mention that there is no golden rule on how to weight and aggregate, and in the further development of indices there are numerous known examples that the procedures can also change in the evolution of indices.

A digital sovereignty index (DSI) for a state can thus be formed as follows:

$$\begin{gathered}
\text{DSI} = \alpha\,(x_1 x_2) \sum_{i=3}^{30} \gamma_i x_i, \\
\sum_{i=3}^{30} \gamma_i = 1, \quad 0 \le \gamma_i \le 1, \quad \gamma_{1,2} = \frac{1}{2}, \\
X = X_n = \begin{pmatrix} x_{n1} \\ x_{n2} \\ \vdots \\ x_{30m} \end{pmatrix}, \\
x_{nm} \in \mathbb{R}, \quad n, m \in \mathbb{N}.
\end{gathered} \tag{38}$$

3.6 Verification, Validation and Robustness

Depending on the use of different normalisation, imputation, weighting and aggregation procedures, different index values or the resulting rankings of the states are produced, as shown in the Fig. 7.

An analysis of variance can identify the best combination of methods. For the data used here, this is simply normalised raw data, mean imputation and equal weighting. In addition to an optimal result through the analysis of variance, this is to be understood in a particularly positive way, as the data thus remain largely unbiased and their weighting is simple.

To validate the index for digital sovereignty, it is compared with other existing indices. In addition to an Economic Forum Index (EFI), the following indices are used for comparison (Miller et al., 2021) as well as sustainable indices in the sense of economically, socially and ecologically relevant indices (Hampel et al., 2016): Food Safety Index (FSI), Better Life Index (BLI), Economic Freedom Index (EFI), Happy Planet Index (HPI), Environmental Performance Index (EPI). In addition and separately, the Digital Dependence Index (DDI), which measures the digital dependence of countries, is compared (Mayer and Lu, 2022).

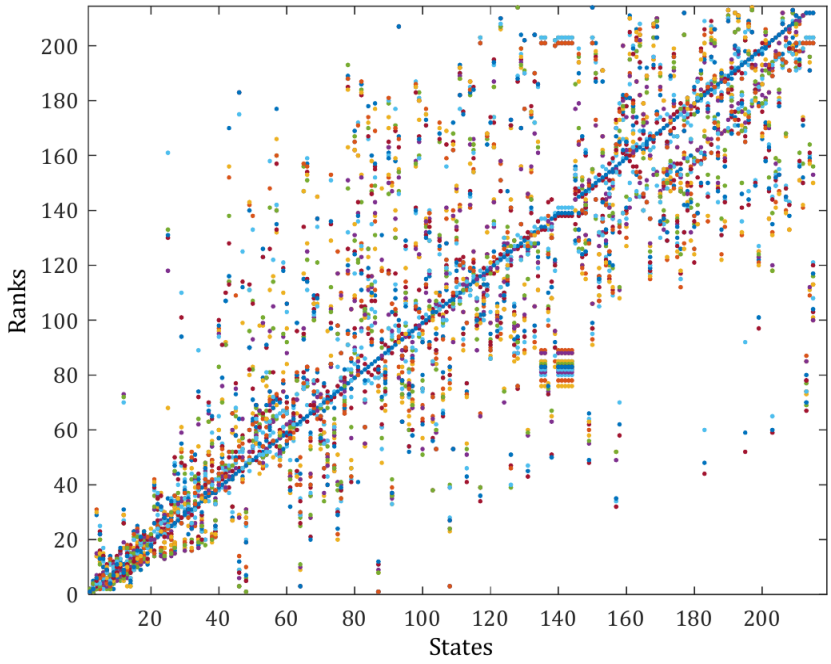

Fig. 7: All states, ranks: sorted by rank, mean imputation, additional ranks of other permutations

Tab. 4: Sum and mean variance calculation

	Raw			MinMax		
	PCA	**AHP**	**equal**	**PCA**	**AHP**	**equal**
Sum	25,059.50	25,907.50	24,969.25	62,177.00	63,138.50	62,821.00
Mean	117.10	121.06	116.68	290.55	295.04	293.56
Rank sum	2	3	1	7	9	8
Rank mean	2	3	1	7	9	8
	MN = 0			**MN = 0, StD = 1**		
	PCA	**AHP**	**equal**	**PCA**	**AHP**	**equal**
Sum	40,583.50	49,113.50	47,897.00	97,503.00	110,100.00	100,745.00
Mean	189.64	229.50	223.82	455.62	514.49	470.77
Rank sum	4	6	5	10	12	11
Rank mean	4	6	5	10	12	11

Focusing on the DSI, it becomes graphically clear that there are linear relationships to the FSI and BLI indices, but not to the other indices. The FSI describes the affordability, availability and quality of food security for 113 countries on the basis of 58 individual indices. The FSI's individual indices largely do not overlap with the parameters of the DSI, and both indices show a high correlation with $R^2 = 0.86$. With the BLI, the OECD assesses elements of quality of life such as the income situation of households, living conditions, education, environment, governance and also security within the framework of the Better Life Initiative (OECD, 2020c). Extensive overlaps with the DSI can be identified, which are also shown in the regression analysis with $R^2 = 0.77$. When focusing on EU states, the degree of determination remains largely identical ($R^2 = 0.79$). This confirms a linear dependence of the DSI on the BLI.

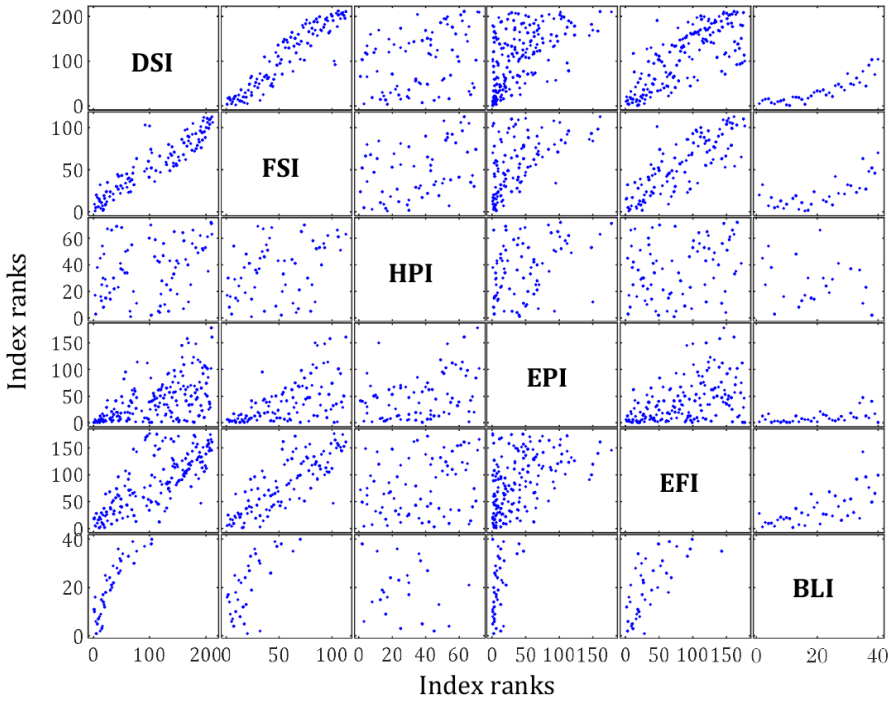

Fig. 8: Scatter plot index comparison ranks, all states

Due to comparable assessment bases, the BLI is suitable in terms of a verification of the selection of the correct parameters for the DSI, but the FSI is suitable as a comparative index for a validation of the correct representation of reality by the DSI.

The Digital Dependence Index (DDI) takes on particular relevance, as it measures the extent to which states act in digital dependence on other states, based on the G20 states as well as Kenya, Israel, Estonia and Singapore. The linear correlation of the ranks of the DSI and DDI is initially not significant ($R^2 = 0.16$). Because some of the main components or sub-indices are similar, it is advisable to analyse them. If there are significant correlations, a significant part of the DSI can be validated. Since the DDI focuses on digital dependencies and does not measure digital sovereignty as a whole, it is recommended not to compare the indices as a whole, but only their sub-indices.

Tab. 5: Coefficient of determination DDI and DSI (main components)

	Δ_2	Δ_3	$\Delta_2 + \Delta_3$	DSI
DDI	0.72	0.26	0.62	0.16

Special attention is thus paid to the main component Δ_2 (KET) with a coefficient of determination of 72%, which also affects the sum of main components 2 and 3 of the DSI.

The main component Δ_3 (technological sovereignty) only has a coefficient of determination of 26%, which can, however, be significantly increased to 56.7% by excluding outliers.

Due to the significance of the regression results, the DSI can be validated by the DDI for two of the three main components.

The verification of the DSI by the BLI and the validation of selected main components of the DDI and in sum with the FSI show that the component model proposed in this article as well as the selection of the 30 parameters seem suitable to measure digital sovereignty.

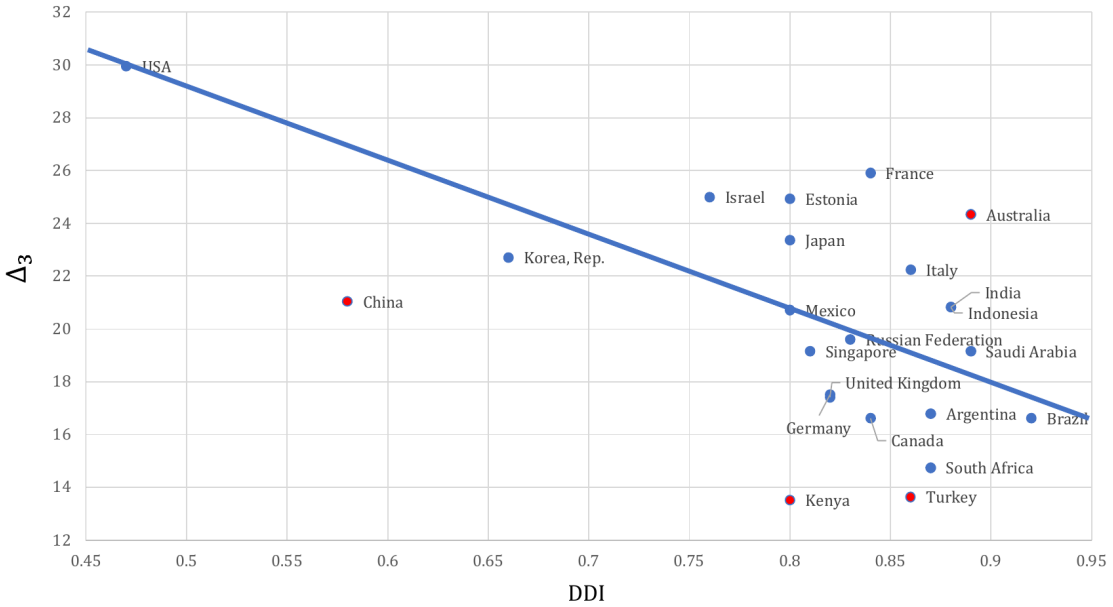

Fig. 9: Regression analysis DDI and Δ_3 without outliers (red)

4 CONCLUSIONS

Digital sovereignty of states is a new concept that has been widely discussed, influencing political and economic actions and creating a proxy discussion on whether dependence on other states' resources affects one's own state sovereignty. There is also no uniform, scientific definition. Although the individual terms "digital" and "sovereignty" as well as elements of digital sovereignty are described in a variety of scientific ways, a synthesis and a common understanding that forms the basis for joint action do not exist. A first qualitative proposal was published by the author in November 2021 and is ready for scientific discourse. The proposal is based on a historical analysis of the individual terms, which was brought together by means of synthesis. The proposal is derived from the understanding of sovereignty of European states and presupposes a free, liberal, democratic basic order. With this proposal, isolationism, autarky and autocracy are considered to prevent digital sovereignty, even if (semi-) autocratic states partly exhibit a high degree of digital sovereignty through protectionism. To concretise the qualitative definition, a hierarchical component model was derived in this article that consists of 3 main components and 10 subcomponents. The subcomponents can each be determined metrically with at least one of a total of 30 parameters from secondary data. The data are subject to different scales and have to be normalised for further consideration. Missing data can be estimated by suitable imputation procedures if necessary. However, normalisation and imputation significantly change the raw data, which must be taken into account in further analyses.

The coefficient of determination can be used to identify linear correleations between the parameters. Redundancies are evident in the evaluation of digital sovereignty with the 30 recommended parameters, since more than 20 pairwise comparisons of the parameters have a coefficient of determination of $\geq 50\%$, but it is suggested by the author that no parameter be completely replaced by the others to prevent information loss. Thus, all parameters should be considered in further analyses. Through the 30 parameters, a metric basis for the assessment of digital sovereignty can be created for each state.

Through equal weightening and a mix of additve and geometric aggregation a composite index is suggested and a basis for verification and validation and the calculated index can be verified and described as valid, because as good correlations can be found with the Better Life Index, which has similar parameters. Various methods are used to validate the model and the index formation. In addition to a visual plausibility check, it can be shown that it, or its main components, have significant correlations with existing indices such as the Food Safety Index and the Digital Dependency Index. It thus maps well the reality, which is formulated as a basis through the definition of the new term with this and an author's previous work, but which can be derived from the previously mentioned indices.

This article can therefore fill the research gap of developing a model that makes digital sovereignty measurable. This can be the basis for quantitatively measuring the digital sovereignty of states and identifying levers with which it can be strengthened. In addition, the effectiveness of the levers can be assessed through simulations, as the effects on digital sovereignty can be measured by changing individual parameters. Therefore, the model can serve as a decision support system for political or economic decision makers who want to strengthen the digital sovereignty of states.

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EFFECT OF FOREIGN DIRECT INVESTMENT ON ECONOMIC GROWTH AND DOMESTIC INVESTMENT: EVIDENCE FROM OECD COUNTRIES

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ABSTRACT

This study assesses the impact of foreign direct investment (FDI) inflows on economic growth and domestic investment in a panel of Economic Co-operation and Development (OECD) countries during the period of 1990–2017 by utilizing the method of fixed-effects and system generalized method of moments (GMM). The findings show that FDI inflows are positively and significantly associated with the economic growth of the host economy. When considering the origin of FDI, we find that FDI from developed countries contributes to the growth rate in the receiving economy, while FDI from developing countries shows no significant effect. Importantly, FDI does not appear to crowd in or out domestic investment. Only FDI from developed countries is associated with crowding in of domestic investment.

KEY WORDS

foreign direct investment, economic growth, domestic investment, crowding in/out, OECD

JEL CODES

E22, F21, F23, F43, O47

1 INTRODUCTION

Foreign direct investment (FDI) has been the largest source of external finance in the world following the drying up of commercial bank lending in the 1990s (Carković and Levine, 2005). Many countries have offered various incentives such as income taxes, import duty exemption, subsidies for infrastructure, etc., in order to attract more inward foreign investment, driven by the belief that FDI provides much-needed capital accumulation and advanced technology transfer, supports employment creation, boosts acquisition of human capital, and encourages adoption of new managerial practises via different channels (Aitken and Harrison, 1999).

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Although there exists a huge body of studies evaluating the effect of FDI on economic growth, the literature has not reached a consensus on the effects of FDI inflows. Most empirical studies such as Borensztein et al. (1998), Li and Liu (2005), and Azman-Saini et al. (2010) observe a growth-enhancing effect of FDI, while others suggest the relationship between these variables is negative (Mencinger, 2003; Kherfi and Soliman, 2005). Some empirical studies, such as Nath (2009) and Ang (2009), even find no significant effect of FDI on the growth of the host country. A review of 108 empirical studies by Iamsiraroj and Ulubaşoğlu (2015) reports that 43% of them found a positive and significant effect of FDI, 17% yielded negative and statistically significant results, while the rest (40%) claimed an insignificant impact of FDI on economic growth. This wide range of findings might stem from the data unavailability in either cross-country or time series examinations. Another possible reason behind the mixed results may be the potential endogeneity issue, as inward FDI flows lead to higher economic growth in the recipient economy, and the higher growth rate at the same time attracts more FDI to the country. In addition, the growth-promoting effect of FDI generally has been studied in the context of developing countries, which are highly heterogeneous with respect to the degree of market economy, level of democracy, real Gross domestic product (GDP) per capita, etc., which can bias the coefficient of variables included in the regressions. Last but not least, the origin of FDI inflows might be another factor leading to inconclusive results, as FDI inflows should not be treated homogeneously across economies in the literature. Because the source country of FDI inflows may determine the potential growth-promoting impact of FDI on the host economy. FDI inflows, for example, contribute to the growth of the host nation by introducing cutting-edge technologies. However, the level of technology owned by foreign corporations determines the extent of technology transfer to domestic firms. Within this framework, the origin of foreign investments matters for this relationship because, as argued by Luo (1998), FDI inflows from developed countries are more engaged in research and development and operate with more advanced technology. Thus, technological transfer is mostly driven by foreign investments from developed nations (it is discussed in detail in the following section).

The purpose of this research is to examine the effect of FDI inflows on the economic growth rate and whether this effect depends on the level of financial development, human capital, political freedom, and infrastructure development in the Organisation for Economic Co-operation and Development (OECD) member countries over the period 1990–2017. One of the things that makes this research different from existing studies is that updated data is applied for all variables. Another contribution is that the results are estimated by the pooled ordinary least squares (OLS) and fixed-effect panel regression to take into consideration country-specific factors. In order to deal with the potential endogeneity issue, the system generalized method of moments (GMM) designed by Arellano and Bover (1995) and Blundell and Bond (1998) was employed in order to obtain consistent and efficient results; this serves as a robustness check of the results estimated by the fixed-effects model. Furthermore, the origin of FDI is considered by dividing countries into two groups: FDI from developed and developing countries, to check if the origin of FDI matters in the link between FDI and the growth rate of the receiving economy. Finally, OECD member countries have been chosen as the sample countries because OECD member countries are similar with respect to market economies, democracy, and (most of them) can be regarded as developed countries. These countries also attract more than half of the world's FDI flows. These common features help reduce the potential biases.

This research also analyses the crowding in or out effect of inward FDI flows on domestic investment in OECD economies between 1990 and 2017. In terms of the crowding in/out impact, the literature suggests three possible outcomes. If domestic firms learn superior technology or managerial practises from foreign enterprises or engage in complementary activi-

ties such as backward and forward linkages, FDI may crowd in domestic investment. However, if indigenous businesses do not absorb superior technology, managerial skills, and so on, they will fall behind their multinational enterprise (MNE) competitors and be forced out of business. Finally, there is a possibility that FDI has no significant influence on domestic investment. Additionally, we consider the source of FDI inflows when examining the relationship between FDI and domestic investment, which has been overlooked in previous research. FDI inflows from various countries may have a distinct effect on the host economy's domestic investment. As stated by Gee and Karim (2011), FDI from developing countries, for instance, concentrates more on export markets than collaboration with local firms, such as backward or forward linkages, which is less related to crowding in domestic investment. Accounting for these factors results in a more accurate assessment.

Taking into account all the potential factors that have been partially considered by existing studies and that could contribute to inconclusive conclusions about the impact of FDI on growth and domestic investment, this study aims to answer the following questions:

- Does FDI affect the growth rate of the host countries?
- What is the role of countries' absorptive capacity in the relationship between FDI and the economic growth of the host countries?
- Does FDI crowd in or out domestic investment in the receiving country?
- Does the origin of FDI matter in the relationship between FDI and growth rate and domestic investment?

The remainder of the paper is organized as follows: Section 2 offers a brief review of the literature on the relationship between FDI, economic growth and domestic investment. Section 3 outlines the methodology and data used in the empirical research. Section 4 presents the outcomes of regressions and discusses them. The results of the robustness check are also shown in this section. Finally, a conclusion and a summary are provided in section 5.

2 LITERATURE REVIEW

In the literature, there are two growth theories, namely the neoclassical growth theory and the endogenous growth theory, according to which FDI is expected to contribute to the growth rate of the host country.

Felipe (1999) argues that in the context of the neoclassical growth theory, the growth of an economy usually derives from two factors: factor accumulation and total factor productivity (TFP). The majority of studies in the literature usually focus on the relationship between factor inputs and growth rather than total factor productivity because of the challenges inherent in measuring TFP, selecting a suitable econometric method and a dearth of sufficient data (Öztürk, 2007).

Borensztein et al. (1998) assert that according to endogenous growth theory, the pace of technological advancement is the primary determinant of the growth rate over the long run. Technical progress may take place in the host country as a result of technological dissemination by overseas multinational corporations. However, the deployment of these more advanced technologies demands that the host economy have an adequate amount of human capital. As a result, the absorptive potential of a developing nation is hampered by the host country's insufficient human capital.

Öztürk (2007) clarifies three major mechanisms via which FDI influences growth in the context of endogenous growth models. To begin, FDI helps the recipient country accumulate capital by bringing new inputs and technology. Second, FDI augments the existing stock of knowledge and skills in the host country through labour training and the introduction of alternative managerial practices. Finally, FDI raises the intensity of competition among firms in the receiving economy by lowering entry barriers and eroding dominant businesses' market dominance (Öztürk, 2007).

To conclude, according to both neoclassical and endogenous growth models, FDI is predicted to have a crucial role in contributing to economic growth in the receiving economy. Although the growth theories predict the growth-promoting impact of FDI, in practice, empirical studies show inconclusive findings regarding the link between FDI inflows and economic growth.

2.1 Possible Reasons for the Different Effects of FDI on Economic Growth and Some Empirical Evidence

As mentioned before, although lots of studies have been done concerning the link between FDI and the growth rate, no consensus has emerged among economists on the nature of this relationship. According to endogenous growth theories, FDI boosts growth directly by increasing capital stock and introducing new technologies, and indirectly through spillover effects which might take the shape of management capabilities, organisational expertise, and workforce development by labour training. Additionally, FDI can aid the host economy in acquiring access to global markets (Iamsiraroj and Ulubaşoğlu, 2015). However, it is possible to find the three possible outcomes, namely positive, negative and insignificant effect of FDI, in the literature.

There are a number of channels through which the positive spillovers of FDI arise in the host economy. Imitation by local operators may provide an opportunity of spillover (Görg and Greenaway, 2004). Domestic firms try to replicate the same processes applied in foreign-owned operations in the local markets. The success of the simulation by local companies depends on the degree of complexity of the production. Any improvements in technology that result from imitation cause a productivity spillover to local firms. Skill acquisition can emerge as an essential channel for spillovers. Although MNEs tend to hire relatively more skilled workers in the host country, they usually invest in training to make labour more qualified. In the case of the movement of workers from foreign to indigenous firms, they are carrying with them knowledge of new technology (Görg and Greenaway, 2004), However, labour mobility may be prevented by forign affilitates by offering a higher wage (Glass and Saggi, 2002). Even if spillovers do not occur, the host country's welfare may increase as a result of the salary paid to the trained workers by the MNE to deter them from joining a local business (Fosfuri et al., 2001). Another way can occur through competition unless a multinational firm dominates an entire market in the recipient economy. When multinationals compete with domestic firms, they exert pressure on local firms to adopt new technology employed by the MNE or to use existing technology more efficiently to be able to keep producing in the market, as discussed by Görg and Greenaway (2004). Linkage of foreign companies with the rest of economy also helps create positive spillovers like providing intermediate goods produced by local counterparts to foreign ones as argued by Blomström and Kokko (1998). The last conduit is export spillover, which may result in productivity increases in the host economy (Görg and Greenaway, 2004). Export case studies indicate that enterprises that penetrate international markets lower entry costs for other potential exporters, either via learning effects or through the establishment of commercial ties (Aitken and Harrison, 1999). Within this context, the entry of foreign affiliates may provide an opportunity for local businesses to learn how to access the worldwide market through partnership.

Negative effect of FDI inflows on the growth of the host economy might occur via distortion in the domestic economy. Once a foreign firm manages to gain monopoly status in the host economy, the foreign company may give up producing efficiently, just focusing on profits (Borensztein et al., 1998). Governments expenditure on infrastructure to attract foreign investors lead to increases in foreign debt and distortion in the tax system, which might crowd out local firms and a decrease in total output in the domestic market. Having a large reliance on foreign capital could be harmful to the host country, especially if FDI inflows are highly volatile (Kherfi and Soliman, 2005). Foreign

affiliates may repatriate their earnings to their parent firms in the form of dividends, resulting in significant capital outflows from the host nation to the home country, which in turn has a detrimental effect on the former's balance of payment (Öztürk, 2007; OECD, 2008). Another negative effect could appear through resource curse for countries with a greater size of natural resource sector. The entrance of foreign direct investment into nations with a natural resource sector increases the growth-hapering effect of natural resources (Hayat, 2018). Another possible way might occur through the financial market. If a foreign investor gets credits in the host economy, the allocation of limited financial resources will not be available for new local entrepreneurs. Also, the local firms suffering from a obtaning loans might be forced out of business. If foreign entrepreneurs prefer to import inputs instead of collaborating with local suppliers, this could lead to less gain from FDI or may even be detrimental (Firebaugh, 1992).

Some studies (e.g., Carković and Levine, 2005; Adams, 2009) do not find a significant effect of FDI on growth. The lack of a significant impact of FDI may be because of the insufficient level of development of the financial system, human capital, institutional quality, infrastructure level, etc. Additionally, overseas affiliates may be able to safeguard the dissemination of knowledge, granting them a competitive advantage in the local market (Görg and Greenaway, 2004). Finally, knowledge spillovers occur only when domestic enterprises have the financial resources to invest in absorbing foreign technology, which may be limited by undeveloped domestic financial markets (Herzer, 2008). All of these possible reasons provided to explain the potential reasons for the positive, negative and insignificant effect of FDI will be considered in this research.

Tab. 1 summarises some prior empirical studies on FDI and economic growth in host countries. There is more research on FDI and economic growth, but the ones chosen are regarded to better represent the literature's ambiguous conclusions on the FDI-growth rate link.

2.2 Crowding in or out Effect of FDI on Domestic Investment

Previous research has been inconclusive regarding the relationship between FDI inflows and domestic investment in the receiving country. Some empirical analyses detect a crowding-in effect of FDI on domestic investment (e.g., Mileva, 2008; Ang, 2009), while others (e.g., Agosin and Machado, 2005; Pilbeam and Oboleviciūtė, 2012) observe a significant crowding out effect of FDI. Other studies even fail to find any evidence of the crowding in or out effect of FDI on domestic investment of the host country (e.g., Liu et al., 2001).

Blomström and Kokko (1998) argue that foreign companies stimulate domestic ones through the absorption of new machinery and advanced technology brought by foreign firms. Crowding in effect could be realised through human capital conduit. Foreign companies tend to hire workers endowed with more educated, talented, and higher levels of skills (De Backer and Sleuwaegen, 2003). Employees are trained by multinational corporations and continue to expand their knowledge by working with advanced technology throughout their employment. Having sufficient skills and knowledge encourages employees to set up their own companies in the future. MNEs also pay skilled workers more than the average wage, which lets them save money and start their own businesses. Another potential channel may occur through labor turnover, wherein local firms employ workers trained by foreign affiliates to be able to work with modern technology. These employees may encourage domestic firms to invest in modern technology to be able to compete with foreign counterparts or at least to use their existing technology more efficiently. Furthermore, crowding in effect may take place with complementary activities like backward linkages, e.g., local firms may provide intermediate goods for foreign companies, as argued by Pilbeam and Oboleviciūtė (2012). Mileva (2008) suggests that FDI may bring capital inflows to the host country, which reduces the interest rates and increases the availability of loans for local investors to finance new investment. With

Tab. 1: Summarise the findings of empirical studies on the link between FDI and growth

Author(s)	Sample and Period	Method	Main Findings
Balasubramanyam et al. (1996)	1970–1985, 46 countries	OLS and Generalised Instrumental Variable	FDI has a greater growth-promoting effect in countries that pursue an outward-oriented trade policy than in those that follow an import substitution regime.
Kohpaiboon (2003)	Thailand, 1970–1990	Engle-Granger method	FDI alone shows a negative effect on the growth rate of Thailand. However, its growth-promoting effect is captured with economic openness level. When comparing countries that follow an export promotion trade regime to those that pursue an import substitution regime, the growth effect is more likely to be greater.
Borensztein et al. (1998)	1970–1989, developing countries	SUR technique, 3SLS	The growth-enhancing effect of FDI depends on the absorptive capacity of the host country.
Balasubramanyam et al. (1999)	1970–1985, 46 countries	OLS, Generalized Instrumental Variable Estimator (GIVE)	More FDI benefits have been recorded for countries that have reached a certain level of human capital and are pursuing an export-oriented policy.
Xu (2000)	1960–1993, 41 countries	Vector-autoregressive (VAR)	Developed countries could benefit more from foreign investment.
Durham (2004)	1979–1998, 80 countries	Cross-sectional OLS	The growth-stimulating effect depends on the level of financial and institutional development of the receiving country.
Bengoa and Sánchez-Robles (2003)	1970–1999, 18 Latin American countries	Fixed effects, Two-Stage GMM	FDI has a positive effect on countries that have a sufficient level of human capital, economic stability, and liberalized markets.
Olofsdotter (1998)	1980–1990, 50 countries	OLS, IV	FDI has a positive effect on the growth rate.
Campos and Kinoshita (2002)	1990–1998, 25 Central and Eastern European and form Soviet Union transition countries	Fixed effects, Granger Causality, Instrumental variables (IV)	The human capital of host countries does not play a significant role in the growth-promoting effect of FDI. FDI alone contributes to the receiving country's growth rate.
Carković and Levine (2005)	1960–1995, 72 developed and developing countries	Pooled OLS, GMM	The evidence for a positive link between FDI and growth rate is weak.
Alfaro et al., (2004)	1975–1995, 71 developed and developing countries	Pooled OLS, Instrumental Variable (IV)	FDI alone does not have a growth-promoting effect on the receiving country. Its positive effect is contingent on the development of financial market.
Ang (2009)	Malaysia	Vector Error Correction Model	FDI does not stimulate economic growth in the long-run. However, the growth-enhancing effect is found through a well-established financial system.
Hermes and Lensink (2003)	67 developed and developing countries.	OLS, fixed and random effects	The direct effect of FDI on the growth rate is negative. However, FDI contributes to the growth rate of host country through a developed financial system.
Iamsiraroj and Ulubaşoğlu (2015)	1970–2009, 140 developed and developing countries	OLS, GMM	Countries with a well-developed financial system get more benefits from FDI.
Azman-Saini et al. (2010)	1975–2004, 85 countries	GMM	FDI by itself does not have a direct effect on the growth rate of host countries. Its positive effect depends on the level of economic freedom.
Alguacil et al. (2011)	1976–2005, 26 developing countries	GMM	They stress the importance of the macroeconomic and institutional background that enables the recipient countries to gain more spillovers associated with foreign investments
Busse and Groizard, (2008)	1984–2003, 84 developed and developing countries	GMM	The key factor of enjoying the benefits of FDI in the receiving economy is regulations. However, FDI has a limited growth effect in countries with most heavily regulated.

Author(s)	Sample and Period	Method	Main Findings
Lensink and Morrissey (2006)	1970–1997,	OLS, Fixed effects, 2LSL	FDI has a positive effect on economic growth, but it is not entirely robust. However, FDI volatility always has a negative effect on the growth rate.
Adams (2009)	1990–2003, Sub-Saharan Africa countries	OLS, Fixed effects	The growth-stimulating effects is observed only in the OLS estimation. Therefore, its positive effect is not robust.
Li and Liu (2005)	1970–1999, 84 countries	Random effects	FDI has a substantial positive impact on economic growth for both developed and developing countries. Besides, the coefficient coefficient of FDI with technology gap is negative indicating that if there is a large gap gap between home country and host country, the growth-enhancing effect of FDI could not be occurred in the recipient country owing to the lack of absorptive capacity of technology.
Khaliq and Noy (2007)	1997–2006, Indonesia	Fixed effects	The positive effect of FDI on the economic growth of China.
Zhang (2006)	1992–2004, China, 28 provinces	OLS, Fixed effects	The growth-promoting effect of FDI on China's income is found. The growth-enhancing impact appears to be greater in the coastal region than in the interior region.
Kherfi and Soliman (2005)	1979–2002, Central and Eastern European (CEE) and the Middle East and North Africa (MENA) countries	Fixed effects and 2LSL	The growth-promoting effect associated with FDI is observed for EU accession countries, while FDI has a negative influence on the growth rate of MENA and non-EU accession countries. They also see human capital as an important conduit through which FDI makes a positive contribution to economic growth in EU candidate nations.
Johnson (2006)	1980–2002, 90 countries	OLS and Random-effects	FDI inflows do not contribute to the growth of developed countries because of the possible explanation that domestic investment is not different from foreign investment in those countries.
Awe (2013)	1976–2006, Nigeria	2SLS	The relationship between FDI and the growth rate of the economy is negative. Capital flight via profit repatriation could be one of the causes of the inverse link.
Sarkar (2007)	1970–2002, 51 least developed countries	Random effects, ARDL	The rising relationship between growth and FDI is observed for only 16 countries that have high incomes and trade openness in panel data analysis. Without making differentiation between countries based on the level of income and trade openness, the majority of countries do show no long-term relationship between FDI and economic growth.
Mencinger (2003)	1994–2001, 8 transition countries	Granger causality test	His empirical findings show a negative correlation between economic growth and FDI. The negative effect of FDI on economic growth is strengthened once the lagged FDI is used as an independent variable instead of FDI.
Hayat (2018)	1993–2012, 106 countries	Fixed effects	FDI accelerates growth rate of the receiving country. However, the growth-enhancing effect slows down with the existence of natural resources in the host economy.
Sirag et al. (2018)	1970–2014, Sudan	Cointegration test	FDI has a positive effect on the growth rate of Sudan. Furthermore, in the presence of financial development in the host economy, FDI contributes more to the economic growth rate.
Raza et al. (2021)	1996–2013, OECD countries	Fixed effects and GMM	In the presence of a good governance system, a positive link is found between FDI and economic growth
Asamoah et al. (2019)	1996–2016, 34 SSA countries	Structural equation modelling	A decreasing effect of FDI on economic growth is observed. This adverse effect increases without good institutional quality.
Louail and Zouita (2021)	1985–2019, 11 developing countries	PMG/Panel ARDL	They conclude that there is a positive relationship between FDI, economic growth and financial development in the long run, while no such proof is found in the short run.

these potential channels, FDI inflows crowd in domestic investment in the receiving economy.

On the other hand, multinational enterprises (MNEs) can displace domestic producers if the latter are not able to absorb the superior technology, management skills, or other advantages introduced by foreign firms, as argued by Blomström and Kokko (1997). Moreover, domestic investment may be substituted by foreign firms if MNEs prevent the leakage of their superior tangible and intangible assets such as modern technology, management expertise, organisational know-how, and so on, or import inputs instead of looking for local suppliers (De Backer and Sleuwaegen, 2003; Mileva, 2008). Incentives, such as tax exemptions, offered by governments to attract more foreign investors may also lead to domestic investments being crowded out. Because foreign investments that benefit from tax exemption can displace local investments supplying similar goods and services. To conclude, unless local companies adapt to the advanced technology had by foreign counterparts or make use of the advantages introduced by MNEs or collaborate with them, such as providing inputs to foreign affiliates, they fall behind the competition with MNEs and could easily be forced out of business.

2.3 Characteristics of FDI Inflows from Different Countries

Research assessing the role of FDI inflows from different countries in contributing to the host countries' economies has been limited. To the best of our knowledge, all existing studies investigating the effects of FDI from various countries focus on industry and firm-level data (e.g., Collis et al., 1994; Banga, 2006; Waldkirch, 2010; Gee and Karim, 2011), except for the study of Fortanier (2007), who utilized macro-economic data.

As previously stated, FDI from various countries may have varying effects on the host country's economy. The possible reasons are argued by various studies. Caves (1974), for example, emphasises that expansionary FDI contributes more to the host economy's intangible assets, such as knowledge transfer, organisation and managerial skills. Additionally, this sort of FDI is typically equipped with advanced technology and operates in capital-intensive industries, resulting in increased market breadth and product differentiation in the host economy (Luo, 1998). Chen and Ku (2000) claim that foreign investments from developed countries are more of the expansionary type, whereas emerging-country FDI is more defensive in nature. Gee and Karim's (2011) findings are consistent with those who argue that FDI inflows should not be treated uniformly across countries. They contend that FDI from developed markets greatly contributes to technology transfer by introducing new inputs and technologies into the host country's production processes. Additionally, FDI from developed economies contributes new knowledge to host countries, using foreign experience in successfully managing host country enterprises. Also, foreign investment from developing markets typically seeks for efficiency and cost savings rather than product differentiation strategy. This type of investment normally benefits the host country in terms of export rather than contributes to new knowledge and technology spillovers, as argued by Gee and Karim (2011). In conclusion, it is expected that the impact of FDI from developing countries on economic growth and domestic investment is less beneficial than that of FDI from developed countries.

3 DATA AND METHODOLOGY

The datasets utilised in the empirical analysis are described along with their sources in this section. The econometric methods are also defined together with their justifications for application.

3.1 Data

To begin, the rate of real per capita GDP growth is applied as a dependent variable and denoted by GROWTH. The data on GROWTH

is extracted from the World Bank national accounts.

Foreign direct investment inflows are represented by FDI, and it equals the net inflows of foreign direct investment divided by GDP. The FDI is an investment to acquire a lasting management interest (minimum 10 per cent of voting stock) in an enterprise operating in an economy other than the investor's economy. The gross FDI states the total absolute values of inflows, apart from the values of outflows of foreign investments. As we focus on inflows to the economy, we prefer to use the net inflows, as in Alfaro et al. (2009). The data for FDI is taken from the World Development Indicator. The data on the origin of FDI is obtained by the OECD's International Direct Investment Statistics Yearbook.

We also employ control variables widely used in the literature as growth rate determinants and briefly described below.

Log (initial GDP) refers to value of countries' GDP lagged by four years converted from domestic currencies using constant 2010 U.S. dollars. The data is used to test the convergence hypothesis and attained from the World Development Indicator.

Inflation used as an independent variable is measured by the change in the consumer price index. It reflects the annual percentage change in the cost to the average consumer of obtaining a basket of goods and services. The data regarding inflation is from the International Monetary Fund.

Openness to trade equals to the ratio of exports plus imports to GDP. The data is obtained from the World Development Indicator.

Gross_capital_form is the ratio of gross capital formation (formerly gross domestic investment) to GDP and equals total investment composed of expenditures on the level of inventories and on the fixed assets of the economy. The data related to this variable extracted from the World Development Indicator.

Gov_exp is Government Expenditure which is the ratio of total cash payments of the government's operating activities in providing goods and services to GDP. It also involves employees (such as wages and salaries), interest and subsidies, grants, social benefits, and other expenses such as rent and dividends. The data on government expenditure is also taken from the World Development Indicator.

Population growth rate is the annual population growth rate based on the definition, which counts all residents regardless of status and citizenship. Population growth rate is presented by percentage. The data concerning the population is drawn from the World Development Indicator.

Landlocked refers to countries which are enclosed completely by land, or their coastal strip lie on closed seas. In this study, landlocked is used as a dummy variable, and landlocked countries take the value of 1, and others get 0. In this research, there are just six landlocked countries out of 36 OECD members.

Finance_index consists of three widely used ratios measuring financial development, namely deposit money banks' assets to GDP (%), liquid liabilities to GDP (%), and private credit by deposit money banks to GDP (%). I follow Samargandi et al. (2015) to combine these three variables using principal component analysis (PCA) to create a single proxy for financial development. They assert that using PCA has two advantages. Firstly, the variables are highly correlated to each other, which leads to the multicollinearity problem. Usage of PCA helps to overcome this issue. Secondly, there is no uniform argument concerning most appropriate variables to present the level of financial development in the literature. I believe, therefore, that the summary indicator is better than the individual variables.

Tab. 2: Principal component analysis for financial development index

Number	Value	Difference	Proportion	Cumulative Proportion
1	2.437	1.916	0.8123	0.8123
2	0.520	0.477	0.1734	0.9857
3	0.0427	–	0.0143	1.0000

Tab. 2 shows the result of the principal component analysis. The first component explains about 81% of the variation of the dependent variable, while the second component accounts for about 17% and the last component corresponds with under 1% of the variation.

Tab. 3: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
gdppercap	970	2.11	3.21	−14.56	24.377
fdi	982	1.88	3.52	−3.339	26.328
inflation	970	4.62	9.931	−9.68	143.692
trade_openness	994	85.689	51.980	16.014	423.984
gov_exp	900	31.949	11.546	1.878	62.242
population_rate	1007	0.5594	0.8030	−2.574	6.0170
gross_capital	978	22.858	4.058	11.518	39.404
finan_index	864	0.218	1.594	−2.539	5.344
school_enrol	896	102.858	15.276	51.869	168.904
polit_freedom	970	9.350	1.442	−4	10
rail_line	804	10.043	89.125	0.00572	812.254

We, therefore, use the first component as our financial indicator (finance_index).

Human capital is represented by the school enrollment rate which is the total number of children enrolled in the level of secondary regardless of age divided by the population that officially corresponds to the same level of the age group. The data concerning human capital is taken from the World Development Indicator.

The Polity IV dataset is employed as a proxy for political_freedom calculated by subtracting the autocracy index from the democracy index. The Polity Democracy Index takes values from zero to ten, arising from codings of the competitiveness of political participation, the openness and competitiveness of executive recruitment, and constraints on the chief executive. Along the same line, The Polity Autocracy Indices ranges from ten to minus ten and consists of coding of the competitiveness of executive recruitment, the openness of executive recruitment, constraints on the chief executive, regulation of participation, and competitiveness of participation. The data concerning political freedom is obtained from the Integrated Network for Social Conflict Research (INSCR) Database.

Finally, rail_line is presented by total kilometres length of railways divided by countries total area (square km), and the data are taken from World Development Indicator.

Descriptive statistics for variables employed in the regression have been presented in Tab. 3 for OECD member countries over the period 1990–2017[1]. A considerable variation in the GDP growth across countries can be seen, with growth ranging from −14.56 per cent in Estonia in 2009 to 24.37 per cent in Ireland in 2015, the mean of growth rate is 2.11 per cent during this period. The share of FDI in GDP also demonstrates many variations with the mean of 3.52 per cent, ranging from −3.33 per cent in Ireland in 2005 to 26.32 per cent in the United States in 1999. Inflation varies significantly from −9.68 per cent in Latvia in 2009 to 143.69 per cent in Turkey in 1998, the average value of this variable is 4.62 per cent. Another considerable variation is shown in trade openness, ranging from 16.01 per cent in Japan in 1993 to 423.98 per cent in Luxembourg in 2017. The variable of gov_exp rate ranges from 1.87 per cent for Estonia in 2007 to 62.24 per cent for Ireland in 2010. While Estonia has the minimum population growth rate with −2.574 per cent in 1993, the maximum belongs to Israel with 6.0170 per cent in 1991. The average value of population growth rate is 0.55 per cent in the sample countries. The ratio of gross capital formation to GDP takes the minimum value of 11.52 per cent in Greece in 2015 and the maximum value of 39.40 per cent in South Korea in 1991. Finan_index shows some variation, ranging from −2.54

[1]See Tab. 9 for the correlation matrix in the Annex.

index in Latvia in 1996 to 5.34 index in Iceland in 2007. School_enrolment rate ranges substantially from 51.87 per cent in Mexico in 1991 to 168.90 per cent in Australia in 2015. As for Polit_freedom variable, the maximum value is 10 points meaning most free, and the minimum is −10 referring to the least free as mentioned above. South Korea and Poland are the only two countries taking −8 index in 1980 and 1981 respectively, but all countries have managed to reach 10 index through the period except Estonia, Israel, South Korea, Latvia, Mexico, and Turkey. Lastly, rail_line demonstrates sizeable variation, ranging from 0.005 kilometres in Canada in 2012 to 812.25 kilometres in Australia in 1997.

3.2 Static Panel Data

Pooled ordinary least square (OLS) method is applied at first to estimate the effect of FDI on economic growth for OECD countries, which yields a preliminary view of each growth determinants used in the regressions. To run the regressions based on OLS, I used the below equation:

$$y_{i,t} = \alpha + \beta_1 \, \mathrm{FDI}_{i,t} + \gamma \, X_{i,t} + u_{i,t}, \qquad (1)$$

where y represents the rate of real per capita GDP growth of country i at time t, α is the constant term, $\mathrm{FDI}_{i,t}$ refers to aggregate FDI inflows to the host country. $X_{i,t}$ refers to the matrix of control variables that is often used to determine economic growth in the empirical growth literature. Lastly, $u_{i,t}$ denotes the error term as usual.

The pooled OLS is the simplest methodology. The weakness of this method is that it does not consider the time-series dimension of data. This method also fails to take into account the country-specific heterogeneity. By omitting the unobserved variables, which may be correlated with the other regressors, the pooled OLS estimation with heteroscedasticity will lead to biased and inconsistent parameter estimates. To deal with this problem, fixed effects or random effects models can be applied.

Assumption of the fixed effects model is that each country has its own unobserved time-invariant individual effect so that this model estimates a separate constant term for each country. In contrast, according to the random-effects model, unobserved country specific variables are distributed normally. One overall constant, therefore, is estimated. I applied the Hausman test to determine which model is more applicable and the results are reported at the bottom of the related tables. The null hypothesis suggesting random-effects model is rejected, that means fixed-effects model perform better for my analysis.

Accordingly, the fixed-effects model applied for the estimation of the effect of FDI on growth rate is based on the following equation

$$y_{i,t} = \alpha + \beta_1 \, \mathrm{FDI}_{i,t} + \gamma \, X_{i,t} + \eta_i + u_{i,t} \qquad (2)$$

In contrast to the equation of polled-OLS, equation (2) includes η_i which denotes the country-specific effects, which consider unobserved heterogeneity owing to time-invariant country characteristics.

The shorcoming of the fixed-effects model is that a possible simultaneity bais is not controlled which may occur with endogenous explanatory variables as explained in below.

3.3 Dynamic Panel Data

Numerous economic relationships are dynamic in nature, and one of the advantages of panel data is that it enables researchers to better grasp the identification of dynamic relationships. A dynamic relationship is characterised by the extent to which economic activity is affected by previous behavior. In this context, the existence of a lagged dependent variable among the regressors characterises these dynamic relationships (Baltagi, 2005).

For our panel estimation, we also use the generalised method of moments (GMM) introduced by Holtz-Eakin et al. (1988). Then, Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998) developed the method. The GMM estimation method takes into account country specific effects and any possible bias caused by omitted variables that are persistent over time, which cannot be captured by applying dummies because of the

dynamic structure of the regression equation. More importantly, the GMM model controls for a possible simultaneity bias caused by some of the endogenous explanatory variables. For instance, Azman-Saini et al. (2010) state that FDI inflows are likely to be an endogenous variable as higher growth rate attracts FDI to the host economy. The effect of FDI on the growth rate can be estimated by the following equation (see Alfaro et al., 2004; Durham, 2004; Azman-Saini et al., 2010).

$$\begin{aligned} y_{i,t} = \alpha\, y_{i,t-1} + \\ + \beta_1\, \mathrm{FDI}_{i,t} + \\ + \gamma\, X_{i,t} + \\ + \eta_i + \\ + \varepsilon_{i,t}, \end{aligned} \tag{3}$$

where the lagged dependent variable is included as an independent variable, in contrast to equation (3).

To eliminate the time invariant effects, η_i, Arellano and Bond (1991) suggest transforming the equation (3) into first differences as below:

$$\begin{aligned} y_{i,t} - y_{i,t-1} = \alpha\,(y_{i,t-1} - y_{i,t-2}) + \\ + \beta_2\,(\mathrm{FDI}_{i,t} - \mathrm{FDI}_{i,t-1}) + \\ + \gamma\,(X_{i,t} - X_{i,t-1}) + \\ + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \end{aligned} \tag{4}$$

To overcome the endogeneity issue, the GMM model uses lagged values of explanatory variables as instruments. However, this transformation causes a new statistical issue that the transformed error term $\varepsilon_{i,t} - \varepsilon_{i,t-1}$ is correlated with the lagged dependent variable $y_{i,t-1} - y_{i,t-2}$. As a solution, Arellano and Bond (1991) suggest that the lagged levels of the explanatory variables are used as instruments, which is valid under the two assumptions; the error is not serially correlated, and the lag of the regressors is weakly exogenous. This technique is also known as difference GMM in the literature. The moment conditions are set following Arellano and Bond (1991):

$$E\left[y_{i,t-s} \cdot (\varepsilon_{i,t} - \varepsilon_{i,t-1})\right] = 0, \tag{5}$$

$$E\left[\mathrm{FDI}_{i,t-s} \cdot (\varepsilon_{i,t} - \varepsilon_{i,t-1})\right] = 0, \tag{6}$$

$$E\left[X_{i,t-s} \cdot (\varepsilon_{i,t} - \varepsilon_{i,t-1})\right] = 0 \tag{7}$$

$$\text{for } s \geq 2; \quad t = 3, \ldots, T.$$

Although the difference GMM is able to account for the simultaneiy bias and country specific heterogeneity, another shortcoming was pointed by Alonso-Borrego and Arellano (1999) and Blundell and Bond (1998). They indicate that the lagged level of the variables becomes weak instruments when the regressors are persistent, which may cause biased parameter estimates in small samples and an increase in the variance of coefficients. An alternaive method to deal with the weakness of the difference GMM is the system GMM proposed by Arellano and Bover (1995), and Blundell and Bond (1998). This method uses the lagged level observations as instruments for differenced variables (equation 4) in addition to the use of lagged differenced observations as instruments for level variables (equation 3). The additional conditions for the second part of the system, the regression in levels, could be written as follows:

$$E\left[(y_{i,t-s} - y_{i,t-s-1}) \cdot (\eta_i + \varepsilon_{i,t})\right] = 0, \tag{8}$$

$$E\left[(\mathrm{FDI}_{i,t-s} - \mathrm{FDI}_{i,t-s-1}) \cdot (\eta_i + \varepsilon_{i,t})\right] = 0, \tag{9}$$

$$E\left[(X_{i,t-s} - X_{i,t-s-1}) \cdot (\eta_i + \varepsilon_{i,t})\right] = 0 \tag{10}$$

$$\text{for } s = 1.$$

Two tests define the consistency of the GMM panel estimator: (i) the Hansen test is used to determine the instrument's validity, and (ii) Arellano-Bond AR (2) is used to determine the error term's second-order serial correlation, i.e., the error term is serially uncorrelated and the moment conditions are correctly specified (Roodman, 2009).

If too many instruments are utilised in the system GMM, the model may become overfit (Roodman, 2009). Nonetheless, it remains unclear how many tools are excessive (Doytch and Uctum, 2011). According to Roodman's (2009) rule of thumb, the number of instruments should not exceed the number of sample nations.

4 RESULTS AND DISCUSSION

First, this research examines the effect of FDI inflows on the growth rate of the host economy over the period 1990–2017 for OECD countries. To be able to select the appropriate econometric method, we apply the Breusch-Pagan Lagrange multiplier test. The null hypothesis is in favour of the pooled-OLS against random/fixed effects. The result shows that the random/fixed effects model is more appropriate for our analysis since we reject the null hypothesis owing to the p-value which is equal to zero for each equation. Next, the Hausman test is undertaken to choose between the random effects and fixed effects models. The test favours the fixed effects model against random effects: its p-value is always zero for each specification. Therefore, we proceed with running the regressions by using fixed effect panel model based on equation (2).

The results of the fixed effect model are reported in Tab. 4[2]. It can be seen from the table that FDI has entered in all regressions positively and is statistically significant. Therefore, the table demonstrates that FDI makes a positive contribution to economic growth in the host country: 1 percentage increase in FDI raises economic growth in OECD countries by a minimum of 0.104 and a maximum of 0.190 percentage through the period between 1990 and 2017. This result is consistent with many studies that find the growth-enhancing effect of FDI in the host economy (e.g., Carković and Levine, 2005; Li and Liu, 2005). Similarly, trade openness is also associated with a higher growth rate, which is perfectly in line with Barro (2000). In a similar way, domestic investment shows a positive effect on economic growth in all columns. This is anticipated, given that investment raises the stock of physical capital as a factor of production, which in turn will boost output.

The log (initial GDP) becomes negative and significant, which lends support to the idea of convergence asserting that per capita income of poorer countries will tend to grow faster than richer economies (Barro, 2000). As expected, inflation has a significantly negative effect on the growth rate, as it is an indicator of macroeconomic instability and gives support to the notion that macroeconomic instability is associated with a lower growth rate. Likewise, the negative coefficient on government expenditure indicates that an increase in government expenditure is associated with a decline in the economic growth of the host country, given that government spending may crowd out domestic investment, hence reducing economic growth. Additionally, it implies higher taxes, which discourages productive and profit-generating activity. The estimated coefficient on population growth is also significantly negative, as anticipated. This is because the newly created production is distributed over a larger population as the population growth rate increases.

The estimated effect of FDI on growth rate is robust to the inclusion of more control variables. The finance_index representing the level of financial development is included in regression 2. The coefficient on finance_index is negative and significant, indicating that any more development in financial system is associated with lower growth rate. The finding is consistent with the study by Samargandi et al. (2015) who suggest that there is an inverted U-shaped link between growth and financial development. The OECD countries in my sample are generally more financially developed so that they should be on the downward sloping part of the inverted U. The human_capital variable is included in column 3. Its effect seems positive and significant in that column, but it is not statistically significant in the last regression so that the effect of human capital on the growth rate is not robust. In our sample, most countries are highly developed. Hence, the possible reason for the insignificant coefficient of school attainment in the last regression may be that in the developed countries, school enrolment rate is generally high and so the

[2]The pooled OLS results are presented in Tab. 10 in the Annex. Mainly, the results show that an increase in FDI flows is related to a higher growth rate of host country. Also, these findings are in consistent with those estimated by the fixed effect.

Tab. 4: Regression coefficients for the impact of FDI on economic growth, Fixed Effect Method

	(1) Growth	(2) Growth	(3) Growth	(4) Growth	(5) Growth	(6) Growth
FDI	0.107**	0.190*	0.110**	0.104**	0.127**	0.182*
	(2.05)	(1.68)	(1.96)	(2.01)	(2.14)	(1.71)
log(initialGDP)	−0.597***	−0.457***	−0.651***	−0.614***	−0.715***	−0.564***
	(−10.64)	(−6.73)	(−10.44)	(−10.90)	(−10.04)	(−6.35)
inflation	−0.0284**	−0.0306**	−0.0193	−0.0281**	−0.0274*	−0.0301*
	(−2.12)	(−2.49)	(−1.12)	(−2.09)	(−1.93)	(−1.81)
trade_openness	0.0583***	0.0569***	0.0577***	0.0585***	0.0708***	0.0639***
	(8.34)	(7.56)	(7.86)	(8.43)	(8.60)	(7.24)
gov_exp	−0.129***	−0.0641**	−0.131***	−0.128***	−0.113***	−0.0522*
	(−4.45)	(−2.28)	(−4.38)	(−4.37)	(−3.55)	(−1.68)
population_rate	−1.242***	−1.137***	−1.161***	−1.345***	−1.610***	−1.391***
	(−7.89)	(−7.74)	(−7.20)	(−8.05)	(−7.99)	(−7.36)
domestic_inv	0.407***	0.459***	0.413***	0.408***	0.449***	0.483***
	(12.04)	(13.66)	(11.78)	(11.87)	(12.01)	(12.89)
finance_index		−0.736***				−0.765***
		(−5.79)				(−4.92)
human_capital			0.0425***			0.0195
			(2.89)			(1.28)
political_freedom				0.235*		0.0142
			(1.80)			(0.08)
rail_network					0.00239	0.00142
					(1.30)	(0.82)
_cons	151.7***	112.0***	160.9***	154.3***	180.1***	136.4***
	(10.38)	(6.27)	(10.08)	(10.55)	(9.74)	(5.92)
Hausman-test	145.31	116.02	137.70	151.23	136.88	104.61
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R^2	0.353	0.418	0.360	0.364	0.365	0.440
N	796	717	746	778	672	587

Note: t-statistics in parentheses, * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$

variation across these countries is limited. The results are in line with Li and Liu (2005), as they also find an insignificant effect of school attainment on economic growth for developed countries. The political_freedom is entered in regression 4 and shows a positive and significant effect on the growth but insignificant in the last column. The rail_network variable is in column 5 and also included in column 6. It has become positive for both regressions, but statistically insignificant.

This research also examines if the growth-promoting effect of FDI on economic growth depends on the level of financial development, political freedom, human capital, or infrastructure in the host country. To do so, we created interaction terms of FDI with each of these variables and used them as regressors in the regressions. Fixed effects panel model is used after undertaking the Hausman test, which is reported at the bottom of each specification.

The results of the regressions are presented in Tab. 5.[3] In the first column, the interaction term of FDI with financial development is included. FDI turns out to be insignificant. However, its interaction term shows up as significant and positive, suggesting that countries with more developed financial system are able to get the growth-stimulating effect of FDI. The results are compatible with the

[3]The results estimated by the Pooled-OLS are released in Tab. 11 in the Annex. Briefly, the results are parallel to those predicted by the fixed effect.

Tab. 5: Conditional Effect of Aggregate FDI on Growth with Fixed Effects

	(1) Growth	(2) Growth	(3) Growth	(4) Growth
FDI	−0.0606	−0.631	0.557*	0.0963*
	(−1.05)	(−1.54)	(1.82)	(1.70)
log(initialGDP)	−0.000222***	−0.000293***	−0.000269***	−0.000323***
	(−7.92)	(−7.95)	(−11.38)	(−11.35)
inflation	−0.00318	−0.0238	−0.0211	−0.0110
	(−0.21)	(−1.35)	(−1.33)	(−0.83)
trade_openness	0.0464***	0.0177***	0.0570***	0.0656***
	(5.91)	(2.71)	(8.38)	(8.94)
gov_exp	−0.0800***	−0.145***	−0.146***	−0.133***
	(−2.80)	(−4.78)	(−5.12)	(−4.43)
population_rate	−1.623***	−2.295***	−1.674***	−1.872***
	(−5.62)	(−7.32)	(−5.51)	(−5.86)
domestic_inv	0.415***	0.417***	0.422***	0.454***
	(11.67)	(11.37)	(12.18)	(12.70)
finance_index	−0.692***			
	(−5.03)			
fdi*finance	0.0546*			
	(1.65)			
human_capital	0.00946	−0.00545		
	(0.70)	(−0.34)		
fdi*human		0.00697**		
		(2.11)		
political_free			−0.00481	
			(−0.04)	
fdi*politic			0.00599**	
			(2.13)	
rail_network				0.000308
				(1.60)
fdi*rail				0.000127
				(0.21)
_cons	−4.667**	−2.696	1.632*	0.687
	(−2.06)	(−1.18)	(1.80)	(1.38)
Hausman-test	86.34	50.98	91.30	96.76
	(0.000)	(0.000)	(0.000)	(0.000)
N	690	770	750	694

Note: *t*-statistics in parentheses, * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$

studies of Alfaro et al. (2004), Carković and Levine (2005), and Iamsiraroj and Ulubaşoğlu (2015), who find that countries benefit more from foreign investment as they improve their financial system.

The school enrollment rate as a proxy for human capital and its interaction term with FDI are included in column 2 instead of the finance index. The results suggest that school enrollment does not have a significant effect on economic growth. As outlined above, this might be because of the high level of schooling attainment in developed countries. FDI also does not exert a significant effect by itself. However, the interaction term with human capital enters the regression significantly positive, suggesting that the availability of educated labour is an important prerequisite to realising the growth-promoting effect in the receiving economy. This finding supports the results found by Borensztein et al. (1998), Balasubramanyam et al. (1999), and Xu (2000).

To look more closely at the relationship between FDI and economic growth, the interaction term of FDI with political freedom is included in column 3. In this regression, both FDI and its interaction with political freedom have significantly positive coefficients, which show that an increase in political freedom enables the receiving economy to get more benefit from FDI inflows.

In specification 4, the last interaction term of FDI with the rail_network is involved, and the results demonstrate that FDI exerts a positive effect on the growth rate by itself. However, the coefficient of the rail_network seems to be positive but insignificant. This is not surprising to find an insignificant effect of infrastructure effect in the literature, as Reinikka and Svensson (1999) claim that the effect of infrastructure on economic growth is at best ambiguous. Similarly, the interaction term appears with a positive but insignificant effect. The result is also consistent with Li and Liu (2005), who find that the interaction term with infrastructure has no effect on the economic growth of developed countries.

Regarding the signs of the control variables, they retain the same sign as those estimated in the previous regressions but with different magnitudes of coefficients.

This research also considers the origin of FDI due to the possibility that FDI from different countries may follow different strategies, which influences their contribution to the host economy. To accomplish this, FDI inflows are separated into two groups; FDI from developed and developing countries to the host economies.[4]

We start the analysis with the fixed effect method after undertaking the Breusch-Pagan Lagrange multiplier test and the Hausman test. The results of the regressions are reported in Tab. 6[5].

In columns 1 to 4 of Tab. 6, the effect of FDI from developed countries is analysed. As seen, developed country FDI has a positive and significant effect in all columns, suggesting that there is a positive relationship between FDI from developed countries and the growth rate of the host country. This contribution might be due to the fact that investors from developed economies follow the market effectiveness strategy in the host economy and behave in highly innovative and proactive ways, which eventually enables local companies to acquire the new technology used by foreign firms, which in turn contributes to economic growth. On the other hand, FDI from developing countries reported in columns 5 to 8 has no significant effect on the growth in any specification. The rationale for the insignificant might be that FDI from less developed countries focuses on countries with lower labour costs and less on innovation and long-term commitment to the host economy, as pointed out by Luo (1998). Hence, it is expected that FDI from these economies will not contribute to the host countries' growth rate. The results of my analysis confirm the findings of Luo (1998), Chen and Ku (2000), and Gee and Karim (2011). The impacts of control variables are more or less the same as those in the previous regressions in terms of the sign and significance level.

To examine the effect of FDI on domestic investment, the ratio of gross fixed capital formation to GDP (GFCF) is used as the dependent variable in the model. The rate of FDI to GDP and other control variables that determine GFCF are the same as those used in previous regressions.

In the literature, to assess the crowding in or out effect of FDI on domestic investment, various variables are used as proxies for domestic investment. For instance, Adams (2009) subtracts FDI inflows from gross fixed capital formation (GFCF) to calculate domestic investment. However, according to the definition of GFCF given by the World Bank, FDI is not necessarily used only for financing fixed capital formation. Rather, FDI might also be used to cover a deficit in the company or to pay off a loan. Therefore, it may not be possible to get the correct results once the domestic investment is calculated via this method. In some studies, like Kim and Seo (2003), gross fixed capital

[4]Countries are classified as developed or developing based on the IMF classification.

[5]See Tab. 12 for the results estimated by Pooled-OLS in the Annex.

Tab. 6: Effect of FDI from Different Countries on Growth

	(1) Growth	(2) Growth	(3) Growth	(4) Growth	(5) Growth	(6) Growth	(7) Growth	(8) Growth
FDI_developed	0.499*	0.512*	0.487*	0.553***				
	(2.59)	(2.53)	(2.39)	(2.68)				
FDI_developing					−0.434	−0.510	−0.348	−0.283
					(−0.65)	(−0.74)	(−0.47)	(−0.38)
initial_GDP	−2.20E−13*	−1.88E−13	−1.80E−13	−5.48E−13	−1.71E−13	−1.52E−13	−1.60E−13	−4.44E−13
	(−1.65)	(−1.50)	(−1.48)	(−1.63)	(−1.50)	(−1.41)	(−1.43)	(−1.51)
inflation	−0.0226	−0.106	−0.0813	−0.173*	−0.0200	−0.0732	−0.0397	−0.106
	(−1.30)	(−1.59)	(−1.11)	(−1.82)	(−1.14)	(−1.10)	(−0.54)	(−1.12)
trade_openness	0.0830***	0.0780***	0.0782***	0.0867***	0.0717***	0.0656***	0.0671***	0.0733***
	(7.19)	(6.29)	(6.21)	(6.50)	(6.53)	(5.57)	(5.62)	(5.81)
gov_exp	−0.110*	−0.121*	−0.117*	−0.0782	−0.0936*	−0.101*	−0.0953*	−0.0556
	(−2.24)	(−2.34)	(−2.17)	(−1.39)	(−1.91)	(−1.96)	(−1.77)	(−0.98)
population_rate	−2.159***	−2.205***	−2.485***	−2.626***	−2.235***	−2.254***	−2.507***	−2.663***
	(−5.71)	(−5.42)	(−5.85)	(−5.92)	(−5.85)	(−5.49)	(−5.85)	(−5.93)
domestic_inv	0.550***	0.587***	0.557***	0.654***	0.568***	0.599***	0.568***	0.661***
	(11.16)	(10.89)	(9.72)	(10.37)	(11.47)	(11.05)	(9.84)	(10.35)
finance_index	−1.014***	−1.003***	−1.171***	−1.150***	−1.060***	−1.047***	−1.195***	−1.161***
	(−6.34)	(−5.99)	(−6.10)	(−5.40)	(−6.58)	(−6.21)	(−6.18)	(−5.39)
human_capital		0.0305	0.0241	0.0386*		0.0377*	0.0318	0.0467*
		(1.35)	(1.04)	(1.68)		(1.66)	(1.36)	(1.90)
political_freedom			0.208*	0.398			0.241*	0.416
			(1.72)	(1.32)			(1.83)	(1.37)
rail_network				0.00260				0.00203
				(1.55)				(1.43)
_cons	−12.97***	−16.17***	−16.91***	−24.64***	−12.78***	−16.70***	−18.01***	−25.36***
	(−5.14)	(−4.71)	(−3.67)	(−4.85)	(−5.03)	(−4.83)	(−3.89)	(−4.94)
Hausman-test	98.99	95.99	95.96	94.34	123.58	125.79	125.69	122.15
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R^2	0.438	0.436	0.441	0.477	0.429	0.427	0.431	0.465
N	552	511	495	447	552	511	495	447

Note: t-statistics in parentheses, * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$

formation is directly used as a proxy for domestic investment, which might lead to misleading findings owing to the inclusion of (some part of) FDI in gross fixed capital formation. Also, in other studies, to evaluate the crowding in or out effect, total investment is calculated by adding domestic investment, and both current and lagged period FDI are used as dependent variables (e.g., Mišun and Tomšík, 2002). If the coefficient of FDI is higher than one, it is assessed as a crowding in effect or else evaluated as a crowding out effect of FDI on domestic investment (Borensztein et al., 1998). As we do not know what proportion of FDI is used to finance capital formation, this method might prevent us from interpreting the results correctly.

Therefore, we take into consideration the uncertainty about the proportion of FDI included in gross fixed capital formation: if the coefficient on FDI lies between 1 and 0, I am unable to say whether FDI leads to crowding in or out of domestic investment. If it is higher than one, then this implies a crowding in effect of FDI, while a crowding out effect is identified when the coefficient is lower than zero.

We examine the link between FDI and domestic investment rate by using the Fixed effect method. The results of the regressions are reported in Tab. 7.[6] The effect of FDI is not statistically significant in all columns except column 4, in which the coefficient on FDI is significant but lower than 1. In this case, neither crowding in nor out effect of FDI on domestic investment occurs given that the uncertainty about the proportion of FDI included in gross fixed capital formation. The other determinants of Gross Fixed Capital Formation have the expected signs. The sign of inflation, trade openness and government expenditure become negative and significant. It is worth noting that an increase in government expenditure causes lower capital formation, suggesting that government spending crowds out investment in OECD countries. In contrast, the effects of population growth rate, financial development, human capital, political freedom, and rail net-

[6]The results of estimations by the Pooled-OLS are given in Tab. 13 in the Annex.

Tab. 7: Effect of FDI on Domestic Investment with Fixed-Effects

	(1) GFCF	(2) GFCF	(3) GFCF	(4) GFCF	(5) GFCF	(6) GFCF
FDI	0.0410	0.0621	0.0346	0.0438*	0.0355	0.0582
	(0.71)	(1.04)	(1.57)	(1.78)	(1.57)	(0.85)
inflation	−0.0264*	−0.0288*	−0.0308	−0.0246*	−0.0301*	−0.0319
	(−1.77)	(−1.94)	(−1.63)	(−1.69)	(−1.95)	(−1.60)
trade_openness	−0.0450***	−0.0506***	−0.0420***	−0.0409***	−0.0434***	−0.0380***
	(−7.52)	(−7.05)	(−6.39)	(−6.95)	(−6.74)	(−4.57)
gov_exp	−0.360***	−0.385***	−0.351***	−0.352***	−0.359***	−0.359***
	(−12.90)	(−13.47)	(−12.14)	(−12.79)	(−12.06)	(−11.51)
population	0.0479**	0.0430*	0.0569**	0.0520**	0.0420*	0.0911**
	(2.15)	(1.88)	(2.35)	(2.39)	(1.64)	(2.52)
finance_index		0.417**				0.167*
		(3.28)				(1.67)
human_capital			0.0257*			0.0297*
			(1.74)			(1.81)
political_free				0.337***		0.173
				(2.68)		(0.99)
rail_network					0.175	0.00472*
					(1.28)	(1.69)
_cons	37.27***	38.37***	39.22***	39.66***	39.71***	40.74***
	(29.73)	(28.57)	(21.75)	(24.81)	(18.85)	(16.85)
Hausman-test	44.92	52.54	42.77	43.75	37.92	36.97
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R^2	0.311	0.333	0.314	0.316	0.314	0.332
N	874	793	814	854	736	644

Note: t-statistics in parentheses, * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$

work are significantly positive, although the significance level of the latter one is only 10%.

Finally, this study analyses whether the origin of FDI matters in the relationship between FDI inflows and domestic investment. FDI from two different country groups is employed as the independent variable: FDI from developed and developing countries, as in the previous analysis.[7]

In Tab. 8, the first four specifications include FDI inflows from developed countries. The coefficients of FDI in the four columns are positive and statistically significant. Most importantly, they are greater than one, suggesting that FDI inflows from developed countries crowd in domestic investment in the host economies. However, in the last four columns, FDI from developing countries does not show a significant effect on the domestic investment of the host country. These findings are consistent with the discussion in the previous sections. Briefly, FDI from developed countries reveals more resources commitment and R&D intensity, leading them to operate with advanced technology, which facilitates technology transfer to local counterparts. Since they tend to cooperate more with local producers than FDI from developing countries which involve with labour-intensive production and focus on export markets instead of complementary activities, which prevents technology diffusion (Chen and Ku, 2000). To conclude, the country of origin matters in determining whether FDI impacts the domestic investment of the host country. About control variables, they show similar patterns as those reported in Tab. 5.

[7]Results estimated by pooled OLS confirm those estimated by the fixed effects.

Tab. 8: Effect of FDI from Different Countries on Domestic Investment with Fixed-Effects

	(1) GFCF	(2) GFCF	(3) GFCF	(4) GFCF	(5) GFCF	(6) GFCF	(7) GFCF	(8) GFCF
FDI_developed	1.213**	1.216**	1.204**	1.207**				
	(2.33)	(2.30)	(2.25)	(2.26)				
FDI_developing					0.526	0.532	0.581	0.498
					(0.82)	(0.80)	(0.87)	(0.74)
inflation	−0.0516***	−0.0579***	−0.0602***	−0.0630***	−0.0290**	−0.0338*	−0.0274	−0.0180
	(−4.37)	(−3.65)	(−3.89)	(−3.98)	(−2.15)	(−1.87)	(−1.61)	(−1.01)
trade_openness	0.0451***	0.0455***	0.0395***	0.0364***	0.0745***	0.0712***	0.0610***	0.0632***
	(5.93)	(5.54)	(4.85)	(4.28)	(8.70)	(7.78)	(7.10)	(6.95)
gov_exp	−0.224***	−0.222***	−0.232***	−0.231***	−0.333***	−0.326***	−0.309***	−0.321***
	(−7.90)	(−7.52)	(−7.97)	(−7.44)	(−11.30)	(−10.61)	(−10.58)	(−10.30)
population_rate	1.062***	1.137***	1.692***	1.893***	1.247***	1.375***	1.805***	1.323***
	(10.65)	(10.25)	(8.50)	(8.68)	(4.65)	(4.24)	(5.81)	(6.37)
finance_index	0.181*	0.146	0.0350	−0.0374	0.219*	0.175	0.150	0.247
	(1.66)	(1.25)	(0.29)	(−0.29)	(1.65)	(1.23)	(1.03)	(1.60)
human_capital		0.00910*	0.00431	−0.00263		0.0263	0.0354**	0.0441**
		(1.68)	(0.28)	(−0.16)		(1.47)	(2.13)	(2.53)
political_freedom			0.280*	0.297**			0.0639	0.0535
			(1.93)	(1.98)			(0.42)	(0.34)
rail_network				−0.00145				0.00434
				(−0.48)				(1.19)
_cons	31.85***	31.02***	29.08***	29.71***	24.899*	21.978	11.10**	23.60**
	(26.18)	(15.74)	(13.09)	(12.70)	(1.68)	(1.48)	(2.33)	(2.42)
Hausman-test	36.29	35.71	28.61	21.90	52.73	47.89	53.69	56.04
	(0.000)	(0.000)	(0.000)	(0.005)	(0.000)	(0.000)	(0.000)	(0.000)
R^2	0.376	0.375	0.330	0.353	0.273	0.268	0.281	0.307
N	551	510	494	446	551	510	494	446

Note: t-statistics in parentheses, * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$

4.1 Robustness Check

To check the robustness of our findings, we employ the system GMM developed by Blundell and Bond (1998). The main reason for using the GMM panel estimator is to control for the potential endogeneity bias stemming from simultaneous causality, especially between the FDI flows and growth rate or between FDI and domestic investment, as explained in detail in the methodology section.

The consistency of the GMM estimator depends on two tests: the Hansen test to check the validity of instruments and the Arellano-Bond AR (2) to test the second-order serial correlation (Carković and Levine, 2005). Both test results are reported at the bottom of each column in the tables below. As shown, we could not reject the null hypothesis of the Hansen test; its p-value is always greater than 0.05, meaning that identifying restrictions are valid, which gives support to the choice of instruments. In a similar manner, failing to reject the null hypothesis regarding Arellano-Bond AR (2) implies that there is no second-order serial correlation.

The results regarding the effect of FDI inflows on the growth rate are set out in Tab. 14 in the Annex. Those results confirm the previous findings: FDI has a positive effect on the growth rate of the receiving economy. As for the control variables, they continue to have the expected signs of coefficients as in the previous results.

Tab. 15 shows the impact of FDI inflows on domestic investment estimated by the system GMM. As seen from the table, FDI enters positively and significantly only in three out of 6 regressions. Even in the column in which FDI is significant, the coefficient is less than 1 as those estimated by fixed effect. This means the effect of FDI on domestic investment is ambiguous.

Tab. 16 reports the results about the effect of FDI from different countries on economic growth. The findings support the previous results and show that the growth-enhancing effect has been found in FDI from developed countries rather than developing countries.

The origin of FDI is also considered in the nexus between FDI and domestic investment in Tab. 17. As seen, the impact of FDI on domestic investment differs according to the country of origin. More clearly, crowding in effect is found in FDI from developed countries, while FDI from developing countries does not have a significant effect.

5 CONCLUSION

Inward foreign direct investment has become the most attractive external finance with drying up commercial bank lending in the 1990s. Countries have competed to attract more FDI by offering incentives with the expectation that foreign investment brings much-needed capital accumulation, advanced technology transfer, employment creation, skill acquisition, and new managerial practises (Aitken and Harrison, 1999). However, there is no consensus about the effect of FDI on economic growth in the literature. The inconclusive empirical results might stem from data unavailability, model misspecification such as disregarding potential simultaneous effect between GDP growth rate and FDI, country-specific factors, and so on, and treating FDI inflows homogenously across economies. This research has taken into consideration all such misguiding issues by using a set of different methods, more reliable and updated data and covering 36 sample countries, attracting over half of total FDI flows in the world.

Empirical findings show that FDI inflows have a positive effect on the growth of the host country. More specifically, the host countries with a well-established financial system, a higher level of human capital, and political freedom are able to gain more benefits from FDI inflows. This study also reveals that the origin of FDI matters in determining FDI's effects on the host country's economy. FDI inflows from developed countries contribute to the growth of the host country, while FDI from developing countries has no significant effect on the growth.

This study also analyses the effect of FDI inflows on domestic investment in the receiving country. The results indicate that the impact of FDI on domestic investment is insignificant. However, the impact of FDI on domestic investment differs according to the country of origin. Accordingly, FDI from developed countries crowds in domestic investment, whereas FDI from less developed economies has no significant effect.

This research has implications for policymakers that FDI inflows should not be treated homogenously across countries. The incentives to attract FDI should only be offered if the FDI can be expected to lead to positive spillovers such as the transfer of modern technology, management practices, etc. Furthermore, countries need to improve the financial system, have a more educated workforce, and have more political freedom to get the maximum benefit from FDI inflows. A possible extension of this research might be to evaluate the effects of different types of FDI inflows on growth rate and domestic investment in the receiving economy.

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7 ANNEX

Tab. 9: Correlation Matrix

	Growth	FDI	Inflation	Trade_open.	Gov_exp	Population	Dom._inv	Fin._index	Human_cap	Pol._free	Rail_net.
Growth	1.0000										
FDI	0.1001	1.0000									
Inflation	−0.1092	−0.0787	1.0000								
Trade_openness	0.1392	−0.2809	−0.1577	1.0000							
Gov_exp	−0.1868	−0.1104	0.1377	0.1224	1.0000						
Population	−0.2115	0.1563	0.1967	−0.1115	−0.0844	1.0000					
Domestic_inv	0.3981	−0.2071	0.1269	0.0434	−0.3443	0.0423	1.0000				
Finance_index	−0.3870	0.0326	−0.3607	0.0543	0.0055	0.1489	−0.1800	1.0000			
Human_cap	0.1031	0.0100	−0.4086	0.2461	0.2375	−0.1168	−0.1688	0.3163	1.0000		
Political_free	0.1094	0.0940	−0.3078	0.1268	0.1505	−0.3658	−0.2225	0.2897	0.3010	1.0000	
Rail_network	0.0907	0.7602	−0.0360	−0.3285	−0.1719	0.1334	−0.1453	−0.0965	−0.1322	0.0588	1.0000

Tab. 10: Effect of Aggregate FDI on Growth with Pooled-OLS

	(1) Growth	(2) Growth	(3) Growth	(4) Growth	(5) Growth	(6) Growth
FDI	0.149***	0.0778*	0.153***	0.146***	0.158***	0.122**
	(3.52)	(1.90)	(3.27)	(3.43)	(3.33)	(2.33)
log(initialGDP)	−0.609***	−0.292***	−0.578***	−0.725***	−0.733***	−0.493***
	(−6.20)	(−2.76)	(−5.36)	(−6.50)	(−5.93)	(−2.87)
inflation	−0.0153	−0.0161	−0.0259*	−0.0168	−0.0140	−0.00921
	(−1.38)	(−1.54)	(−1.74)	(−1.47)	(−1.18)	(−0.62)
trade_openness	0.00528	0.00414*	0.00103	−0.00774	0.00758	0.00399
	(1.22)	(1.64)	(1.41)	(1.32)	(1.28)	(1.21)
gov_exp	−0.0254***	−0.0368***	−0.0222**	−0.0248**	−0.0191*	−0.0261**
	(−2.65)	(−3.86)	(−2.20)	(−2.58)	(−1.77)	(−2.31)
population_rate	−0.000595	−0.00237*	−0.000126	−0.00218	−0.00233	0.0143**
	(−1.17)	(−1.71)	(−1.03)	(−1.62)	(−1.58)	(2.05)
domestic_inv	0.247***	0.212***	0.243***	0.238***	0.247***	0.214***
	(9.86)	(8.63)	(9.32)	(9.05)	(8.66)	(7.44)
landlocked	−1.212***					−1.317***
	(−3.71)					(−3.46)
finance_index		−0.653***				−0.714***
		(−9.09)				(−7.21)
human_capital			0.00222			0.00984
			(0.26)			(1.05)
political_freedom				0.0519		0.223**
				(0.62)		(2.22)
rail_network					−0.00515	−0.00254
					(−0.43)	(−0.91)
_cons	12.96***	5.980*	11.82***	15.82***	16.08***	7.462
	(4.62)	(2.04)	(3.97)	(4.94)	(4.54)	(1.65)
R^2	0.221	0.315	0.218	0.231	0.233	0.317
N	825	745	769	805	694	605

Note: t-statistics in parentheses, * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$

Tab. 11: Effect Conditional FDI on Growth with Pooled-OLS

	(1) Growth	(2) Growth	(3) Growth	(4) Growth
FDI	0.0962***	−0.294	−0.735*	0.210***
	(2.94)	(−1.12)	(−1.71)	(4.21)
log(initialGDP)	−0.00362***	−0.00451***	−0.00415***	−0.00525***
	(−4.27)	(−5.25)	(−4.59)	(−5.11)
inflation	−0.0136	−0.0257*	−0.0316***	−0.0210*
	(−1.29)	(−1.79)	(−2.95)	(−1.74)
trade_openness	0.00324	0.00353	0.00953***	0.00227
	(1.32)	(1.48)	(4.75)	(0.86)
gov_exp	−0.0376***	−0.0274***	−0.0267***	−0.0221**
	(−4.19)	(−2.89)	(−2.96)	(−2.16)
population_rate	−0.494***	−0.587***	−0.907***	−0.735***
	(−3.72)	(−4.29)	(−6.79)	(−4.45)
domestic_inv	0.218***	0.244***	0.253***	0.252***
	(9.01)	(9.83)	(10.12)	(8.90)
finance_index	−0.640***			
	(−7.85)			
fdi*finance	0.0556**			
	(2.44)			
human_capital		−0.00687		
		(−0.71)		
fdi*human		0.00430*		
		(1.66)		
political_free			0.312***	
			(3.15)	
fdi*politic			0.0817*	
			(1.88)	
rail_network				−0.000431
				(−0.81)
fdi*network				−0.000118
				(−0.22)
_cons	7.815***	9.500***	9.597**	10.46***
	(3.15)	(3.51)	(2.45)	(3.36)
R^2	0.340	0.241	0.262	0.256
N	746	770	806	695

Note: t-statistics in parentheses, * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$

Tab. 12: Effect of FDI from Different Countries on Growth with Pooled-OLS

	(1) Growth	(2) Growth	(3) Growth	(4) Growth	(5) Growth	(6) Growth	(7) Growth	(8) Growth
FDI_developed	0.302*	0.353**	0.306**	0.311*				
	(1.77)	(1.99)	(2.27)	(1.66)				
FDI_developing					0.141	0.341	0.612	0.615
					(0.16)	(0.37)	(0.57)	(0.56)
initial_GDP	−4.41E−14*	−4.48E−14*	−4.96E−14*	−4.38E−14	−5.58E−14	−5.59E−14	−5.55E−14*	−1.58E−14
	(−1.71)	(−1.67)	(−1.88)	(−1.03)	(−1.57)	(−1.53)	(−1.79)	(−1.22)
inflation	−0.00909*	−0.00500	−0.00915	−0.00209	−0.00786*	−0.00278	−0.00697	0.00462
	(−1.80)	(−1.32)	(−1.51)	(−0.12)	(−1.69)	(−1.18)	(−1.39)	(1.28)
trade_openness	0.00648**	0.00623*	0.00503	0.00650*	0.00758**	0.00723**	0.00554	0.00696*
	(2.12)	(1.86)	(1.42)	(1.76)	(2.44)	(2.10)	(1.50)	(1.80)
gov_exp	−0.0225*	−0.0203	−0.0203	−0.0140**	−0.0208*	−0.0183	−0.0187	−0.0152
	(−1.86)	(−1.56)	(−1.45)	(−1.96)	(−1.72)	(−1.40)	(−1.34)	(−1.03)
population_rate	−0.416**	−0.361*	−0.334	0.400*	−0.407**	−0.364*	−0.345	0.520**
	(−2.15)	(−1.72)	(−1.41)	(1.68)	(−2.08)	(−1.72)	(−1.45)	(2.02)
domestic_inv	0.228***	0.224***	0.224***	0.235***	0.230***	0.227***	0.228***	0.244***
	(7.37)	(6.83)	(6.07)	(6.26)	(7.43)	(6.91)	(6.16)	(6.45)
landlocked	−1.084***	−0.971**	−1.032**	−0.855*	−0.960***	−0.830**	−0.913**	−0.850*
	(−2.93)	(−2.29)	(−2.27)	(−1.89)	(−2.63)	(−1.98)	(−2.03)	(−1.87)
finan_index	−0.581***	−0.588***	−0.672***	−0.587***	−0.587***	−0.596***	−0.682***	−0.641***
	(−7.66)	(−7.08)	(−7.13)	(−6.00)	(−7.71)	(−7.13)	(−7.21)	(−6.25)
human_capital		0.00920	0.00316	0.0102*		0.00934	0.00346	0.00760
		(0.94)	(0.30)	(1.87)		(0.95)	(0.32)	(0.64)
political_freedom			0.271*	0.134**			0.281*	0.200
			(1.80)	(2.14)			(1.86)	(1.47)
rail_line				0.00434				0.00257
				(0.12)				(1.07)
_cons	−2.670***	−3.677**	−5.419***	−4.337***	−2.855**	−3.907**	−5.706**	−6.156**
	(−2.59)	(−2.65)	(−2.70)	(−2.69)	(−2.77)	(−2.81)	(−2.85)	(−3.16)
R^2	0.249	0.247	0.246	0.251	0.245	0.241	0.242	0.246
N	552	511	459	447	552	511	459	447

Note: t-statistics in parentheses, * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$

Tab. 13: Effect of FDI on Domestic Investment with Pooled-OLS

	(1) GFCF	(2) GFCF	(3) GFCF	(4) GFCF	(5) GFCF	(6) GFCF
FDI	0.171***	0.164***	0.155***	0.143***	0.177***	0.152**
	(3.29)	(3.07)	(2.76)	(2.81)	(2.99)	(2.36)
inflation	0.0146	0.000125	0.00856	−0.000438	0.0143	−0.0119
	(1.08)	(0.01)	(0.47)	(−0.03)	(1.04)	(−0.63)
trade_openness	−0.00484*	−0.00481	−0.00269	−0.00426	−0.00606*	−0.00222
	(−1.72)	(−1.48)	(−0.90)	(−1.55)	(−1.96)	(−0.58)
gov_exp	−0.129***	−0.137***	−0.123***	−0.125***	−0.138***	−0.142***
	(−11.33)	(−11.31)	(−10.23)	(−11.16)	(−11.25)	(−10.56)
population	0.00726*	0.00774**	0.00886**	0.00889**	0.0120**	0.0135**
	(1.92)	(2.01)	(2.14)	(2.40)	(2.01)	(1.98)
finan_index		0.182**				0.233**
		(2.07)				(2.07)
human_capital			0.0230**			0.00993
			(2.28)			(0.85)
political_free				0.397***		0.248**
				(4.15)		(2.06)
rail_network					0.00453	0.00497
					(0.49)	(0.47)
_cons	27.97***	28.28***	29.99***	31.62***	28.67***	31.94***
	(55.35)	(52.15)	(25.23)	(31.36)	(48.74)	(19.24)
R^2	0.214	0.228	0.212	0.241	0.237	0.263
N	873	792	813	853	735	643

Note: t-statistics in parentheses, * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$

Tab. 14: Effect of FDI on Growth with System GMM

	(1) Growth	(2) Growth	(3) Growth	(4) Growth	(5) Growth	(6) Growth
Lag (Growth)	−0.143*	−0.105	−0.177**	−0.149*	−0.133	−0.0915
	(−1.68)	(−1.60)	(−2.37)	(−1.84)	(−1.33)	(−1.21)
FDI	0.225**	0.117**	0.202**	0.224**	0.346***	0.199***
	(2.23)	(2.22)	(2.52)	(2.63)	(2.76)	(2.96)
inflation	−0.0641**	−0.0139	−0.0841***	−0.0440*	−0.0818***	−0.0285
	(−2.13)	(−0.73)	(−3.01)	(−1.90)	(−2.83)	(−1.09)
trade_openness	0.00809	0.00638	0.00920	0.00880	0.0123	0.00786
	(0.75)	(0.99)	(0.93)	(0.99)	(0.98)	(1.00)
gov_exp	0.00231	0.00118	−0.00154	0.00866	0.0118	0.0211
	(0.05)	(0.04)	(−0.04)	(0.20)	(0.23)	(0.59)
population_rate	−1.754**	−1.735*	−1.528***	−1.147**	−1.657***	−1.168**
	(−2.34)	(−1.90)	(−3.54)	(−2.39)	(−3.23)	(−2.17)
domestic_inv	0.516***	0.480***	0.425***	0.500***	0.499**	0.529***
	(3.76)	(5.02)	(3.90)	(4.00)	(3.42)	(4.17)
finance_index		−0.346*				−0.197
		(−1.94)				(−0.81)
human_capital			0.00782			0.00639
			(1.37)			(1.31)
political_free				0.361*		0.248
				(1.68)		(0.67)
rail_network					−0.00150	−0.00389
					(−0.16)	(−0.30)
_cons	−9.647**	−9.116***	−8.589**	−6.464	−10.19**	−9.640**
	(−2.22)	(−3.33)	(−2.10)	(−1.32)	(−2.14)	(−1.96)
Hansen test of overid.	46.53	53.96	51.77	55.33	60.71	40.99
	(0.450)	(0.257)	(0.329)	(0.218)	(0.103)	(0.719)
Arellano-Bond AR (2) p-value	0.241	0.281	0.410	0.571	0.381	0.352
N	843	763	786	824	710	620

Note: t-statistics in parentheses, * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$

Tab. 15: Effect of FDI on Domestic Investment with System GMM

	(1) GFCF	(2) GFCF	(3) GFCF	(4) GFCF	(5) GFCF	(6) GFCF
Lag (GFCF)	0.351***	0.378***	0.372***	0.347***	0.361***	0.322***
	(6.12)	(6.51)	(6.73)	(6.58)	(7.33)	(5.94)
FDI	0.297	0.281*	0.309**	0.264**	0.158	0.137
	(1.33)	(1.71)	(1.97)	(2.11)	(1.34)	(1.51)
inflation	−0.00583	−0.00304	−0.00337	0.00481	−0.00394	−0.00948*
	(−1.15)	(−0.37)	(−0.42)	(0.84)	(−0.59)	(−1.92)
trade_openness	0.00157	0.00142*	0.000927**	0.000724**	0.00218	0.0007621
	(1.42)	(1.65)	(2.17)	(2.21)	(1.59)	(1.61)
gov_exp	−0.00483	−0.00583	−0.00592	−0.00761**	−0.00892*	−0.00985*
	(−0.95)	(−1.31)	(−1.35)	(−2.15)	(−1.81)	(−1.93)
population_rate	0.149	0.0301	0.0348	0.172*	0.0805	0.207**
	(1.55)	(0.51)	(0.64)	(1.87)	(1.05)	(1.98)
domestic_inv	0.678***	0.671***	0.657***	0.659***	0.643***	0.667***
	(9.23)	(15.21)	(15.24)	(16.68)	(17.72)	(14.07)
finance_index		0.0675**				0.0214
		(2.41)				(0.72)
human_capital			0.00581			0.00795
			(1.34)			(0.57)
political_free				0.262***		0.368**
				(2.71)		(1.91)
rail_network					−0.00719	0.00201
					(−1.17)	(1.09)
_cons	1.351	0.607	−0.241	−1.793	1.317*	−2.307
	(1.26)	(1.05)	(−0.37)	(−1.64)	(1.93)	(−1.42)
Hansen test of overid.	58.48	57.38	57.98	55.40	57.75	58.29
	(0.122)	(0.192)	(0.131)	(0.161)	(0.115)	(0.106)
Arellano-Bond AR (2) p-value	0.803	0.517	0.809	0.579	0.351	0.415
N	850	769	713	695	624	624

Note: t-statistics in parentheses, * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$

Tab. 16: Effect of FDI from Different Countries on Growth with System GMM

	(1) Growth	(2) Growth	(3) Growth	(4) Growth	(5) Growth	(6) Growth	(7) Growth	(8) Growth
Lag (GDP)	−0.206***	−0.0902**	0.0847	−0.250***	−0.207***	−0.293***	0.137**	−0.270***
	(−3.16)	(−2.03)	(1.00)	(−3.47)	(−3.25)	(−5.36)	(2.05)	(−4.31)
FDI_developed	0.296*	0.619**	0.612*	0.536**				
	(1.87)	(2.33)	(1.76)	(2.18)				
FDI_developing					−1.547	−0.115	0.768	1.436
					(−1.59)	(−0.14)	(0.45)	(1.19)
inflation	−0.0637	−0.133	−0.0614	−0.114	−0.0493	−0.0584	−0.0856	−0.0900
	(−1.38)	(−1.28)	(−1.21)	(−1.46)	(−1.40)	(−1.07)	(−1.18)	(−1.19)
trade_openness	0.0791***	0.0296	0.0236	0.0441*	0.0913***	0.0984	0.0515	−0.0809
	(3.49)	(1.56)	(0.83)	(1.96)	(3.02)	(1.54)	(1.39)	(−1.38)
gov_exp	−0.100	−0.00623	−0.0452	−0.00857	−0.0542	−0.0631	−0.0523	−0.101**
	(−0.50)	(−1.08)	(−0.44)	(−1.09)	(−1.26)	(−1.62)	(−1.35)	(−2.07)
population_rate	−1.600*	−1.332	−2.742	−0.138	−0.839	−0.129	−1.392	−1.590
	(−1.93)	(−1.02)	(−1.60)	(−0.12)	(−0.55)	(−1.09)	(−1.11)	(−1.58)
domestic_inv	0.785***	0.251**	0.378**	0.344***	0.769***	0.232*	0.260**	0.322*
	(6.53)	(2.26)	(2.37)	(2.99)	(6.40)	(1.87)	(2.21)	(1.85)
landlocked	−13.92**	−6.665**	−8.514*	−9.019**	−1.351**	−0.947	−0.685	−0.787
	(−2.95)	(−2.12)	(−1.80)	(−2.33)	(−2.69)	(−1.30)	(−1.22)	(−1.17)
finan_index	−2.963***	−2.241***	−3.008***	−2.773***	−2.138***	−0.481*	−0.407	−1.769***
	(−3.57)	(−2.92)	(−3.60)	(−3.90)	(−2.92)	(−1.88)	(−0.40)	(−2.59)
human_capital		−0.0666	−0.114	−0.0932		0.166**	0.0659*	0.141*
		(−0.85)	(−1.27)	(−1.11)		(2.29)	(1.65)	(1.86)
political_freedom			2.043*	0.998**			1.150*	1.438*
			(1.84)	(2.01)			(1.80)	(1.91)
rail_network				0.0744				−0.239
				(0.54)				(−0.87)
_cons	−1.347	2.161	−4.427**	−5.909	6.396	4.889**	1.093	−2.910**
	(−0.93)	(0.15)	(−2.18)	(−0.65)	(0.38)	(2.76)	(0.59)	(−2.82)
Hansen test of overid.	50.77	47.88	45.75	38.76	35.66	43.62	50.15	52.34
	(0.141)	(0.214)	(0.359)	(0.526)	(0.666)	(0.361)	(0.211)	(0.182)
Arellano-Bond AR (2)	0.452	0.797	0.507	0.202	0.242	0.416	0.479	0.420
N	489	454	440	396	489	454	440	396

Note: *t*-statistics in parentheses, * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$

Tab. 17: Effect of FDI from Different Countries on the Domestic Investment with System GMM

	(1) GFCF	(2) GFCF	(3) GFCF	(4) GFCF	(5) GFCF	(6) GFCF	(7) GFCF	(8) GFCF
Lag (GFCF)	0.793***	0.781***	0.815***	0.795***	0.793***	0.807***	0.813***	0.832***
	(15.18)	(18.42)	(18.38)	(18.64)	(22.09)	(23.44)	(16.16)	(15.72)
FDI_developed	1.0659*	1.0591*	1.0542*	1.0665**				
	(1.80)	(1.85)	(1.74)	(1.97)				
FDI_developing					0.425	0.498*	0.205	0.410
					(1.60)	(1.65)	(1.26)	(1.49)
inflation	−0.00430	−0.00776	−0.00935	−0.00258	−0.00807	−0.00293	−0.00402	−0.00813
	(−0.46)	(−0.42)	(−0.11)	(−0.29)	(−1.38)	(−0.37)	(−0.46)	(−0.84)
trade_openness	0.00330**	0.000846	0.00499***	0.00287	0.00194	0.00250	0.00539**	0.00820**
	(2.00)	(0.17)	(3.11)	(1.55)	(0.81)	(1.01)	(2.71)	(2.60)
gov_exp	−0.0307**	−0.0451*	−0.0303***	−0.0379***	−0.0349***	−0.0324***	−0.0294***	−0.0145*
	(−2.11)	(−1.78)	(−2.94)	(−3.36)	(−3.02)	(−2.84)	(−2.74)	(−1.80)
population_rate	0.197	0.211	0.114	0.286	0.181	0.147	0.229	0.372*
	(0.86)	(−0.49)	(0.59)	(1.31)	(0.92)	(0.86)	(0.64)	(1.83)
finan_index	0.210**	0.234***	0.185**	0.257***	0.209**	0.214***	0.185**	0.343**
	(2.35)	(2.80)	(2.24)	(3.02)	(2.56)	(2.98)	(2.28)	(2.39)
human_capital		0.00174	0.00617*	0.00495		0.00858	0.00641	0.0197**
		(1.13)	(1.75)	(0.72)		(1.45)	(1.18)	(2.11)
political_free			0.0311	0.0569			0.0326	0.172
			(0.21)	(0.33)			(0.23)	(0.90)
rail_network				0.000626***				0.000544*
				(3.09)				(1.84)
_cons	5.096***	6.258*	4.134*	4.403*	5.441***	4.031***	4.047*	0.944
	(3.53)	(1.79)	(1.94)	(1.68)	(5.74)	(3.62)	(1.78)	(1.27)
Hansen test of overid.	52.68	51.63	48.57	45.62	50.21	45.74	45.33	42.83
	(0.231)	(0.263)	(0.409)	(0.446)	(0.310)	(0.441)	(0.542)	(0.606)
Arellano-Bond AR (2)	0.152	0.190	0.159	0.164	0.146	0.191	0.151	0.132
N	489	453	437	393	489	453	437	393

Note: *t*-statistics in parentheses, * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$

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IMPACT OF BANK REGULATION ON BANKS' PROFITABILITY: CROSS-COUNTRY EVIDENCE

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ABSTRACT

The clarion call for reform in bank regulation that ensures sound financial system and better performance following the financial melt-down of 2007–2009 across the globe has made it necessary to identify reforms that ensure these objectives are achieved. Using the most recent Banking Regulation and Supervision Survey of the World Bank and showing through empirical evidence, this paper adds to recent literature on the assessment of the impact of bank regulation on the profitability of banks across the globe. An Orbis financial database for 7535 banks observations in 114 countries over the period 2011–2018 is used for this study. The study shows that stringent capital requirement has positive and very significant impact on bank profitability. Same result is reported for Accounting/Information disclosure implying that regulations that strictly enforce information disclosure by banks to stakeholders eventually impacts positively on profitability. However, regulation on discipline/Problem institutions/exit has very significant and negative impact on bank profitability. Finally, the study again shows through the results that restriction on banking activities has positive impact on bank profitability though not significant just as expected.

KEY WORDS

banks, regulation, supervision, financial meltdown

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E5, G38, L51

1 INTRODUCTION

The global financial melt-down of 2007–2009 generated so much debate among academicians, policy makers and industry players with regards to how best the whole industry should be regulated to ensure sound and efficient financial system across the globe to prevent future

occurrence of that magnitude. The financial crisis was generally attributable to structural problems in the industry as well as the subprime mortgage crisis in the US and other major financial hubs around the globe.

Post-financial crisis led to several reforms across the globe mainly spearheaded by the Basel Committee on Banking Supervision from which it came out with sweeping reforms in the global financial sector to forestall and address any future financial meltdown. To prevent financial stress at the individual bank level, the Basel III accord was implemented and subsequently some aspects of Basel IV. It is also important to mention some other reforms in the banking sector which includes but not limited to; The G20 Accord (Over the Counter Derivatives), The Frank Dodd's Act and the European Market Infrastructure Regulation (EMIR).

In the wake of financial crisis of 2007–2009, many governments, central banks and financial institutions like the World Bank and the IMF were spurred to provide financial reforms and regulations that ensure sound and efficient banking system across the globe. The United States' Congressional Report on what led to the global financial meltdown of 2007–2009 as reported by Jickling (2010) provides as much as 26 major causes and provides strong arguments as to why they were the cause. But it is good to note that the debate as to the cause of the crisis will rage on for decades due to varying opinion on the matter.

This study seeks to contribute to literature on bank regulation and supervision for the countries understudy between the periods of 2011–2018. This research is interesting from both the perspective of theory and policy making. Worth mentioning are the myriad of contradictory predictions made by various scholars on the impact of bank regulations on bank performance even though the topic has received greater attention following the global financial crisis of 2007/2009. Also, there is no strong evidence that suggests one system of bank regulation that is effective universally. For instance Barth et al. (2013) used 4050 banks observations in 72 countries mostly from developed and emerging economies to examine whether bank regulation and supervision impacts positively or negatively on bank efficiency. Bank efficiency was used as the dependent variable, this current research however employs over 7500 banks in 114 countries from across the globe where return on asset is used as a dependent variable to show how bank regulations and supervision impacts on bank profitability for the banks sampled. Furthermore, Ozili (2017) and Yang et al. (2019) empirically researched on the regulatory impact of bank regulations on profitability of banks in Africa and Asia Pacific regions respectively. These however, do not provide a broader perspective of understanding of the phenomenon due to the limitation in scope. The novelty of this research is that it provides broader understanding of the findings since more banks are involved leading to enhancement of policy making and future theory formulation.

This paper again contributes to existing literature in several ways. It first shows that regulation on stringent capital requirement has very significant positive impact on bank profitability. Second, this research also shows that Accounting/Information disclosure has very significant and positive impact on bank profitability where vital information disclosure to stakeholders in the banking industry eventually impacts positively in banks performance. The paper again shows that restriction on banking activities increase bank profitability though not significant. Finally, this paper shows that regulation on discipline/Problem institutions/exit however has very significant and negative impact on bank profitability.

This paper is organised as follows; the review of literature on how bank regulation impacts bank profitability is provided in section two (2), in section three (3) also, methodology of data and estimation techniques are discussed. The main results and findings are analysed in section four (4). Robustness and sensitivity analysis are also provided in section five (5). Finally, section six (6) deals with conclusion of the entire research.

2 LITERATURE REVIEW

Relevant literature pertaining to the impact of bank regulation and supervision on bank profitability is analyzed in this section by looking into the theoretical and empirical perspectives. The empirical literature specifically reviews regulations on capital requirement, restrictions on banking activities, accounting/information disclosure and discipline/Problem institutions/exit.

In order to protect the banking sector from excessive risk-taking and reduce moral hazards to the barest minimum, the combination of banking regulations, supervisions and policy restrictions ensure all these goals are ultimately achieved (Ayadi et al., 2016). Other research by Casu et al. (2017) posit that the complexity and turbulence of the whole banking industry in the past decades has led to changes in banking regulation that focuses more on internal management promotion than on supervisory and monitoring activities. Furthermore, in the wake of financial and regulatory reforms comes the tightening of capital requirement for banks (Djalilov and Piesse, 2019).

Nevertheless, the effectiveness of banking regulation following the financial crisis of 2007–2009 continue to be questioned by policymakers as well as researchers who see the weakness of this regulation as a key determinant of the crisis (Čihák et al., 2013).

The theoretical perspective on the exact impact of bank regulation and supervision is not clear due to some general views held in the industry (Barth et al., 2013). The two views as elaborated in Barth et al. (2008) discusses about the "public interest view" where governments are expected to provide a regulatory framework that seeks to promote efficient banking and avoid market failures. The other view which is "private interest view" as explained, mainly make regulations to seek the interest of the minority group which eventually does not lead to bank efficiency. Due to these conflicting views which may affect predictions on theoretical studies, it is imperative that an empirical perspective should be looked at to help make an informed policy decisions.

Early empirical studies have emphasized on how regulatory as well as supervisory frameworks have impacted the performance of the banking sector amongst which include but not limited to (Dewatripont and Tirole, 2018; Hovakimian and Kane, 2000; Rochet, 1992). In evaluating the regulatory impact on banks profit, Barth et al. (2013) raises a cautionary flag with regards to the use of policies by governments in supervising and regulating bank activities which they posit will affect the banks' performance. The study was based on the sample of banks in 107 countries. Similar findings was reported by Demirgüç-Kunt and Huizinga (1999) where they shows that tighter regulation on banking activities tends to increase the cost of financial intermediation which eventually affects banks profitability.

Based on the analysis of 4050 banking institutions across 72 countries, Barth et al. (2013) found that bank efficiency and restrictions on bank activities had negative relationship. Positive relationship was however found between bank profitability and bank efficiency and same results for strengthening of supervisory power. Financial transparency based on market monitoring of banks also impacts positively on bank efficiency. Same results was reported by Agoraki and Tsamis (2017) in their research of emerging European banks in 2000–2016. They find that banks in countries with high capital requirement, restrictions on banking activities and market activities perform better with regards to efficiency and profitability. However, Other research by Ahamed et al. (2021) find that limited restrictions on banking activities as well as stringent high capital regulation leads to greater flow of low-cost fund hence good return on investment. This research was based on international sample of 1740 in 2004–2015.

Other recent empirical study in the Eurozone area by Asteriou et al. (2021) find strong positive relationship between regulation and bank profitability but the relationship according to the study depends on the type of regulation. In their study on the "Role of Bank Regulation on Bank Performance" in the Asia-Pacific region,

Yang et al. (2019) also find that Australian and Indonesian banks exhibit highest and lowest level of technical efficiency respectively. They further find evidence of tighter bank regulation and supervision resulting in high efficiency for both small and large size banks. In the Africa region, some other research finds evidence of impact of bank regulation on profitability and efficiency. Ozili (2017) and Triki et al. (2017) all find divergent impact of bank regulation on profitability. Ozili (2017) for instance show evidence that capital regulation having both significant and positive impact on the profitability of listed banks in the stock exchange than the unlisted banks. The study further finds negative impact on the profitability of non-listed banks with high regulatory capital. Triki et al. (2017) also show that the effect of some bank regulation depends on bank size as well as the risk level of the bank. Their findings further show that more stringent restrictions on entry increase large banks' efficiency. Restrictions on exit for small banks however affect the efficiency of the banks.

In a nutshell, two important points stand out from the above regarding previous studies on the impact of bank regulation on bank performance. First and foremost, there is no empirical evidence that show the best universal application of one bank regulation. Also, the efficiency of various bank regulations and supervision measures significantly changes depending on the regulatory framework as well as the type of the banking sector in question.

3 EMPIRICAL STRATEGY AND DATA

3.1 Sample

Financial data from 114 countries across the globe was used for the purpose of this study and the period covered is 2011–2018. The study uses an unbalanced panel financial data from Orbis and it involves a little over 7500 banks sampled from six continents. The variables used in this paper follow many others used in recent literature like Barth et al. (2013), Bitar et al. (2018), Borio et al. (2017), Chortareas et al. (2012) and many others.

3.2 Return on Asset (Dependent Variable)

To account for and measure profitability in the banking industry, Return on asset, Return on Equity and Net interest margin are widely used by many scholars. The return on asset shows how much profit is earned by a bank after tax as it deploys all its total assets (expressed in %). Return on equity indicates profit earned after tax per each equity capital invested by equity shareholders.

3.3 Control Variables

In order to ensure that the heterogeneity of banks are accounted for in cross-country data, bank performance variables used in many literatures are used as in Athanasoglou et al. (2008), Demirgüç-Kunt and Huizinga (1999), Dietrich and Wanzenried (2014) and Goddard et al. (2004). The net interest margin shows the net of interest earned as a result of loans granted to banks customers and what it pays for loans taken to finance its activities, which is measured per total assets of the bank. The ROA explains how efficient the banks' management are in utilising the assets of the bank. It shows the profits earned per USD of assets and indicates how effectively the bank's assets have been managed to generate revenues (Dietrich and Wanzenried, 2014). As Goddard et al. (2004) point out, Return on asset is mostly considered as the main ratio so far as the evaluation of bank profitability is concerned and has become the yardstick for bank profitability measurement in many literatures.

The cost-to-income ratio as an independent variable is the cost associated with running the banks' operation which comes in the form of (emoluments to staff; maintenance cost of

properties; administration running cost, discounting non-performing and bad loans losses as against total generated revenue (Dietrich and Wanzenried, 2014). Accordingly in this research, it is expected that a high cost-income ratio will exhibit a negative relationship with bank profitability. Loan loss reserves over gross loans represent credit risk in this paper and extant literature indicates that much exposure to credit risk impacts negatively on bank profitability and by implication a negative effect of this variable on bank profitability should be expected. Another important variable in our model (Net Loans over Total Assets) looks at the liquidity risk of the bank with the expectation of low liquidity resulting in positive impact on profitability.

As in Athanasoglou et al. (2008), Demirgüç-Kunt and Huizinga (1999), this paper uses the logarithm of Total Assets to represent bank size which is also an important determinant of bank profitability. It is worthy of note that total assets may not be the best measure for bank size of big banks for the simple reason of some having important off-balance sheet activities (Dietrich and Wanzenried, 2014). For the purpose of having a uniformity to fit the sample in this research, the log of total asset is used. Due to divergent definitions of what represents large, medium and small banks in different countries, this paper uses of dummy variables for three different bank size categories generated on country level (Dietrich and Wanzenried, 2014). Naturally, the expectation is that large and medium sized banks impacts positively on bank profitability as compared to small sized banks due to economies of scale they enjoy in the short term. However, economies of scale may be impacted negatively for heavy capitalised banks in the long run.

This paper also uses equity to total assets as capital adequacy which is the measure of risk of insolvency of the bank as well as the assets' market value as in Maudos and de Guevara (2004). According to Agoraki and Tsamis (2017), equity represents the resources (funds) owned by the bank available for its operations and provides a cushion when markets condition is not favourable and negatively affects banks' development. As posited by Martínez-Peria and Mody (2004) and Saunders and Schumacher (2000) the relative expensive nature of equity being source of funding may lead to rise in capital cost. Depositors in developing countries have strong conception that banks with sufficient capital provide safety net and a marginal bankruptcy cost (Agoraki and Tsamis, 2017).

This research uses real GDP Per Capita to capture the impact of macroeconomic environment on bank profitability as a means of measuring economic activity shocks and the policy-rate to capture monetary policy decisions. Again consumer price indexes (inflation) as well as nominal exchange rate are included in the model. Brock and Rojas-Suárez (2000) and Claeys and Vennet (2008) all posit that a rise in GDP Per Capita could lead to increase in profitability mainly on the account of more lending and lower default rates.

The swift and timely manner in which banks adjust interest rates to cope with rising inflation increases profitability which results in income rising faster than cost (Pasiouras and Kosmidou, 2007). The reverse happens if banks fail to anticipate inflation. Most studies find that inflation positively influences profit (Bourke, 1989; Molyneux and Thornton, 1992) and even net interest margins (Demirgüç-Kunt and Huizinga, 1999). On the other hand, Abreu and Mendes (2001) researched on banks from four European countries (Germany, France, Portugal and Spain) between the period 1986–1999 and find that return on asset and inflation have a negative relationship.

With regards to the nominal exchange rates, Hardy and Pazarbasioglu (1999) and Sahminan (2007) confirm that exchange rate depreciation significantly leads to banking distress. They strongly argue that exchange rate depreciation significantly reduces the profitability on lending in foreign currency. Thus, it is expected from this research that sharp decline in real effective exchange will impact negatively on bank profitability.

Monetary policy rates as another important determinant of bank profitability impacts profitability in a couple of ways; firstly, reduction in policy rates impacts positively on

the macroeconomic conditions that eventually helps the banks in reducing their associated cost of funding and increasing the creditworthiness of borrowers. Again, it is also argued that accommodating policy rates may result in the contraction in the net interest income of banks in the long-run.

3.4 Regulation Indices

To account for the regulation and supervision of banks in the model of this research, four regulatory indices are used as in Agoraki and Tsamis (2017), Anginer et al. (2021) and Barth et al. (2008). The study uses four dummy variables that the researcher thinks are a good representatives (proxies) for regulations and supervision.

The first dummy variable represents the area on regulation for capital requirement and the survey question as used by the World Bank is: *"What items and in what percentage do they constitute Tier 1 capital?"* An answer "capital instruments" represents 1 and otherwise represents 0. This research uses the World Banks' Banking Regulation and Supervision Survey of 2016 as a guide for this study.

The second dummy variable represents restrictions on banking activities and the survey question is: *"Under which conditions are banks allowed to engage in securities activity?"* An answer "Banks could engage in full range of these activities." is scored 1 and 0 for otherwise.

The third dummy variable also represents accounting/information disclosure and the survey question is: *"Are financial statements submission to the banking supervisor required before public disclosure?"* An answer "yes" is scored 1 and 0 for "no".

Finally, the last dummy variable is a proxy for regulation on discipline/Problem institutions/exit and the survey question for this variable is: *"Are formal enforcement actions by bank regulators supposed to be made public especially in the areas of cease and desist orders and mutual agreements between the regulator and the banking organisation?"*. An answer for "yes" is scored 1 and "no" 0.

See details in Tab. 5 in the Annex.

3.5 Model Specification

To achieve the objective of this paper, the following mathematical model was used and applied and the model is a modified version of Cross-sectional model used by Barth et al. (2013), Demirgüç-Kunt and Huizinga (1999) and Pasiouras and Kosmidou (2007). However, there is a slight variation of the above model as this research specifically uses a pooled regression time series as in Goddard et al. (2004), Staikouras and Wood (2011) and Neely and Wheelock (1997). The pooled regression model as used here assumes the same effect for profit and so therefore cross sectional variation (among banks) in any of the independent variables as well as variation overtime in that variable for an individual bank (Goddard et al., 2004). Yearly dummy is included in the model to make up for time impact.

$$\begin{aligned} \mathrm{ROA}_i = &\sum_{b=1}^{B} \beta_k \, \mathrm{BankSpec}_i^b + \\ &+ \sum_{s=1}^{s} \gamma_s \, \mathrm{Macro}_j^s + \\ &+ \sum_{r=1}^{R} \rho_\eta \mathrm{BankReg}_j^r + \\ &+ \theta_t + \mu_i, \end{aligned}$$

where the model relate the profitability of a Bank i in time t, denoted by ROA and selected back control variables (BankSpec) that are associated with bank profitability, liquidity risk, capital adequacy and leverage (net interest margin, cost to income, equity over total assets, net loans over total assets, loan loss reserves over gross loans, total assets). Included in the model are macroeconomic variables in country j at time t; Macro GDP per capita, inflation, and exchange rate and policy rate. BankReg from the model represents dummy variables for bank regulation and supervision survey (Bank Regulation Survey 1, Bank Regulation Survey 2, Bank Regulation Survey 3 and Bank Regulation Survey 4). Time dummy in model is θ_t with an error term μ_i.

4 MODEL ESTIMATION RESULTS

In this section, the researcher dissects how bank regulation and supervision impacts on the profitability of banks under study. Before examining the main model, the paper in Tab. 4 in the Annex shows the descriptive statistics of the main variables used in the research.

4.1 Descriptive Statistics

The mean average return on asset is approximately 1% for over 7500 banks sampled across 114 countries. It shows how much profit the banks earn per asset. This corresponds with the same as mean value obtained by Staikouras and Wood (2011). Banks generally make an average net interest margin of 4.3%, relatively close to 6.4% in Adelopo et al. (2018). The cost to income ratio which signals how efficient management are in managing cost has mean value of 75.6 for the sampled banks as obtained in Pasiouras and Kosmidou (2007) for Spanish banks 70.3. The financial leverage ratio which measures the use of debt by the banks to finance assets has mean value of 19.50.

With regards to macroeconomic statistics, the GDP Per Capita which measures the economic health of an economy for countries under study has a mean value of 1.03 and this is close to results obtained by Pasiouras and Kosmidou (2007) for the United Kingdom. The policy rate for the central banks used in the determination of commercial banks' interest rates as well as inflation have mean of 1.6 and 1.0 respectively.

The correlation matrix among these variables enables to identify that using some of the variables at the same time is not prudent, since the same phenomenon would probably have been explained. A closer look at the table below shows no correlation amongst all the variables, thus good selection of variables for the model. This research test for multicollinearity by studying whether the correlation coefficients absolute values between the explanatory variables exceed 0.80 (Studenmund, 2014). The details in Tab. 6 in the Annex suggest that all correlation coefficients are below 0.80. Hence, this research does not have a multicollinearity problem.

To ensure the absence of multicollinearity among explanatory variables the study uses OLS regression of the model to estimate Variance Inflation Factor (VIF) and as stated in Robinson and Schumacker (2009) the value should not exceed the value of 10. In Tab. 7 in the Annex, we show that none of the explanatory variables have a VIF value more than 10.

4.2 Pooled Regression Results

The study presents the findings on the impact of bank regulation on banks profitability and the model introduces the bank regulation variables gradually until all the variables are included simultaneously and the details are available in Tab. 1. The results for the control variables show that cost to income ratio, net interest margin, Equity to total assets, bank size, loan loss reserves over gross loans are significant. Except for cost to income and loan loss reserves over gross loans that have negative signs, all the other control variables have positive signs. This result indicates that competitive banks in the countries understudy earn enough profit from deployed resources. From the macro-economic environment, GDP Per capita, inflation, exchange rate are positive and significant except for policy rate that has negative sign. Somewhat surprisingly, this study finds a hike in policy rate leading to decline in bank profit. Perhaps the use of inter-bank rates could confirm this results or otherwise.

Three bank regulation and supervision measures (bank regulations supervision 1, 3 and 4) have very significant and positive impact on bank profitability. It is clear from the results that Bank regulation and supervision survey 1 which represents regulation on capital requirement is associated with an increase in bank profitability as the coefficient is positive and significant (at the 1% level) and this is consistent with Fethi and Pasiouras (2010), Barth et al. (2013), Agoraki et al. (2017) and Yang et al. (2019). Overall Accounting/Information disclosure which is bank regulation survey 3 is significant and positive (at 1% level).

Tab. 1: Impact of Bank Regulation and Supervision on Bank Profitability: All benchmark models

	(Model 1)	(Model 2)	(Model 3)	(Model 4)	(Model 5)
Dependent variable: Return on asset	**Panel Data (pooled)**	**Panel Data (pooled)**	**Panel Data (pooled)**	**Panel Data (pooled)**	**Panel Data (pooled)**
Cost to income	−0.0219***	−0.0219***	−0.0219***	−0.0218***	−0.0218***
	(0.0022)	(0.0022)	(0.0022)	(0.0022)	(0.0023)
Net interest margin	0.0190***	0.0187***	0.0186***	0.0175***	0.0175***
	(0.0046)	(0.0045)	(0.0045)	(0.0044)	(0.0043)
Log of total assets	0.0685***	0.0504***	0.0422**	0.0462***	0.0659***
	(0.0144)	(0.0130)	(0.0139)	(0.0136)	(0.0145)
Loan loss reserves	−0.0139*	−0.0142*	−0.0143*	−0.0143*	−0.0140*
over gross loans	(0.0059)	(0.0060)	(0.0060)	(0.0060)	(0.0059)
Net loans over total assets	0.0146	0.0151	0.0139	0.0117	0.00791
	(0.0148)	(0.0148)	(0.0149)	(0.0152)	(0.0152)
Equity over total assets	0.0318***	0.0313***	0.0306***	0.0299***	0.0297***
	(0.0068)	(0.0068)	(0.0069)	(0.0069)	(0.0070)
GDP per capita	1.147*	1.123*	1.058*	1.129*	1.129*
	(0.625)	(0.654)	(0.622)	(0.639)	(0.661)
Policy rate	−0.0365**	−0.0387**	−0.0407**	−0.0375**	−0.0345*
	(0.0134)	(0.0135)	(0.0132)	(0.0134)	(0.0135)
Inflation	0.0291**	0.0316**	0.0277*	0.0285**	0.0189
	(0.0102)	(0.0103)	(0.0109)	(0.0110)	(0.0116)
Exchange rate	0.00845**	0.0104***	0.0105***	0.0115***	0.0085**
	(0.0029)	(0.0027)	(0.0026)	(0.0026)	(0.0029)
Bank regulation and	0.178*				0.296***
supervision survey 1	(0.0808)				(0.0737)
Bank regulation and		−0.0318			0.0662
supervision survey 2		(0.0877)			(0.0868)
Bank regulation and			0.184*		0.216**
supervision survey 3			(0.0804)		(0.0791)
Bank regulation and				−0.198*	−0.250**
supervision survey 4				(0.0925)	(0.0863)
_cons	−1.185*	−1.016	−0.857	−0.864	−0.934
	(0.712)	(0.737)	(0.720)	(0.727)	(0.708)
Time dummies	Yes	Yes	Yes	Yes	Yes
Number of observations	33632	33632	33632	33439	33439
Number of countries	114	114	114	114	114
Number of banks	7535	7535	7535	7535	7535
R^2	0.159	0.159	0.159	0.159	0.161

Note: The estimation is based on pooled regression time series. The pooled regression model as used here assumes the same effect for profit and so therefore cross sectional variation (among banks) in any of the independent variables as well as variation overtime in that variable for an individual bank (Goddard et al., 2004). The sample is 8 period panels with yearly dummy included in the model to make up for time impact. The parenthesis covers the standard errors in the table. * = statistically significant at 10%; ** = statistically significant at 5%; *** = statistically significant at 1%

The result implies that a very stringent requirement for banks to provide vital accounting information leads to strong confidence in the banking industry which eventually leads to positive investor decisions and favorable market performance. Bank regulation survey 4 which is a proxy for regulation on discipline/Problem institutions/exit however is associated with less

bank profitability as indicated by its negative coefficient (at 1% level) has very significant and negative impact on bank profitability in sharp contrast to the findings of Yang et al. (2019). Restriction on banking activities (Bank regulation and supervision survey 2) has positive impact on bank profitability at 7% though not significant just as found in Barth et al. (2013) and Yang et al. (2019).

5 ROBUSTNESS CHECK

We conduct sensitivity analysis of our research findings above to reinforce strongly that the results obtained are valid in some other situations. To achieve this objective the study asks two important questions; whether bank size and income level of the bank present a significantly different outcome from the main research results or will further support it?

Tab. 2 details of the estimates of the model are provided by using the banks' size (log of total assets), where bank sizes are categorised as large, medium and small. Like the main results in Tab. 1, many of the bank-specific variables have very significant and positive impact bank profitability irrespective of the bank size. Cost to income ratio has a very significant negative coefficient at 1% impact on profit for all bank sizes. The results show an average reduction in bank profit for all bank sizes by 2.2%. The net interest margin has very significant positive coefficient (1.7%) on average for all bank sizes same as the main model in Tab. 1. The leverage as well as total assets both has very strong and positive coefficients for all bank sizes, same results in main model. Net loans to total assets however has positive even though significant coefficient same as the main model.

The macroeconomic and bank regulation and supervision variables largely show significant and positive results for all bank sizes. This reaffirms the results of our main model in Tab. 1. The exchange rate at nominal value has positive 5% significance on profitability for all bank sizes as obtained in model 1. Inflation has positive coefficient though not significant, thus confirming the results in model 1. GDP Per Capita is also significant at 10%.

Three bank regulation measures (thus, regulations 1, 3 and 4) show very significant coefficients though bank regulation and supervision survey 4 is negative. The coefficients for regulation on capital requirement suggest that stringent capital requirement is very significant and positive (at 1%) for all bank sizes. Bank regulation and supervision survey 4 which is a proxy for regulation on discipline/Problem institutions/exit however has very significant and negative impact on bank profitability at all bank levels. Bank regulation and supervision survey 2 which proxy restrictions on banking activities have positive and insignificant coefficients for all bank sizes.

To further support the results of the researcher's main findings, the model is estimated by classifying and categorising countries by income levels. Countries are therefore categorised as high, middle and low incomes and the model estimation is in Tab. 3. Irrespective of the countries income level, cost to income coefficient is negative and very significant at 1% as in the main model. Thus high cost to income ratio is reflected in low bank profitability for high, medium and low income countries. One percent increase in net interest margin increase bank profit by an average of 1.8% for both high and middle income countries whilst same applies to low income countries but 5% significance and same result is reported for leverage. Net loans over total assets for all countries income level are positive though not significant further proving the sensitivity of the first model.

The macro environment further confirms the coefficients of the first model to be robust; the exchange rate regime is significant and positive at all countries income levels. Policy rate is positive and insignificant for both high and low income countries except for middle income which is negative and significant at 10%. This tells us that decision to raise policy rate by central banks in the middle level income countries only decreases bank profitability by 3.5%. Inflation largely is positive and insignificant

Tab. 2: Impact of bank regulation and supervision on bank profitability: Bank size

	(Large banks)	(Medium banks)	(Small banks)
Dependent variable: Return on asset	**Panel Data (pooled)**	**Panel Data (pooled)**	**Panel Data (pooled)**
Cost to income	−0.0218***	−0.0218***	−0.0225***
	(0.0023)	(0.0023)	(0.0024)
Net interest margin	0.0175***	0.0175***	0.0173***
	(0.0043)	(0.0044)	(0.0043)
Log of total assets	0.0659***	0.0659***	0.0860***
	(0.0145)	(0.0145)	(0.0157)
Loan loss reserves over gross loans	−0.0140*	−0.0140*	−0.0139*
	(0.00594)	(0.00594)	(0.00598)
Net loans over total assets	0.0079	0.0079	0.0029
	(0.0152)	(0.0152)	(0.0163)
Equity over total assets	0.0297***	0.0297***	0.0296***
	(0.0070)	(0.0070)	(0.0071)
GDP per capita	1.129*	1.129*	1.918*
	(0.661)	(0.661)	(0.793)
Policy rate	−0.0345*	−0.0345*	−0.0471**
	(0.0135)	(0.0135)	(0.0157)
Inflation	0.0189	0.0189	0.0204*
	(0.0116)	(0.0116)	(0.0118)
Exchange rate	0.0085**	0.0085**	0.0104**
	(0.0030)	(0.0029)	(0.0033)
Bank regulation and supervision survey 1	0.296***	0.296***	0.316***
	(0.0737)	(0.0737)	(0.0752)
Bank regulation and supervision survey 2	0.0662	0.0662	0.113
	(0.0868)	(0.0868)	(0.0938)
Bank regulation and supervision survey 3	0.216**	0.216**	0.244**
	(0.0791)	(0.0791)	(0.0884)
Bank regulation and supervision survey 4	−0.250**	−0.250**	−0.254**
	(0.0863)	(0.0863)	(0.0902)
_cons	−0.934	−0.934	−2.003*
	(0.708)	(0.708)	(0.833)
Time dummies	Yes	Yes	Yes
Number of observations	33439	33439	31898
Number of countries	114	114	114
Number of banks	7535	7535	7535
R^2	0.161	0.161	0.166

Note: The estimation is based on pooled regression time series. The pooled regression model as used here assumes the same effect for profit and so therefore cross sectional variation (among banks) in any of the independent variables as well as variation overtime in that variable for an individual bank (Goddard et al., 2004). The sample is 8 period panels with yearly dummy included in the model to make up for time impact. The parenthesis covers the standard errors in the table. * = statistically significant at 10%; ** = statistically significant at 5%; *** = statistically significant at 1%

for all income levels except for low income countries.

In model 3, bank regulations on capital requirement (Bank regulation and supervision survey 1) increases bank profitability for both higher income and middle income countries but reduce profitability for countries with low income. Restriction on banking activities

Tab. 3: Bank regulation and profitabilty: Country income level

	(High income)	(Middle income)	(Low income)
Dependent variable: Return on asset	**Panel Data (pooled)**	**Panel Data (pooled)**	**Panel Data (pooled)**
Cost to income	−0.0136***	−0.0218***	−0.0460***
	(0.0017)	(0.0023)	(0.0064)
Net interest margin	0.0182***	0.0175***	0.0182**
	(0.0041)	(0.0044)	(0.0059)
Log of total assets	0.0862***	0.0659***	0.111*
	(0.0127)	(0.0145)	(0.0563)
Loan loss reserves over gross loans	−0.0191*	−0.0140*	−0.0100
	(0.0097)	(0.0059)	(0.0073)
Net loans over total assets	0.0132	0.00791	0.0503
	(0.0133)	(0.0152)	(0.0539)
Equity over total assets	0.0357***	0.0297***	0.0320**
	(0.0083)	(0.0070)	(0.0110)
GDP per capita	0.979	1.129*	0.519
	(0.802)	(0.661)	(0.830)
Policy rate	0.000150	−0.0345*	0.124
	(0.0113)	(0.0135)	(0.184)
Inflation	0.0381*	0.0189	0.0350**
	(0.0213)	(0.0116)	(0.0109)
Exchange rate	−0.00491*	0.00852**	0.0150**
	(0.00224)	(0.00296)	(0.00462)
Bank regulation and supervision survey 1	0.379***	0.296***	−0.162
	(0.0657)	(0.0737)	(0.190)
Bank regulation and supervision survey 2	−0.0557	0.0662	0.533**
	(0.104)	(0.0868)	(0.198)
Bank regulation and supervision survey 3	0.0321	0.216**	0.148
	(0.0672)	(0.0791)	(0.182)
Bank regulation and supervision survey 4	−0.0863	−0.250**	−0.945***
	(0.0723)	(0.0863)	(0.219)
_cons	−0.807	−0.934	−0.0407
	(0.717)	(0.708)	(1.743)
Time dummies	Yes	Yes	Yes
Number of observations	27594	33439	5845
Number of countries	114	114	114
Number of banks	7535	7535	7535
R^2	0.154	0.161	0.244

Note: The estimation is based on pooled regression time series The pooled regression model as used here assumes the same effect for profit and so therefore cross sectional variation (among banks) in any of the independent variables as well as variation overtime in that variable for an individual bank (Goddard et al., 2004). The sample is 8 period panels with yearly dummy included in the model to make up for time impact. The parenthesis covers the standard errors in the table * = statistically significant at 10%; ** = statistically significant at 5%; *** = statistically significant at 1%

(Bank regulation and supervision survey 2) has mixed results for all three income levels; it is significant at 5% and increase bank profit for low income countries. However it reduces bank profitability but the coefficient is insignificant for high income countries and the results largely confirm the results in model 1. Accounting/Information disclosure represents

bank regulation and supervision survey 3 and it increase bank profitability for all countries income level but only significant for middle income economies. And regulation on discipline/Problem institutions/exit is largely significant and decreases bank profitability across board.

6 CONCLUSION

This research examines the impact of bank regulation and supervision on bank profitability and provides further check through sensitivity analysis whether bank size and countries income level impacts differently from main model estimation. Based on the analysis of the impact of bank regulation on bank profitability, the results show through our main model and robustness check that bank regulation and supervision has very much significance on the profitability of banks. This research confirms in particular that stringent capital requirement has significant impact on bank profitability. Accounting/Information disclosure from this research, confirms that it has some significant level of impact on bank profitability. The results also show regulation on discipline/Problem institutions/exit having some marginal impact and reduction on bank profitability. Finally, the only bank regulation and supervision variable from the results that increase bank profitability though not significant is restrictions on banking activities. This result explains to large extent an important trade-offs between sound financial systems and bank profitability.

This study contributes by way of complementing other existing studies where we have mixed evidence of the impact of bank regulation on the profitability of banks across the globe (Agoraki and Tsamis, 2017; Ahamed et al., 2021; Barth et al., 2013; Mashamba, 2018; Ozili, 2017; Triki et al., 2017). In particular, this study extend the current literature by examining how bank regulation impacts bank profitability using cross country evidence since most of the current studies are based on individual countries, regional economic blocs and continents based. Investigating from the global perspective of such a phenomenon gives us more insight into the understanding of the impact of bank regulation on profitability. The researcher recommends the use of other banking regulation and supervision surveys measures like external auditing requirements; bank governance; consumer protection and many others as these would prove or otherwise the impact on bank profitability.

By way of policy implication of this research, the researcher believes that the results as obtained, point to the fact that actions taken by governments and central banks on regulations impacts the profitability of commercial banks and therefore new regulations must be aimed and targeted at important trade-offs to ensure banks run efficiently and profitably. Thus, policy makers and supervisors in the industry need to identify the shortcomings and weaknesses in the current banking regulations and work towards improving their effectiveness in the long run.

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8 ANNEX

Tab. 4: Descriptive Statistics on bank specific, macroeconomy and bank regulation variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Return on asset	51084	0.989	5.057	−99.27	99.34
Net interest margin	46791	4.324	15.504	−383	933.37
Cost to income	46569	75.555	45.123	−947.56	990.81
Total assets	51239	11.996	2.51	0	22.328
Net loans over total assets	48392	5.149	2.449	−0.925	10.473
Loan loss reserves over gross lons	39236	4.127	13.301	−14.28	807.94
Equity over total assets	49844	19.501	23.4	−516.35	100
GDP per capita	60186	1.013	0.075	0.008	4.958
Policy rate	56414	1.596	1.454	−1	35
Exchange rate	55144	98.998	15.062	3.5	141.875
Inflation	60034	1.038519	4.767895	−126.9265	134.4944
Bank regulation survey 1	58354	0.437	0.496	0	1
Bank regulation survey 2	58354	0.207	0.405	0	1
Bank regulation survey 3	58250	0.205	0.403	0	1
Bank regulation survey 4	57346	0.63	0.483	0	1

Tab. 5: Model explanatory variables

Variable name	Definition	Source
Bank Specific Variables		
Dependent:		
Return on Asset	It represents Return on Asset, thus the net income to total assets ratio.	Orbis
Independent:		
Net Interest Margin	It represents net interest margin expressed as a percentage of earnings asset. A higher margin indicates high profitability for the bank if only asset quality is maintained.	Orbis
Equity over Total Assets	It measures equity to total assets and looks at the equity funding in the balance sheet as well as capital adequacy.	Orbis
Cost to Income	Cost to income ratio is the ratio of operational expenses and gross revenue. It measures management's efficiency in managing cost.	Orbis
Loan Loss Reserves over Gross Loans	It is a proxy for credit risk.	Orbis
Net Loans over Total Assets	A net loan over total assets represents the liquidity risk of the bank with high liquidity impacting negatively on profitability.	Orbis
Log of Total Assets	Total assets proxies bank size.	Orbis
Macroeconomic Variables		
GDP per Capita	It captures fluctuations in economic activity.	IMF/IFS
Inflation	It captures fluctuations in economic activity.	IMF/IFS
Exchange rate at nominal rate	Nominal exchange rate captures fluctuations in the economy.	IMF/IFS
Policy rate	The rate at central banks lend to commercial banks.	IMF/IFS
Bank Regulation and Supervision		
BRSS1	Dummy variable on regulation for capital requirement and the survey question is: *"What items and in what percentage do they constitute Tier 1 capital?"* An answer "capital instruments" represents 1 and otherwise represents 0.	World Bank BRSS 2016
BRSS2	Dummy variable on restrictions on banking activities and the survey question is: *"Under which conditions are banks allowed to engage in securities activity?"* An Answer "yes" is scored 1 and 0 for "no".	World Bank BRSS 2016
BRSS3	Dummy variable for accounting/information disclosure and the survey question is: *"Are financial statements submission to the banking supervisor required before public disclosure?"* An answer "yes" is scored 1 and 0 for "no".	World Bank BRSS 2016
BRSS4	It is a proxy for regulation on discipline/Problem institutions/exit and the survey question for this variable is: *"Are formal enforcement actions by bank regulators supposed to be made public especially in the areas of cease and desist orders and mutual agreements between the regulator and the banking organisation?"* An answer for "yes" is scored 1 and "No" 0.	World Bank BRSS 2016

Tab. 6: Correlation matrix for bank specific, macroeconomic and bank regulation variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Net interest margin	1.000													
(2) Cost to income	−0.017	1.000												
(3) Loan loss reserves	0.075	0.016	1.000											
(4) Equity to total assets	0.194	0.040	0.212	1.000										
(5) Total assets	−0.083	−0.329	−0.009	−0.271	1.000									
(6) Net loans over total assets	0.054	−0.189	−0.144	−0.123	0.166	1.000								
(7) Exchange rate	−0.109	0.115	−0.125	−0.114	−0.221	−0.042	1.000							
(8) Inflation	0.189	−0.046	0.111	0.200	−0.038	0.044	−0.364	1.000						
(9) GDP per capita	−0.007	−0.050	−0.014	0.026	0.096	0.054	0.108	−0.034	1.000					
(10) Policy rate	−0.004	0.021	−0.014	−0.005	−0.115	0.051	0.277	−0.003	0.257	1.000				
(11) Bank regulation 1	−0.036	0.228	−0.105	0.022	−0.609	−0.081	0.433	−0.016	−0.102	0.130	1.000			
(12) Bank regulation 2	0.124	−0.122	0.135	0.122	0.184	0.025	−0.269	0.084	0.162	0.049	−0.423	1.000		
(13) Bank regulation 3	0.060	−0.100	0.051	0.081	0.257	0.089	−0.150	0.266	0.037	−0.042	−0.272	−0.037	1.000	
(14) Bank regulation 4	−0.225	0.125	−0.142	−0.226	−0.145	−0.140	0.302	−0.307	−0.024	0.099	0.367	−0.203	−0.253	1.000

Tab. 7: Variance inflation factor for bank specific, macroeconomic and bank regulation variables

	VIF	**1/VIF**
BRSS1	2.446	0.409
Total assets	1.979	0.505
Exchange rate	1.632	0.613
Inflation	1.412	0.708
BRSS4	1.402	0.713
BRSS2	1.368	0.731
Equity over total assets	1.279	0.782
BRSS3	1.274	0.785
Policy rate	1.193	0.838
Cost to income	1.158	0.864
GDP per capita	1.132	0.883
Net loans over total assets	1.116	0.896
Loan loss reserves over gross loans	1.099	0.91
Mean VIF	1.422	.

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TIME-VARYING EFFECT OF SHORT SELLING ON MARKET VOLATILITY DURING CRISIS: EVIDENCE FROM COVID-19 AND WAR IN UKRAINE

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ABSTRACT

In this paper, we empirically investigate the effect of short selling on market volatility during exogenously-induced uncertainties. Using the Covid-19 pandemic and the onset of the Russian-Ukraine Conflicts periods as event study, we employ the asymmetric EGARCH model. We show high persistence and asymmetric effects of market volatility during the pre-covid outbreak and post-covid outbreak periods. We find evidence that short selling increases market volatility during the pre-covid outbreak period while the period of the Russian-Ukraine conflict is characterized by reduced volatility. We find no evidence of short selling effect on market volatility during the post-covid outbreak period. Our findings provide significant implications for short-selling strategies during crisis periods.

KEY WORDS

short-selling, market volatility, COVID-19, Russian-Ukraine conflict

JEL CODES

C22, G11, G12, G14

1 INTRODUCTION

The years 2020 to 2022 represent an exogenous shock to the financial markets and global economy. The outbreak of the novel coronavirus (Covid-19) in 2020 led to an unprecedented impact on the global financial markets (Ding et al., 2021). The recovery from the pandemic has been impeded by another crisis; the Russian invasion of Ukraine which began in February 2022. These crises have generated high uncertainties in the financial markets. The outbreak of Covid-19 led to market declines and increased market risks (Zhang et al., 2020). While the effect of Covid-19 on the financial markets (see Zhang et al., 2020; Ding et al., 2021; Guo et al., 2021; Liu et al., 2022) and the impact of the Russian-Ukraine on the financial market (see

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Umar et al., 2022b; Boungou and Yatié, 2022) is well documented in existing literature, little is known about the behaviour of short sellers during these turbulent times. Given the significant role short sellers play in securities trading and their impact during bearish markets, it is vital to analyse how they contribute to risk in financial markets during these periods.

This paper aims to investigate the effect of short selling on volatility in the U.S. stock market during the Covid-19 outbreak and the onset of the Russian-Ukraine conflict. On the Covid-19 outbreak, few studies have examined its impact on market volatility (see Albulescu, 2021; Baker et al., 2020; Zaremba et al., 2020) but little evidence is provided on the impact of short sellers on volatility. In the literature, our paper is close to the recent study of Lin et al. (2022) which examines the effect of margin trading and short selling on stock return volatility. They show no evidence that short selling destabilizes the stock market and observe that intensified short selling effectively reduces return volatility when infection risk is high. While Lin et al. (2022) investigate the Chinese stock market, our paper focuses on the US stock market and extends the data to cover the recovery period of Covid-19 and the onset of the Russian-Ukraine conflict.

Our paper contributes to the emerging literature to investigate the impact of the covid-19 outbreak and the Russian-Ukraine conflict on the financial market and focus on the effect of short selling on volatility. Using the asymmetric EGARCH model proposed by Nelson (1991), we show that there is high volatility persistence and asymmetric effects during the pre-covid outbreak and post-covid outbreak periods in market volatility. We show that the pre-covid outbreak is associated with bullish market conditions and short selling during the period increases the market volatility. We explain these results as investors can process available information better to identify overvalued stocks and apply them in their trading strategies under bullish market conditions. Our analysis of short selling during the post-covid outbreak period shows that there is no significant effect on market volatility. We argue that the uncertainties in the financial markets were short-term and caused by speculations of market players. Short-selling activities during the period of the Russian-Ukraine conflict reduce market volatility. The period is characterized by high inflation and interest rate hikes which makes the debt market more attractive to stocks. Investors are likely to reduce their stock portfolio, and this can lead to price falls. Short sellers can take advantage to increase short positions to hedge against their risk exposures.

The remainder of this paper is organized as follows. In section 2 we provide a review of existing literature. Section 3 introduces the data and methodology. In section 4, we present the empirical results of the analysis while section 5 concludes the study.

2 LITERATURE REVIEW

Volatility in the financial market indicates the price fluctuations of securities. It is used as a proxy for risk measurement and an important variable for investment and asset pricing (Zhang et al., 2020). The vast literature has examined the impact of exogenous factors on market volatility. Albulescu (2021) investigate the impact of the coronavirus pandemic uncertainty on the U.S. financial market volatility. He argued that both new infections and the fatality ratio recorded positively influenced the US financial market.

Zaremba et al. (2020) examine stock data on a global level (from 67 countries) during the Covid-19 period using data from January to April 2020 and provide evidence that stringent policy responses led to a significant increase in market volatility. Bakas and Triantafyllou (2020) show a strong negative effect of covid-19 on commodity volatility using quarterly data from the S&P GSCI broad commodity index from 1996 Q1 to 2020 Q1.

Market regulators always target short-selling activities to introduce bans during turbulent

periods to stabilise the markets. While bans were introduced in some European countries during Covid-19, no bans were introduced in the U.S. market. Bessler and Vendrasco (2022) argue that bans introduced on short selling failed to boost stock prices, reduce volatility and preserve liquidity when they studied 12 European countries (6 countries with bans on short selling) from 2nd January 2020 to 30th June 2020. They further recommend regulators should abstain from imposing short-selling bans. The emerging literature on the effect of Covid-19 on the financial markets has mainly employed data that covers the onset of the outbreak in 2020. Prior to the Russian invasion of Ukraine, the global economy was on a recovery trend from the Covid outbreak. It is vital to analyse the effect of the covid outbreak with available data to capture the recovery period.

The literature on the ongoing Russia-Ukraine conflict is expanding and early studies have provided evidence of adverse effects on the financial markets. The conflict poses geopolitical-induced uncertainty in the global economy and financial markets. This leads to many economists predicting a recession in most developed economies and high speculative market activities. Boungou and Yatié (2022) show that the war has negatively impacted the world's stock indices and this effect was more significant after the invasion of Ukraine when they study indices from 94 countries from 22nd January 2022 to 24th March 2022. Boubaker et al. (2022) provide evidence that the invasion generated negative cumulative abnormal returns for global stock market indices but with heterogenous effects when they examine all countries in the Morgan Stanley Capital Investment (MSCI) market. Chortane and Pandey (2022) examine the impact of the Russia-Ukraine war on the value of global currencies against the US dollar (USD) and show that the war adversely affected global currencies, however on the regional level, European currencies depreciated against the USD while Pacific currencies appreciated significantly.

Engelberg et al. (2012) argue short sellers trading advantage emerges from their ability to analyze publicly available information. The information provides valuable opportunities that influence trading strategies used by short sellers who are considered to be skilled processors of information. The two crises create a pessimistic view in investors on the performance of the financial markets and influences them to take short positions to either hedge against risk or profit from expected market declines. Greppmair et al. (2022) study how informed market participants incorporate fiscal space into their trading decisions in the European market during Covid-19. They suggest that after the outbreak of Covid-19, short sellers correctly anticipated the underperformance of illiquid firms in countries with low credit ratings. They highlight the skills of short sellers as they were adept to process complex information on the unprecedented effects of the pandemic by linking the economic consequences to the financial markets. On the Russian-Ukraine conflict, Umar et al. (2022a) analyse how short stocks respond to military conflicts and employ sectoral shorted equity indices from 2nd February 2022 to 5th July 2022. They show strong and high co-movement between the shorted shocks and geopolitical risk and provide evidence that hedging strategies with shorted shocks would be beneficial. This study contributes to the literature and focuses on how short-selling activities affect risk during unprecedented market uncertainties caused by exogenous factors.

3 METHODOLOGY AND DATA

3.1 Data

Our data sample comprises two sets – the daily NYSE CI (New York Stock Exchange Composite Index) and short selling between 1st January 2019 and 31st October 2022. The daily NYSE CI index is obtained from Yahoo Finance[1] and consists of 965 observations. We use the daily log return of the NYSE CI. The NYSE CI is used to represent the stock market

[1] https://finance.yahoo.com/quote/%5ENYA/history?p=%5ENYA

in the U.S. and it consists of all common stock listed on the New York Stock Exchange which includes, tracking stocks, REITs, ADRs and foreign stocks. The short-selling data is obtained from the Financial Industry Regulatory Authority (FINRA) database[2]. The daily short sale volume data provided by FINRA consist of the date, symbol, short volume, and total volume of all list stocks. We aggregate the short volume and total volume for each stock to obtain the total trading volumes for each daily.

We use 2 important dates of announcement and events to categorise the data into the pre-covid outbreak, post-covid outbreak and the Russian-Ukraine conflict periods. Prior studies have used the event-study method to choose dates covid-19 is publicly announced (see Baker et al., 2020; Kim et al., 2020; Ding et al., 2021). The World Health Organisation (WHO) declared the Covid-19 outbreak a pandemic on 11$^{\text{th}}$ March 2020. Thus, we choose 10$^{\text{th}}$ March 2020 as the cut-off point for the pre-covid period. The Russian invasion of Ukraine began on 24$^{\text{th}}$ February 2022, hence we choose 23$^{\text{rd}}$ February 2022 as the cut-off point for the post-covid outbreak. The pre-covid period consists of data from 01.01.2019 to 10.03.2020; the post-covid period from 11.03.2020 to 23.02.2022 and the Russian-Ukraine conflict from 24.02.2022 to 31.10.2022.

Tab. 3 in the Annex presents the descriptive statistics of the NYSE composite index (NYSE CI) and short volumes for the three periods; pre-covid outbreak, post-covid outbreak and Russian-Ukraine conflict. The NYSE CI returned between 0.0001 and 0.0429 for the pre-covid outbreak; 0.0007 and 0.0956 during the post-covid outbreak; −0.0005 and 0.0329 during the conflict. The post-covid outbreak period is the most volatile. The returns distribution of the index is negatively skewed with high excess kurtosis in all periods except the Russian-Ukraine conflict. This indicates the return series is not normally distributed and confirms the presence of volatility in all periods. The short volumes are at the highest and most volatile during the post-covid outbreak. This is followed by the period of the Russian-Ukraine war. This indicates the level of uncertainties in the financial market during the pandemic. The decline in stock prices and the increase in short-selling activities are captured in Fig. 1 and Fig. 3 in the Annex.

3.2 Methodology

We apply the Exponential GARCH (EGARCH) model proposed by Nelson (1991) to investigate the effect of short selling during crisis periods. The EGARCH model detects the asymmetric (leverage) effect in the volatility.

The conditional variance of EGARCH (1,1) model is specified as follows:

$$\ln(\delta_t^2) = \beta_0 + \beta_1 \left[\frac{|\varepsilon_{t-1}|}{\delta_{t-1}} - \sqrt{\frac{2}{\pi}} \right] + \Upsilon \frac{\varepsilon_{t-1}}{\delta_{t-1}} + \beta_2 \ln(\delta_{t-1}^2), \tag{1}$$

where $\ln(\delta_t^2)$ represents the conditional variance of the NYSE CI, β_0 represents the constant of volatility, $\Upsilon \frac{\varepsilon_{t-1}}{\delta_{t-1}}$ measures the asymmetric effect of the volatility, δ_{t-1}^2 is the variance estimation of the previous period and $\beta_1 \left[\frac{|\varepsilon_{t-1}|}{\delta_{t-1}} - \sqrt{\frac{2}{\pi}} \right]$ captures the impact of changes in news on volatility.

We follow Engelberg et al. (2012) and He et al. (2022) to construct the short ratio as follows:

$$\text{ShortRatio}_t = \frac{\text{ShortVol}_t}{\text{TotalVol}_t}, \tag{2}$$

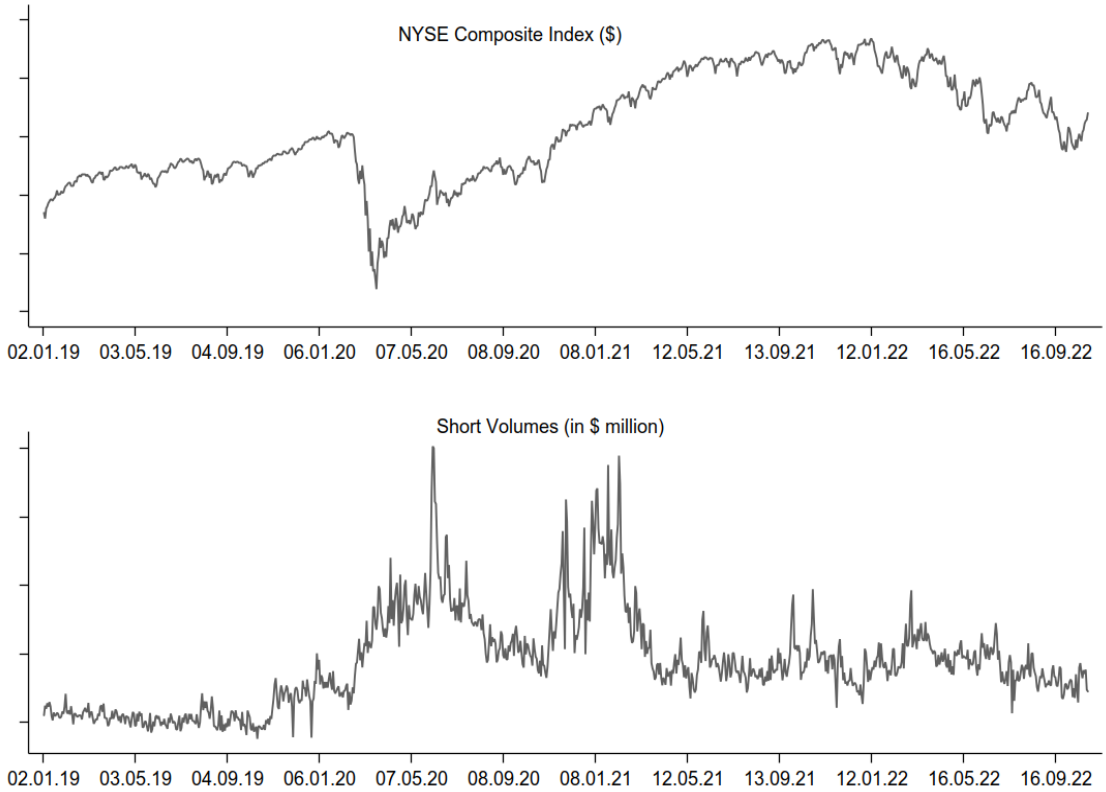
where ShortRatio_t is the aggregate short ratio day t, ShortVol_t is the aggregate short volume on day t and TotalVol_t is the total aggregate total volume on day t.

To investigate the impact of short selling on market volatility, we follow Chen et al. (2011) and introduce short ratio as an additional regressor to equation (1) as

$$\ln(\delta_t^2) = \beta_0 + \beta_1 \left[\frac{|\varepsilon_{t-1}|}{\delta_{t-1}} - \sqrt{\frac{2}{\pi}} \right] + \Upsilon \frac{\varepsilon_{t-1}}{\delta_{t-1}} + \beta_2 \ln(\delta_{t-1}^2) + \lambda \, \text{ShortRatio}_t, \tag{3}$$

where λ is the parameter of the short ratio.

[2] https://www.finra.org/finra-data/browse-catalog/short-sale-volume-data/daily-short-sale-volume-files



Note: All data are sampled from January 2019 to October 2022. The trading prices of the NYSE Composite Index and short volumes are indicated on the y-axis of the first and second graphs. The periods are indicated on the x-axis for both graphs.

Fig. 1: NYSE Composite Index and Short volumes

The EGARCH model follows a Generalized Error Distribution (GED). The distribution of GARCH models is assumed to be normally distributed, however, the assumption does not suit financial time series with excess kurtosis. Nelson (1991) applies the GED to depict the leptokurosis of the time series.

Nelson (1991) expresses the density function of the GED as:

$$f(z) = \frac{\nu \cdot \exp\left[-\frac{1}{2}\left|\frac{Z}{\lambda}\right|^{\nu}\right]}{\lambda \cdot 2^{1+\frac{1}{\nu}} \cdot \Upsilon\left(\frac{1}{\nu}\right)}, \quad -\infty < z < \infty, \tag{4}$$

where Υ is the gamma function, and

$$\lambda = \left[2^{\frac{-2}{\nu}} \cdot \frac{\Upsilon\left(\frac{1}{\nu}\right)}{\Upsilon\left(\frac{3}{\nu}\right)}\right]^{\frac{1}{2}}, \tag{5}$$

ν denotes the shape parameter, z follows a standard normal distribution when $\nu = 2$.

4 RESULTS

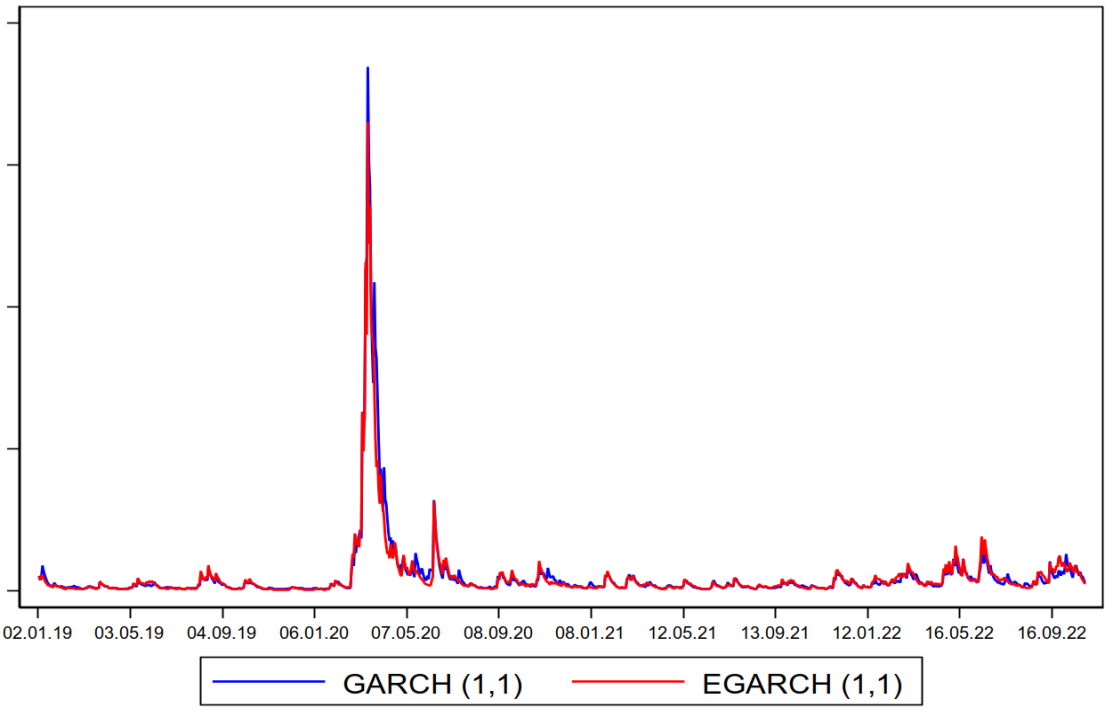
In this section, we provide the results of the empirical analysis. First, we run the EGARCH (1,1) model on the NYSE CI to estimate the market volatility. We provide the analysis in Tab. 1. The ARCH term (β_1) indicates the volatility clustering of the market. The coefficients for all periods are positive. The pre-covid outbreak and post-covid outbreak periods are significant at a 5% and 1% level respectively. This implies that larger shocks to the market returns, regardless of the signs, will increase the volatility to a greater extent than smaller shocks for the periods (Elyasiani and Mansur, 2017). The post-covid outbreak period exhibits the strongest clustering tendency with a coefficient of 0.2597. This is driven by the high level of uncertainties in the financial markets after the declaration of the pandemic.

The GARCH effect (β_2) determines how the past conditional volatilities of the market influence the current conditional volatility. The coefficients β_2 for all periods are positive and significant at a 1% level. This implies the current volatilities for the pre-covid outbreak, post-covid outbreak and the Russian-Ukraine conflict periods are more dependent on the previous volatility of the market. The periods exhibit high volatility persistence ($\beta_1 + \beta_2$) which shows that volatility shocks take a higher time to dissipate.

The asymmetric effect (Υ) is negative for the pre-covid outbreak and post-covid outbreak period and positive for the period of the Russian-Ukraine conflict. The coefficients of the pre-covid and post-covid outbreaks are -0.3065 and -0.1499 respectively and significant at a 1% level. The coefficient of the Russian-Ukraine conflict period is 0.1399 but not significant. The negative coefficients of the asymmetric effect imply that negative shocks increase market volatility more than positive shocks for the pre-covid outbreak and post-covid outbreak periods (Jeribi et al., 2015; Fakhfekh et al., 2016). Fig. 2 shows the high volatility in the market during the post-covid outbreak period.

We present the main analysis of the effect of short selling during the pre-covid outbreak, post-covid outbreak and the Russian-Ukraine conflict in Tab. 2. The U.S. financial market during the pre-covid outbreak (2019) was on a positive trajectory after recovering from the negative performance in 2018. Investors' confidence increased and the markets performed better ending the 2019 calendar year with positive returns on major indices. The results of the pre-covid period in our analysis exhibit significant high volatility persistence and asymmetry in the market. The coefficient of short selling on the market (λ) is positive and significant at a 1% level (2.2464). This implies that short-selling activities increase the market volatility during the pre-covid outbreak. The period is associated with increased market activities and prices. Short sellers and investors identify over-valued stocks and predict future price falls either through their analysis of stock or speculations. These activities lead to high volatility in the market. This finding is consistent with Ho et al. (2022) which indicates that short selling has some incremental positive effects on volatility.

The post-covid outbreak period is characterised by uncertainties in the global market. The announcement by World Health Organization (WHO) led to lockdowns introduced by most governments to limit the spread of the disease. This led to a decline in the financial markets and an increase in short-selling activities. The period exhibits an asymmetric effect of short-selling activities with a coefficient of -0.1677. The coefficient of short selling on the market volatility is 1.0244 but not significant. This indicates short selling does not impact market volatility during the post-covid period. We explain this results that the covid outbreaks resulted in uncertainties in the financial market however since there were no short-selling bans in the U.S., the market recovered. Government measures such as vaccine roll-out were able to control the spread of the disease and restore investors' confidence in the markets. We suggest that the increase in short-selling activities during the period was mainly speculative and had no economic or fundamental basis. However, short sellers may have profited in the short term



Note: Estimated GARCH (1,1) and EGARCH (1,1) conditional volatilities of the NYSE Composite Index. Conditional volatility ranges from 0.000 to 0.008 on the y-axis. Period for sample data indicated on the x-axis.

Fig. 2: Estimated conditional volatility of the NYSE Composite Index

during the onset of the pandemic. This implies investors can increase their short positions in the short term during uncertain periods caused by exogenous factors.

The period of the Russian-Ukraine conflict has impeded the full recovery of the global economy from the Covid-19 pandemic. Russian plays an important role in the supply of natural gas while Ukraine is a key exporter of grains. The conflict has resulted in high energy and food prices across the globe leading to higher inflation and raising the cost of living for many countries. While the U.S. does not directly rely on Russian gas, the significant increase in global energy prices during the conflict is witnessed in the U.S. markets. In an attempt to control the high inflation, the Federal Reserve (FED) of the U.S. has increased the interest rate by 75 basis points on 4 conservative reviews to 3.75–4%[3]. The U.S. stock market is sensitive to the FED rates and the increases have led to the decline of major market indices. The effect of short selling on market volatility during the period is negative and significant at a 5% level. We conclude that short selling during the period of the Russian-Ukraine conflict reduces the market volatility in the U.S. This is attributed to uncertainties in the financial markets from the continuous increase of interest rates. Higher rates imply investors shift their attention to bonds which provide high yields. This can lead to investors increasing their portfolio allocations in bonds and reducing that in stocks. When this happens it can increase the volatility in the stock market and short sellers can use their short positions to hedge against risk.

[3]https://finance.yahoo.com/news/fed-set-to-raise-rates-powell-rate-hike-path-101845316.html?fr=sycsrp_catchall

Tab. 1: EGARCH (1,1) estimates for NYSE CI

	Full Period	Pre-Covid Outbreak	Post-Covid Outbreak	Russian-Ukraine Conflict
β_0	−0.3047***	−0.6027**	−0.3087**	−13.5873**
	(0.0919)	(0.2623)	(0.1476)	(3.8235)
β_1	0.2633***	0.2130**	0.2597***	0.0937
	(0.0400)	(0.0893)	(0.0513)	(0.0874)
β_2	0.9668***	0.9394***	0.9658***	0.8032***
	(0.0098)	(0.0267)	(0.0160)	(0.2128)
Υ	−0.1811***	−0.3065***	−0.1499***	0.1399
	(0.0259)	(0.0450)	(0.0420)	(0.1069)
Log-likelihood	3119.11	1071.76	1550.51	491.8
Obs.	965	299	494	172

Note: *** and ** are significant at 1% and 5% respectively. Robust standard errors are in parentheses. The parameter estimates follow GED.

Tab. 2: Effect of short selling on volatility

	Full Period	Pre-Covid Outbreak	Post-Covid Outbreak	Russian-Ukraine Conflict
β_0	−0.7876***	−0.5676	−0.8724	−4.2254
	(0.2352)	(0.3800)	(0.4790)	(5.0964)
β_1	0.2344***	0.2114**	0.2477***	0.1047
	(0.0418)	(0.0910)	(0.0550)	(0.0892)
β_2	0.9608***	0.9385***	0.9550***	0.7911***
	(0.0111)	(0.0269)	(0.0206)	(0.2177)
Υ	−0.1905***	−0.3081***	−0.1677***	0.1914
	(0.0260)	(0.0465)	(0.0438)	(0.1084)
λ	0.9360***	2.2464***	1.0244	−19.0345**
	(0.3561)	(0.6110)	(0.7486)	(8.0171)
Log-likelihood	3119.34	1071.77	1551.42	495.34
Obs.	965	299	494	172

Note: *** and ** are significant at 1% and 5% respectively. Robust standard errors are in parentheses. The parameter estimates follow GED.

5 DISCUSSION AND CONCLUSIONS

In this study, we analyse the effects of short selling on market volatility in the U.S. stock market during crisis periods. Using daily short selling and the NYSE composite index data, we apply the asymmetric EGARCH (1,1) model. We use two exogenous factors, the Covid-19 pandemic, and the ongoing Russian-Ukraine conflict as events study to divide our data into the pre-covid outbreak, post-covid outbreak and Russian-Ukraine conflict periods.

First, we analyse the effects of the two events on market volatility. We show that there is high volatility persistence and asymmetric effects during the pre-covid outbreak and post-covid outbreak periods in market volatility. The negative shocks in the market increase the volatility more than the positive shocks. These characteristics are consistent with the literature on stock markets. We proceed to identify the effect of short-selling activities on market volatility. Our results show that during the pre-covid outbreak period, short selling is associated with an increase in market volatility. The period is characterized by increasing market activities and prices and short sellers can analyse available information. The Short selling activities are associated with an increase in market volatility during bullish market conditions.

Our findings during the post-covid outbreak period show while uncertainties in the financial

market and economy increased, short selling has no significant effect on market volatility. We argue that the uncertainties were short-term and caused by the speculations of investors and have no economic or fundamental basis. There were no short-selling bans in the U.S. markets and the policies introduced by the government to control the pandemic restored investors' confidence and market recovery from the sharp price falls. The Russian-Ukraine conflict has led to unprecedented inflation across the globe. As a result, central banks have increased their interest rates as a measure. This directly affects the financial markets. During the Russian-Ukraine conflict period, short-selling activities reduce market volatility. This implies investors can use their short positions to reduce their risk exposure.

Our results provide important implications for policymakers and regulators. Our findings show that short-selling activities can continue during crisis periods and we recommend regulators should not introduce new bans. However, strengthen their monitoring activities of short sellers to prevent market manipulations. The findings give better insights to investors and short sellers on the periods to either increase or decrease their short positions in their portfolio to profit from price falls and mitigate against risk during crisis periods.

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7 ANNEX

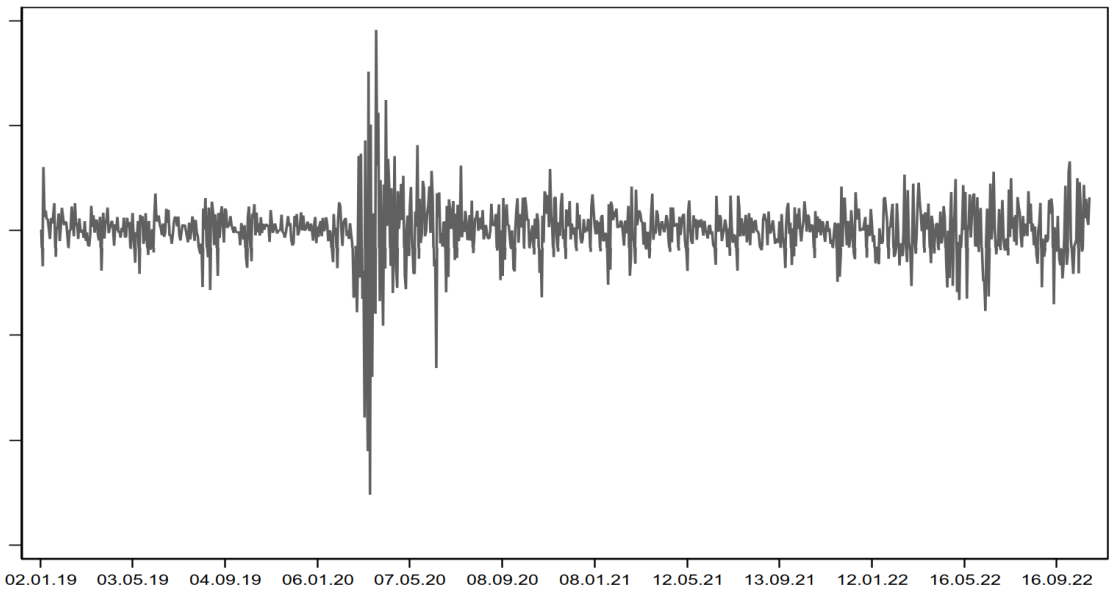

Fig. 3: NYSE Composite returns

Tab. 3: Descriptive statistics

	NYSE CI	Return of NYSE CI	Short Vol. (in $ millions)	Total Vol. (in $ millions)	Short Ratio
Full Period					
Mean	14258.00	0.0003	374.04	825.51	0.4514
Max.	17353.76	0.0956	1006.38	2444.21	0.5125
Min.	8777.38	−0.1260	152.60	329.50	0.3734
S.D.	1848.54	0.0140	139.14	299.63	0.0246
Skewness	−0.07	−1.1950	1.14	1.34	−0.3083
Kurtosis	−0.95	16.3161	2.10	2.94	−0.6185
Jarque-Bera	36.85***	10933.72***	385.52***	633.39***	30.69***
Obs.	965	965	965	965	965
Pre-Covid Outbreak					
Mean	12984.53	0.0001	240.10	545.58	0.4389
Max.	14183.20	0.0429	497.39	1072.68	0.4998
Min.	11190.44	−0.0892	152.60	329.50	0.3882
S.D.	584.25	0.0104	55.36	111.44	0.0257
Skewness	0.00	−2.2879	1.47	1.42	0.2084
Kurtosis	0.09	20.6674	2.64	3.74	−1.0727
Jarque-Bera	0.09	5582.31***	194.78***	274.91***	16.50***
Obs.	299	299	299	299	299
Post-Covid Outbreak					
Mean	14686.68	0.0007	455.53	1004.98	0.4531
Max.	17353.76	0.0956	1006.38	2444.21	0.5125
Min.	8777.38	−0.1260	243.26	552.23	0.3734
S.D.	2165.53	0.0156	131.69	287.58	0.0222
Skewness	−0.60	−1.2037	1.42	1.61	−0.2926
Kurtosis	−0.91	17.9435	2.27	3.17	−0.0915
Jarque-Bera	46.97***	6746.49***	272.53***	420.75***	7.22**
Obs.	494	494	494	494	494
Russian-Ukraine Conflict					
Mean	15240.58	−0.0005	372.85	796.69	0.4683
Max.	17014.76	0.0329	586.22	1325.67	0.5003
Min.	13472.18	−0.0384	227.06	464.08	0.4194
S.D.	900.65	0.0140	56.94	123.08	0.0165
Skewness	0.05	−0.1498	0.42	0.67	−0.4483
Kurtosis	−0.88	−0.0115	0.62	1.52	0.2058
Jarque-Bera	5.62	0.6400	7.7**	29.42***	6.06**
Obs.	172	172	172	172	172

Note: This table presents the descriptive statistics of all variables; NYSE Composite index, short volumes, and total volumes from January 2019 to October 2022. The observations include all variables (obs), the mean, maximum value (max.), minimum value (min.), standard deviation (S.D.), skewness, kurtosis, Jarque-Bera (1987) test which is normally distributed and ***, ** represent significance at 1% and 5% respectively.

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