Bank non-performing loans in the Fintech era

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Abstract

This study investigates the behavior of bank non-performing loans in the Fintech era. Using data from 35 developed countries from 1998 to 2016, the findings show that non-performing loans are fewer in the second wave Fintech era. Also, bank non-performing loans are positively related to the state of the business cycle in the second wave Fintech era. Countries that have high supply of credit to the private sector experience high non-performing loans in the second wave Fintech era. The two-way interaction analysis show that non-performing loans are lower during times of economic boom and when there is higher credit supply in the second-wave Fintech era.

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1. Introduction

Fintech is any activity or process that combine financial services with digital innovation. Schueffel (2016) defines Fintech as any process that applies technology to improve financial activities. Ozili (2018) defines Fintech as the use of technology to deliver financial services.

In recent years, the activities of Fintech lenders have led to an exponential growth in lending. More individuals, households and firms have greater access to diverse loans at affordable rates offered by Fintech lenders. Lending by Fintech lenders may give rise to non-performing loans (NPLs) when borrowers default. Fintech lenders may experience fewer NPLs compared to banks due to their small size, smaller loan portfolio and due to their excessive focus on retail loans rather than commercial loans (Bruckner, 2018; Claessens et al, 2018). On the other hand, banks are more prone to high NPLs due to their large size, bigger loan portfolio and their focus on commercial lending.

Understanding the link between Fintech activities and non-performing loans is important for the following reasons. Firstly, Fintech lenders have fewer collateral requirements compared to banks. This can expose Fintech lenders to credit risk from borrowers (Magee, 2011), and the loans they give to borrowers may not be fully recovered from collateral value when borrowers default. Secondly, Fintech lenders often do not have the legal support to directly undertake loan recovery activities from debtors. This can lead to little or no loan recovery action against borrowers who default on loan repayment, leading to rising non-performing loans (Usanti et al, 2020). Thirdly, banks may be unwilling to partner with Fintech lenders when Fintech agents experience high levels of loan default (Temelkov, 2018; Romānova and Kudinska, 2016).

A growing literature examine the impact of Fintech activities on banking sector performance (e.g. Buchak et al (2018), Ozili (2018), Hornuf et al (2020), Vives (2017) and Phan et al (2020)). Previous studies show that the activities of Fintech players can negatively affect bank performance through loss of income (Thakor, 2019), loss of market share (Zalan and Toufaily, 2017), and loss of bank customers and employees to Fintech providers (Alt et al, 2018). But the literature has not examined how the activities of Fintech players affect the size of non-performing loans in banks. Also, the NPL literature has examined the behavior of NPL during financial crisis, fluctuating business cycles and in several country-specific and cross-country contexts (e.g. Kauko (2012), Ozili (2019a&b), Klein, (2013) and Barseghyan (2010)), but the literature has not examined the behavior of bank non-performing loans during the Fintech era. There are no studies that show how the activities of Fintech players in the Fintech era affected NPL in the banking sector. This paper extends the literature by examining whether the activities of Fintech players in the Fintech era are associated with greater or fewer NPLs in the banking sector.

The existing literature often use aggregate country-level data to analyse non-performing loans because it substantially reduces the risk of non-representativeness in the sample of banks. This

paper also uses country-level NPL data. In contrast with previous studies, I use country-level NPL data to assess the level of NPL in the different phase of the Fintech era, to gain insight into the behavior of NPL in the Fintech era. Focusing on the Fintech era, rather than the number of Fintech lenders, helps to address a major issue which is that the number of Fintech lenders, both those regulated and unregulated, and information about their loan books and activities are unobservable as data on Fintech activities is not publicly available. For this reason, it makes sense to assess country-level NPL in the Fintech era. To identify the Fintech era, I rely on Arner (2016)'s classification of the Fintech era. Arner (2016) divides the Fintech era into the first wave era and the second wave era. Thereafter, I compare the level of NPL in the two era. Also, I perform some interaction analyses to examine the behavior of NPL in the second wave Fintech era relative to the first wave Fintech era.

I predict that the Fintech era is a period characterized by strict bank regulation and supervision as well as the emergence of many Fintech lenders. This is because strict bank regulation and supervision, especially after the 2008 global financial crisis, created an opportunity for Fintech lenders to enter credit markets and compete with traditional banks (Philippon, 2016). This encouraged many Fintech lenders to emerge especially in the post 2008 period (Romānova and Kudinska, 2016). Also, risky borrowers who cannot access loans from traditional banks tend to rely extensively on Fintech lenders for loans due to the low interest rates offered by Fintech lenders or due to the need to get quick loans (Ozili, 2018; Ozili, 2021a). Loans issued by Fintech lenders can reduce the reliance on banks for credit, and subsequently lead to fewer non-performing loans. This effect is expected to be more pronounced in the second wave Fintech era than in the first wave era due to technological developments and the emergence of robust payment technologies in the second wave era which helped Fintech lenders to perform their lending operations more efficiently than traditional banks.

To test this prediction, data was collected from 35 developed countries. The findings show that non-performing loans are lower in the second wave Fintech era. Also, bank non-performing loans are positively related to the state of the economic cycle in the second wave Fintech era. Countries that have high supply of credit to the private sector experience high non-performing loans in the second wave Fintech era.

This paper contributes to the literature. First, this study contributes to the literature that examine the implication of the Fintech evolution on bank performance. This paper is the first to explicitly examine the behavior of country-level NPLs in the Fintech era. Secondly, the study contributes to the policy literature on NPL. The analysis of the behavior of NPLs in the Fintech era adds to this literature by providing an analysis to help policy makers in their evaluation of the benefits and risks of Fintech players in the banking sector and the economy. It can help policy makers assess whether NPLs are lower in the first wave or second wave Fintech era. Such assessment can help

policy makers formulate policies that encourage more Fintech lenders to participate in the credit market, depending on the outcome of such assessment.

The rest of the paper is organized as follows. Section 2 presents the literature review. Section 3 reports the data and sample. Section 4 reports the NPL trend analysis. Section 5 presents the methodology and the empirical results. Section 6 concludes.

2. Literature review

2.1. Fintech evolution

Fintech combines financial services with digital innovation (Ozili, 2018). Arner (2016) categorize the Fintech evolution into the first wave and second wave Fintech era. Arner (2016) argue that Fintech evolved over two distinct evolutionary phases. The first wave Fintech era witnessed the transition from analogue technology to digital technology. This era was led mostly by traditional financial institutions. The second wave Fintech era witnessed the emergence of new players, alongside existing technology companies that acted as banking agents and vendors (Arner, 2016; Arner et al, 2016), as shown in table 1.

Table 1: Fintech evolution				
Evolution	First wave		Second wave	
Era	1866 – 1967	1967 – 2007	2008 to present	
Geography	Global / Developed countries	Global / Developed countries	Developed countries	Emerging / Developing countries
Key elements	Infrastructure / computerisation	Traditional / internet	Mobile / Start-ups / New entrants	
Shift Origin	Linkages	Digitalization	2008 financial crisis / smartphone	Last mover advantage
Source: Arner (2016), p.8.				

2.2. Fintech and the banking sector

Fintech are disruptive innovations that affect the banking industry (Kjellman et al, 2019; Martino, 2019; Ozili, 2020). They provide smart financial products and services and offer improved efficiency and risk management for financial services providers (Ozili, 2021b). Some studies analyse the effect of Fintech in the banking sector. Balyuk et al (2020) show that Fintech loans are risky and tend to replace loans offered by large banks. This is because Fintech lenders have efficiency advantages in the processing of large data. Pierri and Timmer (2020) analyse the behavior of NPL among banks that adopted information technology (IT) for assessing bank loans during the 2008 global financial crisis. They find that banks with high intensity IT-adoption had

fewer NPL during the global financial crisis. Buchak et al (2018) find that Fintech lenders serve more creditworthy borrowers, they are more active in the refinancing market, they charge a premium of about 14 to 16 basis points and they provide convenience rather than cost savings to borrowers. Hau et al (2019) show that Fintech credit providers in China's credit market enjoy a competitive advantage over traditional banks because of their cheaper distribution channels and information advantage. Ozili (2021a) show that banks manage their reported earnings by smoothing out abnormal fluctuations in income in response to competitive pressure from Fintech lenders.

2.3. Review of the non-performing loans determinants

Several studies analyse the determinants of non-performing loans (NPL). Arham et al (2020) investigate the determinants of NPL among banks in emerging Asian countries. They find that NPL is positively related to unemployment rate and real interest rate, and negatively related to total external debt/GDP and inflation rate. Lee et al (2019) examine the determinants of NPL among EU banks after taking into account the existing macroeconomic factors, country governance factors and bank-specific characteristics. They examine 1,053 EU banks from 2007 to 2016, and find that NPL has a positive relationship with cost efficiency. They also find that NPL is negatively related to the state of the business cycle, which implies that NPL is lower during economic boom and higher during a recession. Huljak et al (2020) estimate the impact of exogenous shocks to the change in NPL ratio across twelve (12) euro area countries using a panel Bayesian VAR model. They find that an exogenous increase in the change in NPL ratio depress the volume of bank lending, widen bank lending spreads and leads to a fall in real GDP growth and residential real estate prices. Ozili (2019a) compare the non-performing loans of systemic and non-systemic banks in Europe, and find that systemic banks have fewer NPL during economic booms while non-systemic banks experience higher NPL when they increase lending and exceed regulatory capital requirements. Kuzucu and Kuzucu (2019) compare the determinants of NPL in emerging countries compared to advanced countries during pre- and post-global financial crisis. They find that real GDP growth, exchange rate and foreign direct investment are determinants of NPL in the two country group. Ghosh (2015) investigates the determinant of NPL in 51 US states from 1984 to 2013. Their results show that GDP, personal income growth, unemployment, inflation rates affect NPL. Boudriga et al (2009) analyse the determinants of NPL while controlling for the influence of the institutional environment. They examine 59 countries from 2002 to 2006, and find that strong legal systems lower the size of NPL. Ozili (2019b) investigate the influence of financial development on non-performing loans using a global sample, and find that the presence of foreign banks and greater financial intermediation are associated with higher non-performing loans.

This paper contributes to the literature, and is the first to explicitly examine the behavior of country-level NPL in the Fintech era.

3. Data

Financial and institutional data were collected for 35 developed countries. The study focused on developed countries because developed countries are considered to have a well-developed Fintech industry that can potentially disrupt the banking sector compared to developing countries where the Fintech industry is still very small in size. Data was collected from the World Bank's global financial development (FINDEX) database and the World Economic Forum database (see Appendix A1 for variable source and description). The sample period covers the period from 1998 to 2016. The sample period captures a significant part of the first wave and second wave Fintech era. I rely on Arner (2016)'s Fintech era classification to determine which year falls into the first wave Fintech era and the second wave Fintech era.

4. Trend analysis for NPL in the EU, non-EU and G7 countries

4.1. Countries in the European Union (EU)

The trend analysis in figure 1 shows that a large number of EU countries experienced a high average NPL ratio in the second wave Fintech era compared to the first wave Fintech era. The average NPL ratio is higher in the second wave Fintech era than in the first wave Fintech era for most EU countries particularly for Bulgaria, Hungary, Latvia, Lithuania, Slovenia, Belgium, Denmark, Greece, Ireland, Luxembourg, Netherlands, Portugal, Spain, United Kingdom and Italy. In contrast, the average NPL ratio is higher in the first wave Fintech era than in the second wave Fintech era in other EU countries particularly for Czech, Malta, Poland, Sweden, Switzerland, Germany and France. See Appendix A2 for the table showing the actual mean NPL values related to figure 1.

Figure 1: EU countries
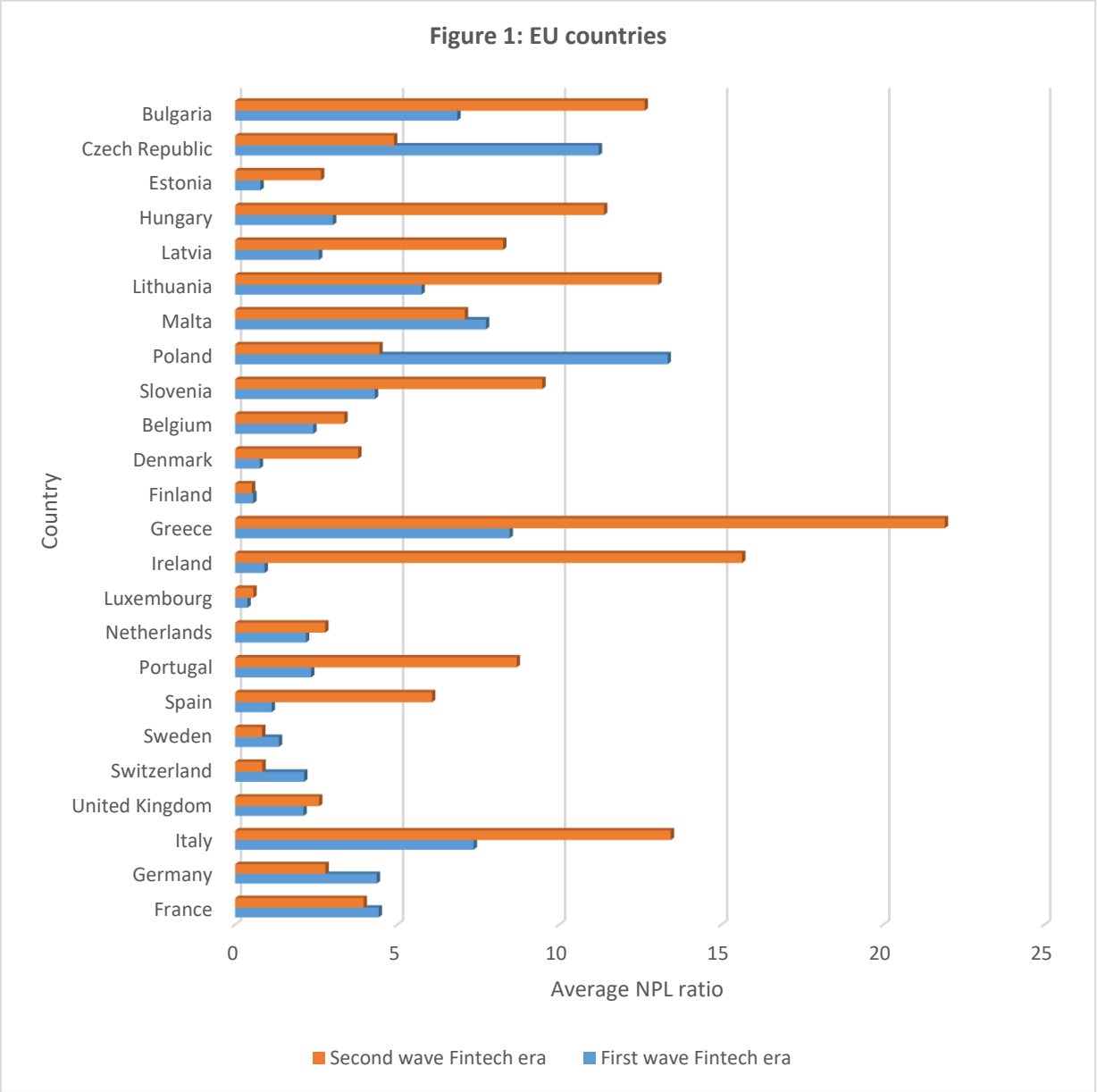
4.2. Non-EU countries

The trend analysis in figure 2 shows that non-EU countries such as the United States, Norway, Iceland, Australia and New Zealand have a much higher NPL ratio in the second wave Fintech era compared to the first wave Fintech era. In contrast, Canada and Japan have a higher NPL ratio in

the first wave Fintech era than in the second wave Fintech era. See Appendix A2 for the table showing the actual mean NPL values related to figure 2.

Figure 2: Non-EU countries
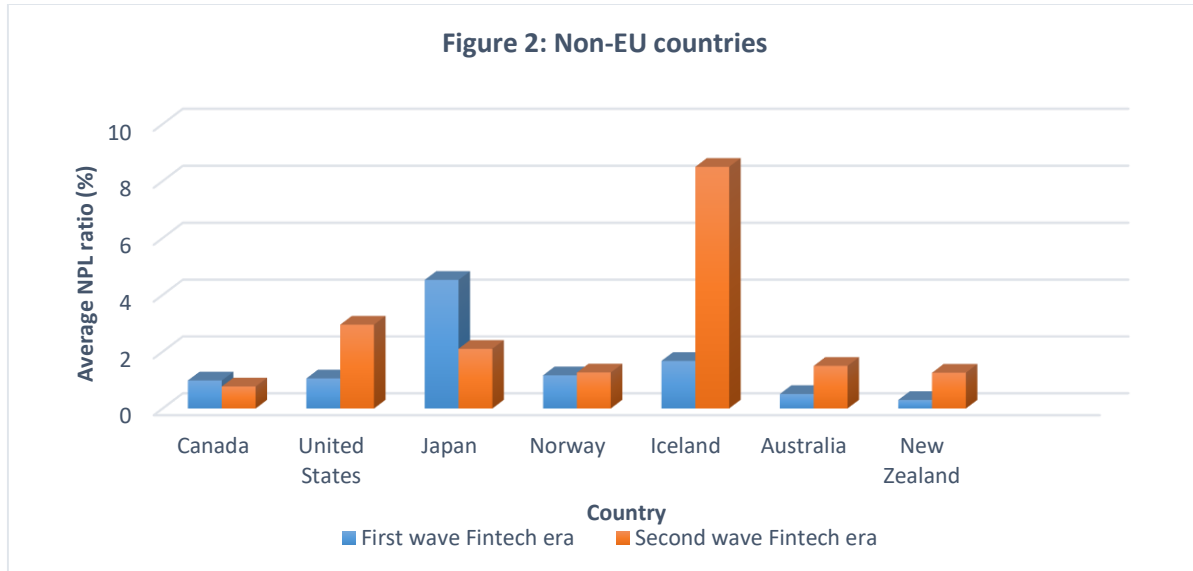
4.3. G7 countries (advanced economies)

The trend analysis in figure 3 shows that G7 countries such as Italy, United Kingdom and the United States have a high NPL ratio in the second wave Fintech era compared to the first wave Fintech era. In contrast, Canada, Japan, France and Germany have high NPL ratios in the first wave Fintech era than in the second wave Fintech era. See Appendix A2 for the table showing the actual mean NPL values related to figure 3.

Figure 3: G7 countries
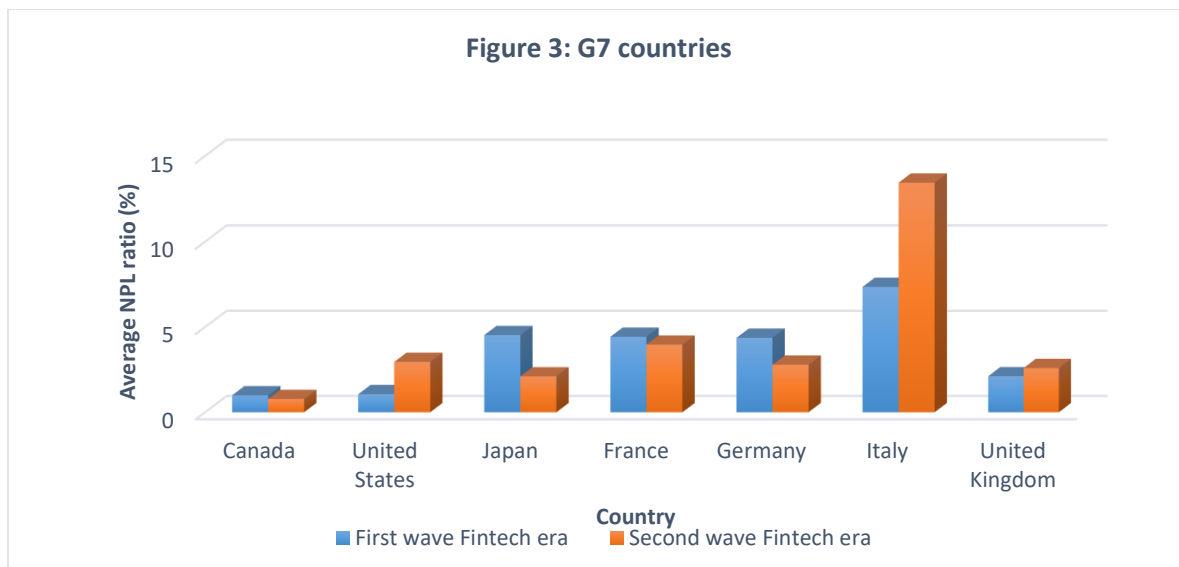
5. Empirical result

5.1. Methodology

This section analyses the determinants of NPLs using the model below.

$$NPL_{i,t} = c + \beta 1 LG_{i,t} + \beta 2 LAW_{i,t} + \beta 3 \Delta GDP_{i,t} + e \dots\dots\dots\dots. equation\ (1)$$

The extended model which takes into account the interaction analysis is stated below.

$$NPL_{i,t} = c + \beta 1 LG_{i,t} + \beta 2 \Delta GDP_{i,t} + \beta 3 LAW_{i,t} + \beta 4 FT2_t + \beta 5 LG * FT2_{i,t} + \beta 6 \Delta GDP * FT2_{i,t} + \beta 7 LAW * FT2_{i,t} + \beta 8 \Delta GDP * LG * FT2 + e \dots\dots\dots.. equation\ 2$$

Where, NPL = non-performing loan to gross loan ratio for each country; FT2 = a binary variable representing the second wave Fintech era; LG = private credit supply to the domestic economy as a percentage of GDP; LAW = rule of law index, representing legal system quality; ΔGDP = growth in real gross domestic product; t = year; i = country; c = the constant term; e = the error term.

The non-performing loan ratio is the dependent variable. The three explanatory variables are ΔGDP, LG and LAW. The growth in GDP (ΔGDP) variable controls for non-performing loans during fluctuating economic cycles. The literature show that the banking sector generally experience fewer non-performing loans in good times and higher non-performing loans in bad times because greater loan defaults occur in bad times and fewer defaults occur in good times (Lee et al, 2019; Ozili, 2019a). This suggest a negative relationship between ΔGDP and NPL (Ozili, 2019b).

The private credit to GDP ratio (LG) measures the size of private credit provided to the economy by banks. I predict that banks in credit-driven countries will have higher non-performing loans due to increasing contemporaneous credit risk in the business environment. Therefore, a positive relationship between NPL and LG is expected. The LG ratio is derived arithmetically by multiplying the 'bank loan to bank deposit ratio' data with the 'bank deposit to GDP' data obtained from the World bank database, using the formula below.

$$LG = LOAN / GDP = (LOAN / BANK\ DEPOSIT) * (BANK\ DEPOSIT / GDP)$$

Next, I control for the impact of the prevailing legal environment on banking sector non-performing loans using the LAW variable. Higher values of LAW indicate greater legal system quality. A negative relationship between NPL and LAW is predicted because banks in strong legal environments can use the power of the courts to compel debtors to repay their debt which can help to reduce the size of non-performing loans in banks (Cristini et al, 2001).

FT2 is a binary variable that equal one from 2008 to 2016 and zero otherwise. FT2 represents the second wave Fintech era. A negative relationship between FT2 and NPL is predicted because the

presence of Fintech lenders in the second wave Fintech era will reduce reliance on bank credit, therefore reducing non-performing loans in the banking sector. Table 2 reports the variables and the predicted sign. Finally, the models are estimated using fixed effect regression model.

Table 2: Variables and the expected sign		
Variable	Expected Sign	Description
NPL		Ratio of non-performing loan to gross loan
LG	(+)	Supply of private credit to the economy
LAW	(-)	Rule of law index, measuring legal system quality
ΔGDP	(-)	Real gross domestic product growth rate
FT2	(-)	Binary variable representing the second wave Fintech era

5.2. Descriptive statistics

Table 3 and 4 report the summary of the descriptive statistics for the first wave and second wave Fintech era, respectively. NPL is 3.5% in the first wave Fintech era and 6.79% in the second wave Fintech era. This suggest that NPL is lower in the first wave Fintech era and higher in the second wave Fintech era. This implies that the presence of many Fintech lenders in the second wave Fintech era did not reduce the size of bank NPL. Similarly, the ΔGDP, LAW and LG variables are higher in the second wave Fintech era compared to the first wave Fintech era.

Table 3: Descriptive statistics - first wave Fintech era				
	ΔGDP	LAW	LG	NPL
Mean	3.70	9.85	76.76	3.57
Median	3.59	9.00	73.48	2.20
Std. Dev.	2.42	2.34	43.08	4.30
Observations	350	280	327	303

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Table 4: Descriptive statistics - second wave Fintech era				
	ΔGDP	LAW	LG	NPL
Mean	0.99	12.03	98.86	6.79
Median	1.64	12.00	93.26	4.04
Std. Dev.	3.57	2.09	45.61	7.81
Observations	315	315	289	303

Table 5 reports the summary of the country-specific descriptive statistics for the variables. NPL is 5.2% on average, and is higher in Croatia, Italy and Cyprus. The LG variable, on average, is 87%. LG is higher in Switzerland, Denmark and Iceland, and much lower in Romania and Poland. The LAW variable is 11, and is higher in Romania and Poland. This indicates that Romania and Poland have high quality legal systems. The LAW variable is lower in Cyprus and Malta. The ΔGDP variable, on average, is about 2.4% and lower in Greece and Italy while Lithuania and Latvia have

higher ΔGDP. Overall, the mean value from the descriptive statistics suggest that there are wide variations across the countries in the sample.

S/N	Countries	Region	NPL	ΔGDP	LAW	LG
	Table 5: The mean values of country-specific descriptive statistics					
1	Canada	G7, Non-EU	0.8	2.3	11.3	105.5
2	United States	G7, Non-EU	1.9	2.2	10.9	51.1
3	Japan	G7, Non-EU	3.3	0.7	10.5	116.2
4	France	G7, Non-EU	4.2	1.5	10.5	86.8
5	Germany	G7, Non-EU	3.6	1.4	10.4	96.4
6	Italy	G7, Non-EU	10.2	0.44	10.9	76.8
7	United Kingdom	G7, Non-EU	2.3	2.0	10.3	-
8	Norway	Non-EU	1.2	1.7	10.2	88.5
9	Iceland	Non-EU	4.6	3.4	8.6	136.3
10	Switzerland	European Union	1.5	1.9	9.8	153.3
11	Sweden	European Union	1.1	2.5	10.3	110.8
12	Spain	European Union	3.4	2.1	10.5	127.5
13	Portugal	European Union	5.5	0.9	10.2	128.2
14	Netherland	European Union	2.5	1.7	10.1	114.7
15	Luxembourg	European Union	0.4	3.5	7.6	83.9
16	Ireland	European Union	7.8	5.3	9.8	104.9
17	Greece	European Union	14.8	0.5	10.5	79.3
18	Finland	European Union	0.5	1.9	10.1	72.8
19	Denmark	European Union	2.3	1.3	10.1	152.5
20	Belgium	European Union	2.8	1.6	10.2	61.5
21	Austria	European Union	2.6	1.7	10.2	90.9
22	Australia	Non-EU	0.9	3.1	10.1	105.7
23	New Zealand	Non-EU	1.1	2.8	10.2	122.0
24	Slovenia	European Union	7.2	2.3	13.1	54.6
25	Romania	European Union	14.7	3.3	14.5	22.8
26	Poland	European Union	8.8	3.7	14.4	37.2
27	Malta	European Union	7.3	3.7	6.8	101.7
28	Lithuania	European Union	9.2	4.1	12.9	34.1
29	Latvia	European Union	5.2	3.9	12.5	49.8
30	Hungary	European Union	6.9	2.3	13.9	43.9
31	Estonia	European Union	1.6	3.7	13.3	61.3
32	Cyprus	European Union	24.6	2.4	8.4	174.5
33	Czech Republic	European Union	8.2	2.5	13.7	42.9
34	Croatia	European Union	10.1	1.7	13.4	53.4
35	Bulgaria	European Union	9.7	3.2	14.1	41.6
	Total (mean)		5.2	2.4	11	87.1

5.3. Correlation results

Table 6 reports the Pearson correlation coefficient and the associated p-values. NPL is positively correlated with FT2. The correlation between NPL and FT2 is significant. This indicates that NPL is higher in the second wave Fintech era. LAW is positive and significantly correlated with NPL, which indicates that NPL is higher in countries with strong legal systems. NPL is negative and significantly correlated with ΔGDP (-0.18***). This indicates that NPL is procyclical with fluctuating business cycles. LG is insignificant and negatively correlated with NPL. Overall, the correlations are sufficiently low to be concerned about multi-collinearity.

Table 6: Pearson correlation matrix

	NPL	LG	ΔGDP	LAW	FT2
NPL	1.000				

LG	0.032	1.000			
	(0.74)	-----			
ΔGDP	-0.189***	-0.353***	1.000		
	(-4.33)	(-8.48)	-----		
LAW	0.243***	-0.310***	-0.111**	1.000	
	(5.62)	(-7.32)	(-2.52)	-----	
FT2	0.277***	0.249***	-0.426***	0.435***	1.000
	(6.47)	(5.79)	(-10.59)	(10.84)	-----

T-values are reported in parenthesis. ***,**,* denotes statistical significance at 1%, 5% and 10% levels.

5.4. Regression results

5.4.1. NPL determinants

The ΔGDP coefficient is negative and significant in column 1 of table 7. This suggests that NPLs are lower during economic booms and higher during economic downturns. This confirms the prediction that NPLs are higher in bad times and lower in good times. This result supports the findings of Ozili (2019b) who find a negative relationship between the size of non-performing loans and the state of the economic cycle. The LG coefficient is positive and significant in column 1. This suggests that higher level of private credit to the economy is associated with higher NPL. The LAW coefficient is not significant in column 1.

5.4.2. Interaction results: NPL in the Fintech era

In this section, I perform some interaction analysis to test whether each NPL determinant has a significant effect on NPL in the second wave Fintech era than in the first wave Fintech era. The reasoning is that current economic conditions, legal system quality and the size of credit markets can provide the preconditions that allow Fintech lenders to thrive in credit markets. Over time, these preconditions will contribute to reducing the size of non-performing loans in the banking sector (Hau et al, 2019; Claessens et al, 2018). In the analysis, I interact each NPL determinant with the year dummy variable (FT2) to determine the effect of each NPL determinant on NPL during the second wave Fintech era.

The interaction result for the second wave Fintech era is reported in columns 2 and 3 of table 7. The FT2 coefficient is negative and significant in column 2. This suggests that NPL is lower in the second wave Fintech era. The negative sign for the FT2 coefficient confirms the prediction of low NPL in the second wave Fintech era. This is because the presence of many Fintech lenders in the second wave Fintech era will reduce the reliance on banks for credit and reduce non-performing loans in the banking sector.

The LG*FT2 coefficient is positive and significant in column 2. This suggests that higher private credit to the economy is associated with higher NPL in the second wave Fintech era. ΔGDP*FT2 coefficient is positive and significant in column 2. This suggests that NPL is positively related to the state of the economic cycle in the second wave Fintech era. The LAW*F2 coefficient is not significant in column 2.

Meanwhile, the ΔGDP*LG*F2 coefficient is negative and significant in column 3. This indicates that NPL is lower during the second wave Fintech era and in times of economic boom as well as when there are high levels of private credit to the economy. The result supports the expectation that economic conditions and the size of credit markets can jointly provide preconditions that allow Fintech lenders to thrive in credit markets which, over time, will contribute to reduce the size of non-performing loans in the banking sector.

Table 7: Full sample regression analysis			
	(1)	(2)	(3)
	Coefficient	Coefficient	Coefficient
	(t-statistic)	(t-statistic)	(t-statistic)
c	4.456	9.292***	9.171***
	(1.20)	(4.32)	(4.28)
ΔGDP	-0.342***	-0.668***	-0.635***
	(-3.65)	(-4.11)	(-3.92)
LG	0.049***	0.024*	0.022*
	(4.09)	(1.89)	(1.70)
LAW	-0.249	-0.501**	-0.483**
	(-0.79)	(-2.38)	(-2.30)
FT2		-7.742**	-7.857**
		(-2.18)	(-2.22)
ΔGDP*FT2		0.774***	1.188***
		(4.24)	(4.68)
LG*FT2		0.044***	0.046***
		(3.33)	(3.47)
LAW*FT2		0.357	0.353
		(1.48)	(1.47)
ΔGDP*LG*F2			-0.005**
			(-2.34)
Country fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	No	No
R^2	59.63	53.69	54.23
Adjusted R^2	55.00	49,71	50.18
F-Statistic	12.87	13.47	13.41
Prob (F-Statistic)	0.000	0.000	0.000
Observation	506	506	506
T-values are reported in parenthesis.			
***,**,* denotes statistical significance at 1%, 5% and 10% levels.			

5.4.3. Robustness check

1. Impact of the European sovereign debt crisis

In this section, I test whether the results remain robust after excluding the countries in the sample that were severely affected by the European debt crisis. The countries that were excluded from the sample are: Greece, Ireland, Portugal, Spain and Italy. The results are then re-estimated and reported in table 8. The FT2 coefficient is negative and significant in column 2 of table 8, which confirms the earlier result shown in column 2 of table 7. Also, the LG*FT2 and ΔGDP*FT2

coefficients are positive and significant in column 2 of table 8, and confirms the earlier result shown in column 2 of table 7. The ΔGDP*LG*F2 coefficient is negative and significant in column 3 of table 8, and confirms the earlier result shown in column 3 of table 7.

Overall, the result in table 8 confirms that the NPL behavior observed in the earlier result (in table 7) was not caused by the European sovereign debt crisis.

Table 8: Robustness check - regression result adjusted for the European sovereign debt crisis		
	(1)	(2)	(3)
	Coefficient (t-statistic)	Coefficient (t-statistic)	Coefficient (t-statistic)
c	5.207 (1.48)	9.752*** (4.75)	9.562*** (4.71)
ΔGDP	-0.529*** (-5.41)	-0.674*** (-4.27)	-0.645*** (-4.12)
LG	0.045*** (3.81)	0.025** (1.97)	0.021* (1.69)
LAW	-0.280 (-0.96)	-0.523*** (-2.68)	-0.492** (-2.55)
FT2		-12.027** (-3.54)	-12.549*** (-3.73)
ΔGDP*FT2		0.637*** (3.47)	1.244*** (4.66)
LG*FT2		0.046*** (3.45)	0.050*** (3.83)
LAW*FT2		0.616*** (2.73)	0.618*** (2.77)
ΔGDP*LG*F2			-0.007*** (-3.10)
Country fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	No	No
R^2	61.40	56.06	57.13
Adjusted R^2	56.55	52.08	53.13
F-Statistic	12.65	14.07	14.25
Prob (F-Statistic)	0.000	0.000	0.000
Observation	422	422	422
T-values are reported in parenthesis.			
***,**,* denotes statistical significance at 1%, 5% and 10% levels.			

2. *Effect of the global financial crisis*

In this section, I test whether the results remain robust after excluding countries in the sample that were severely affected by the 2007-2008 global financial crisis. To identify the countries that were severely affected by the global financial crisis, I rely on data in the International Economic Bulletin's report obtained from the Carnegie Endowment for Internal peace Institute[1]. The report lists the top 10 countries that were most affected by the global financial crisis. The top 10 countries are: Ukraine, Argentina, Hungary, Poland, Jamaica, Ghana, Russia, Kazakhstan, Bulgaria and Mexico. Of these 10 countries, only three countries are in the sample of this study, namely, Poland, Bulgaria and Hungary. These three countries were excluded from the sample. The results are then re-estimated and reported in table 9. The FT2 coefficient is negative and significant in column 2 of table 9, which confirms the earlier result shown in column 2 of table 7. Also, the LG*FT2 coefficient and ΔGDP*FT2 coefficients are positive and significant in column 2 of table 9, and confirms the earlier result shown in column 2 of table 7. The ΔGDP*LG*F2 coefficient is negative and significant in column 3 of table 9, and confirms the earlier result in column 3 of table 7. Overall, the results in table 9 confirm that the NPL behavior observed in the earlier result (in table 7) was not caused by the global financial crisis.

Table 9: Robustness check - regression result excluding countries severely affected by the global financial crisis			
	(1)	(3)	(5)
	Coefficient	Coefficient	Coefficient
	(t-statistic)	(t-statistic)	(t-statistic)
c	1.531	7.348***	7.281***
	(0.40)	(3.34)	(3.34)
ΔGDP	-0.277***	-0.592***	-0.545***
	(-2.95)	(-3.65)	(-3.37)
LG	0.055***	0.029**	0.027**
	(4.53)	(2.33)	(2.15)
LAW	-0.095	-0.449**	-0.441**
	(-0.29)	(-2.02)	(-2.00)
FT2		-8.809**	-8.977**
		(-2.38)	(-2.45)
ΔGDP*FT2		0.755***	1.278***
		(4.14)	(5.05)
LG*FT2		0.042***	0.044***
		(3.21)	(3.33)
LAW*FT2		0.472*	0.480*
		(1.76)	(1.80)
ΔGDP*LG*F2			-0.006***
			(-2.95)
Country fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	No	No

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[1] https://carnegieendowment.org/2009/07/09/unequal-impact-of-economic-crisis-pub-23385

R²	61.43	56.40	57.29
Adjusted R²	56.78	52.54	53.39
F-Statistic	13.19	14.61	14.72
Prob (F-Statistic)	0.000	0.000	0.000
Observation	456	456	456

T-values are reported in parenthesis.

***,**,* denotes statistical significance at 1%, 5% and 10% levels.

6. Conclusion

This paper analysed bank non-performing loans in the Fintech era using data for 35 developed countries from 1998 to 2016.

The estimation results show that non-performing loans are lower in the second wave Fintech era compared to the first wave Fintech era. This result supports the prediction that the presence of many Fintech lenders in the second wave Fintech era will lead to less reliance on banks for credit due to increased patronage of Fintech lenders. This will lead to a reduction in the amount of loans issued by banks, thereby leading to fewer non-performing loans in the banking sector. The findings also reveal that non-performing loans are positively related to the state of the business cycle in the second wave Fintech era. This suggests that developed economies that have high supply of credit to the private sector experience high non-performing loans in the second wave Fintech era.

The findings have several implications for financial regulation and policy. Financial regulators should place emphasis on strong credit risk controls in the second wave Fintech era as banks seek to collaborate with Fintech lenders to increase lending to the private sector. Also, bank supervisors should take into account the disruptive capacity of Fintech lenders in their stress-test scenarios as well as the effect of such disruption on the activities and performance of traditional banks in their stress-test scenarios. This will help bank supervisors to gain a more robust picture of how financial innovation, such as Fintech, affects the level of non-performing loans in the banking sector.

The study has some limitations. One, the study did not include more recent data in the analysis. This is because information for recent country-level NPL data is not available. Two, the study did not analyse NPL in the years before the Fintech evolution. Three, the study did not examine the indirect mediated effect of the Fintech era on bank non-performing loans. Four, the set of explanatory variables used in the study are limited.

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Finally, I suggest some areas for future research. Future studies can expand the dataset to more recent years when the data becomes available. Two, future research can examine the behavior of NPL in the Fintech era in other regional blocs such as the ASEAN, ECOWAS, MENA and the Eurozone region. Three, future studies can conduct a mediation analysis to examine the extent to which the Fintech era affects the overall amount of loans which in turn affect the level of non-performing loans following the approach of MacKinnon (2008). Four, future studies can re-assess NPL in the Fintech era and take into account a wide range of explanatory variables such as the unemployment rate and the level of sovereign debt which might affect the size of non-performing loans.

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Appendix

A1: Variable description		
Indicator	Short definition	Source
ΔGDP	Gross domestic product growth rate	Global Findex database, World Bank
LG	Credit to private sector by banks as a share of GDP.	Global Findex database, World Bank
NPL	Bank non-performing loans to gross loans (%)	Global Findex database, World Bank
LAW	Rule of law / quality of legal system	World Governance Indicator, World Bank
FT2	Fintech era variable	Constructed by author

s/n	Countries	First wave Fintech era	Second wave Fintech era
A2: Average NPL ratio (used for the graphical analysis			
1	Canada	0.9	0.7
2	United States	1.1	2.9
3	Japan	4.5	2.1
4	France	4.4	3.9
5	Germany	4.3	2.7
6	Italy	7.3	13.4
7	United Kingdom	2.1	2.5
8	Norway	1.1	1.3
9	Iceland	1.6	8.5
10	Switzerland	2.1	0.8
11	Sweden	1.4	0.8
12	Spain	1.1	6.1
13	Portugal	2.3	8.6
14	Netherland	2.2	2.7
15	Luxembourg	0.4	0.6
16	Ireland	0.9	15.6
17	Greece	8.4	21.9
18	Finland	0.6	0.5
19	Denmark	0.7	3.8
20	Belgium	2.4	3.4
21	Austria	2.5	2.7
22	Australia	0.5	1.5
23	New Zealand	0.3	1.3
24	Slovenia	4.3	9.5
25	Romania	-	14.7
26	Poland	13.3	4.5
27	Malta	7.7	7.1
28	Lithuania	5.7	13.1
29	Latvia	2.5	8.2
30	Hungary	3.0	11.3
31	Estonia	0.8	2.6
32	Cyprus	-	24.6
33	Czech Republic	11.2	4.9
34	Croatia	7.9	12.4
35	Bulgaria	6.8	12.6