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The Effects of Unconventional Monetary Policy on Firm Capital Structure

By Jun Takahashi *

This study investigates the effects of unconventional monetary policy on firms' financing decisions using techniques drawn from corporate finance and monetary economics. The data set utilized contains 9,220 firms in 40 countries and 22 sectors from 1998 to 2018. The data is analysed through a variety of techniques including feasible generalized least squares with fixed effects with the Prais-Winsten estimator, reduced vector autoregression, and structural vector autoregression. This research determines that the effects of unconventional monetary policy on capital structure can vary amongst different groups. However, it also finds that most capital structure theories are applicable during periods of unconventional monetary policy. In addition, this work reveals that monetary policy transmission mechanisms differ across conventional and unconventional monetary policy schemes. Unconventional monetary policy most significantly impacts leverage ratios for large private enterprises and has spillover effects globally. The cross-country, cross-sector, cross-firm-type, and cross-firm-size variations suggest that there are group specific factors that determine the impacts of unconventional monetary policy on firm capital structure.

Keywords: *Capital Structure, Corporate Debt, Conventional and Unconventional Monetary Policy, Global Financial Crisis, Vector Autoregression, Structural Vector Autoregression, Impulse Response Functions*

I. Introduction

After the global financial crisis (GFC) in 2008, major central banks conducted a series of unconventional monetary policy interventions to rescue their economies. In some cases, the policy rate was cut below zero, breaching what was believed to be the lower bound. Conventional monetary policy (CMP) tools reached their limits before fully healing the scar of the global financial crisis. As a result, central banks shifted to unconventional monetary policy (UMP). Although unconventional monetary policies were initially thought to be short-term emergency methods, some remained active for more than a decade. Looking at unconventional monetary policy intervention gives a chance to further explore capital structure decisions. Since monetary policy directly affects the country's interest rate, the policy alters the cost of debt and the opportunity cost of equity. This change in the relative cost of funding will eventually influence the capital structure of firms. Furthermore, the use of unconventional monetary policy can

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provide case studies for testing the robustness of existing corporate finance theories. For instance, negative interest rates violate the assumption of the zero-lower bound in the existing literature[1].

This paper is focused on answering three key questions: How does monetary policy affect the capital structure during a crisis and in its aftermath? Is existing capital structure theory still applicable in an extreme state of the world economy? How does the impact of unconventional monetary policy differ from the orthodox monetary policy on corporate financing decisions? Hence, this study interconnects the academic fields of corporate finance and monetary economics. Different techniques from each academic area are applied in this research. In order to address these questions this paper utilizes data from both developed and developing countries with a focus on the effects of UMP that are employed in several high-income countries[2]. The data are organized based on differing monetary policy regimes after 2008, levels of economic development and firm characteristics. Two empirical models are explored, a corporate finance model and a monetary economics model. The framework of the corporate finance model follows [Rajan and Zingales (1995)]; [Booth et al. (2001)]; and [Demirguc-Kunt et al. (2015)]. These studies all utilize a dummy variable for periods of unconventional monetary policy. The monetary economics model employs vector autoregression (VAR) and will be applied to capture the effects of monetary policy and capital structure. The VAR model follows the empirical settings of [Sims (1980)]; [Stock and Watson (2001)]; [Gertler and Karadi (2011)]; and [Lhuissier and Szczerbowicz (2018)].

II. Existing Literature

Past research emphasizes the effects of firm and institutional factors on capital structure. This research suggests how cross-country characteristics such as institutional differences, tax codes, and regulations affect financing decisions [Rajan and Zingales (1995)]; [Booth et al. (2001)]. However, there is limited research on the effects of monetary policy on corporate finance. Similarly, although a large volume of research analyzes the economic impacts of conventional monetary policy, much of the impact of unconventional monetary policy is left to be uncovered.

Since the global financial crisis of 2007/08 firms have been reluctant to rely on long term debt [Demirguc-Kunt et al. (2015)]. Demirguc, Martinez and Tressel found there was a reduction in leverage and debt to maturity in both developed and developing countries from 2008 to 2011. The decline was more severe in the countries with poorer financial infrastructure. These differences resulted from less established banking systems, less sophisticated legal systems around bankruptcy, less investor protection, limited credit information, and more barriers to entry for the banking sector. Large publicly listed firms experienced a smaller decline in their leverage and maturity. The authors concluded that capital markets were a "spare tire" for the large or publicly listed firms since these firms have access to an alternative source of funding when banking systems are damaged.

Classical papers on the international capital structure comparison state that determinants

[1]This paper follows the standard definitions of conventional and unconventional monetary policy from the literature. CMP refers to the modification of key policy rates. UMP includes, but is not limited to, forward guidance (FG), quantitative easing (QE), credit easing (CE), negative interest rates (NIR), and yield curve controls (YCC).

[2]High-income countries are defined by the World Bank as countries with Gross National Income (GNI) per capita higher than US$12,235 in 2016 (calculated based on the Atlas method).

of capital structure are similar among developed and developing countries [Rajan and Zingales (1995)]; [Booth et al. (2001)]. However, there are country-specific factors that influence capital structure. Capital structure is determined by factors such as GDP growth rates and inflation rates which are different for each country. These findings support the view that monetary policy may also be treated as a country specific factor. Although the major central banks set their inflation target at 2%, they must adjust monetary policy depending on country characteristics.

More recent literature on capital structure identifies several key theories including the Static Trade-Off Model (STO), the Pecking-Order Hypothesis (POH), and the Agency Theoretic Framework (ATF). [Myers (1984)] explained the Static Trade-Off as the model that can balance the benefits of interest tax shields and the cost of bankruptcy. The optimal capital structure is found where the marginal benefits of tax shields are equal to the marginal cost of bankruptcy. Using POH, the 'good' companies order the preferred financing source under a financial hierarchy with an internal source (retained earnings or equity), an external debt, and an external equity. The 'bad' companies order the financial hierarchy conversely. The 'good' companies are more profitable than 'bad' companies. If this theory holds during periods of unconventional monetary policy, we shall see an inverse relationship between leverage ratios and the proxy for the firm profitability[3]. The alternative could be explained by the Pecking-Order Hypothesis through the debt-overhang problem [Myers (1977)]. The debt-overhang problem is when companies forego positive net present value projects since the risks are bore by equity holders but benefits are extracted by debt holders. The Agency Theoretic Framework is a model that determines an optimal capital structure given conflicts amongst internal and external investors. The optimal capital structure depends on agency and financing costs. Firms assets and growth opportunities are key determinants for the ATF model [Booth et al. (2001)].

The theoretical consensus on leverage ratios and other factors is summarized in [Harris and Raviv (1991)]. Hariss and Raviv state that "leverage increases with fixed assets, non-debt tax shields, investment opportunities, firm size and decreases with volatility, advertising expenditure, the probability of bankruptcy, profitability and uniqueness of the product." In the presence of asymmetric information, profitability measures are predicted to have a negative relationship with leverage [Myers and Majluf (1984)]. Rajan and Zingales have argued that among the Group of Seven (G7)[4] countries, profitability has a negative impact on leverage [Rajan and Zingales (1995)]. The same is true for developing countries [Booth et al. (2001)]. Booth et al. have shown that the Pecking-Order Hypothesis is appropriate to analyze the various phases of economic development. In other words, the Pecking-Order Hypothesis holds both in developed and developing countries. If POH is applicable among the different states of an economy (i.e. countries with conventional and unconventional monetary policies), then the profitability measure is expected to have an inverse relationship with debt ratios. Fixed assets to total assets (FATA) are assumed to have a positive impact on leverage since the bigger the proportion of tangible assets to total assets, the greater the collateral for the investors. Therefore, the risks of investors bearing agency costs are lower. Higher fixed assets to total assests indicates higher liquidity as well. Hence, FATA is expected to positively correlate with the use of debt.

Literature on the diversity of monetary policy approaches has begun to reveal the relationship

[3]Return on assets (ROA) and gross income are used as proxies for profitability in this research.
[4]G7: Canada, France, Germany, Italy, Japan, the United States, and the United Kingdom

between the choice of policy stance and the capital structure of countries. Several existing unconventional monetary policy models interpret the leverage ratio as one of the key variables during a crisis [Gertler and Karadi (2011)]. Gertler and Karadi have updated dynamic stochastic general equilibrium (DSGE) models of conventional monetary policy with the direct intervention of central banks in capital markets. They successfully quantified the effect of the Federal Reserve System tapping into private markets. Gertler and Karadi's model considers the leverage ratio as an endogenous variable in the dynamism of a steady state where it is profitable for bankers to expand assets in response to an increase in the tolerant leverage ratio of depositors. Their model shows a possible connection between capital structure and monetary policy. Gertler and Karadi also construct a vector autoregressive (VAR) model to study the effect of conventional monetary policy on the economy [Gertler and Karadi (2015)]. They use a monetary policy 'surprise' variable as an instrumental variable for the unobservables in their VAR model. They use the change in interest rates from several monetary policy meeting dates as a policy surprise measure. They find that Forward Guidance (FG) is crucial in a monetary policy transmission mechanism to the real economy. Gertler and Karadi also show that small changes in the short-term interest rates result in large changes in credit costs, which in turn will affect the real economy.

Recently, Gertler and Karadi's framework was repurposed to analyze the effect of unconventional monetary policy [Lhuissier and Szczerbowicz (2018)]. Lhuissier and Szczerbowicz have looked at the effects of monetary policy on aggregate economic activity and firms' debt structure in the United States. They compared the results of VAR models for conventional and unconventional monetary policies. Their findings suggest that conventional and unconventional monetary policies impact capital structure differently. Conventional monetary easing raises the number of loans to non-financial corporations and lowers corporate bonds, whereas unconventional monetary easing is associated with higher bond financing and no change in the number of loans. Conventional monetary policy affects the real economy through interest rates, asset prices, exchange rates, access to credit, and the banking system [Kuttner (2018)]; [Kashyap and Stein (1994)]; [Bernanke and Gertler (1995)]. Unconventional monetary policy influences the real economy through various other channels. Past research identified at least five major transmission channels of unconventional monetary policy.[5] These transmission channels include signalling, portfolio balancing, liquidity, exchange rate, and bank lending [Dell'Ariccia et al. (2018)]. These models and findings will inform the models constructed in this paper.

III. Data Summary

Data has been collected and organized to analyze both the corporate finance and monetary economics models. For the corporate finance model, the firm- and country-level data consist of quarterly data for 9,220 firms from 40 countries over the period 1998 to 2018 (1998 Q4 to 2018 Q4). For the monetary economic model, firm and country level data consists of monthly data for G7 countries over the period 2001 to 2018 (Jan 2001 to Dec 2018). Firm-level data were collected from FactSet. Country-level data were gathered both from FactSet and the World

[5]Notable examples are: [Alsterlind et al. (2015)]; [Amiti and Weinstein (2013)]; [Bernanke (2014)]; [Cahn et al. (2017)]; [Campbell et al. (2012)]; [Curcuru et al. (2018)]; [Fawley and Juvenal (2012)]; [Fiedler et al. (2016)]; [Haldane et al. (2016)]; [Series (2017)]; and [Mokhova and Zinecker (2014)].

Bank data repository.

In both the corporate finance model, three measures of capital structure act as dependent variables in different model specifications. These measures are total debt to total assets (TDTA), long term debt to total assets (LTDTA) and long-term debt to total debt (LTDTD). Independent variables include FATA, return on assets (ROA), sales to total assets (STA), gross income to total assets (GITA), total assets (TA), gross domestic product (GDP) per capita, and dummy variables for years under global financial crisis (GFC) and periods of unconventional monetary policy (UMP). The firm level data are categorized into 6 company types, 3 company sizes[6] and 22 sectors. The country level data are identified based on four income levels[7] and global financial crisis indicators from [Laeven and Valencia (2018)].

In the firm level data the majority of observations represent public firms in developed countries. The sample data includes public companies (89.03%), private companies (5.45%), subsidiaries (4.74%), holding companies (0.57%), non-profit organizations (0.17%) and joint ventures (0.04%). In terms of income classes, 59.37% are high-income, 25.56% are upper-middle-income, 14.32% are lower-middle-income and 0.75% are low-income countries. Small companies make up 11.48%, medium companies 11.35% and large companies 77.17% of all observations. Due to the extreme debt position of some companies, the full sample has been restricted with outliers removed. Both the restricted and unrestricted sample have been indicated on all tables throughout. Table A1 in the appendix provides a breakdown of the data across various categories discussed.

The variables of interest for this research are total debt to total assets (TDTA), long term debt to total assets (LTDTA) and long-term debt to total debt (LTDTD). The first two ratios, TDTA and LTDTA, measure the firms' leverage, which indicates how much of their assets are financed by either short-term debt, long-term debt or both. The third ratio, LTDTD, measures the maturity composition of firm leverage. Total Assets (TA) is the sum of total current assets, long-term notes receivable, total investments and advances, property, plant, and equipment, intangible assets and deferred tax assets. Total Debt (TD) includes short-term debt, the current portion of long-term debt, long-term debt excluding capitalized leases, and capitalized lease obligations. Long-term debt (LTD) consists of any convertible long-term liabilities, bonds, finance leases, long-term royalties, long-term notes payables, preferred liabilities, interest-free loans, borrowing reported as part of total debt, industrial revenue bonds, revolving credit, senior subordinated bonds and notes, and subordinate loans[8].

Table 1) and Table 2) summarize the data under both approaches taken in this paper. The data indicates that considerable dispersion and outliers are visible without restrictions on the sample. Without any restrictions, the global means of TDTA, LTDTA, and LTDTD are 0.3512, 34.41 and 42.1865 respectively. Once TDTA, LTDTA, and LTDTD are strictly restricted to less

[6]The size of the companies is determined by the number of employees aligning with the literature. The small companies have less than or equal to 99 employees. The medium companies have between 100 and 249 employees. The large companies have more than or equal to 250 employees.

[7]Following the World Bank's definitions, country classifications by income levels for 2018-2019 are: low-income if GNI per capita < 996, lower-middle-income if GNI per capita is higher than or equal to 996 and lower than or equal to 3,895, upper-middle-income if GNI per capita is in between 3,896 and 12,055, and high-income if GNI per capita is $> 12{,}055$. GNI per capita is in current USD.

[8]The definitions of TA, TD and LTD differ across industries and countries. The complete lists of constituents in each measure are available from the author on request.

Table 1—Data Summary for the Corporate Finance Model

	Without Restrictions					With Restrictions				
Variables	N	mean	sd	min	max	N	mean	sd	min	max
Firm Characteristrics										
TA	885,119	3,049	21,289	0	$1.529e^{+06}$	482,896	3,913	23,839	0.000115	$1.529e^{+06}$
TD	908,629	716.8	4,446	-2.942	356,571	482,896	953.6	4,990	-2.942	356,571
LTD	568,598	635.7	3,560	-355.7	275,800	482,896	705.1	3,702	-35.02	255,011
ROA	874,903	-12.93	5,482	$-4.622e^{+06}$	292,069	479,764	2.216	182.4	-90,510	15,703
FA	859,895	1,563	9,495	-0.350	546,138	469,632	2,064	11,360	-0.350	546,138
Sales	910,988	1,776	7,998	-143.8	333,542	482,767	2,342	9,615	-0.162	333,542
Cash	908,508	281.2	1,980	-0.455	220,696	482,809	354.8	2,136	-0.455	133,768
Gross Income	576,666	127.4	645.6	-68,336	90,958	455,471	143.2	686.8	-68,336	90,958
TDTA	884,277	0.351	23.50	-0.0128	11,968	482,896	0.254	0.254	-0.0128	9.478
LTDTA	539,094	34.43	17,807	-0.103	$9.253e^{+06}$	482,896	0.134	0.182	-0.103	8.350
LTDTD	497,389	42.20	17,423	-3.235	$8.793e^{+06}$	482,896	0.486	0.467	-3.235	9.997
FATA	837,510	0.565	1.896	-0.00304	807.0	469,632	0.600	2.400	-0.00304	807.0
STA	884,414	1.012	5.641	-0.791	2,386	482,767	0.966	0.805	-0.193	50.18
CTA	884,254	0.168	0.163	-0.325	1.519	482,809	0.154	0.142	-0.325	1.519
GITA	544,756	23.56	12,633	-1,022	$7.993e^{+06}$	455,471	0.0589	1.656	-1,022	227.9
Country Characteristics										
GDP	939,330	25,695	250,869	346.5	$2.177e^{+06}$	253,517	27,299	114,334	373.0	$2.177e^{+06}$
Log GDP	939,330	9.188	1.578	5.848	16.90	253,517	9.620	1.353	5.922	16.90
UMP Dummy	$1.408e^{+06}$	0.168	0.374	0	1	482,896	0.252	0.434	0	1
GFC Dummy	$1.408e^{+06}$	0.0741	0.262	0	1	482,896	0.0591	0.236	0	1
Low-Income	$1.408e^{+06}$	0.00748	0.0861	0	1	482,896	0.00161	0.0401	0	1
Low-Middle-Inc	$1.408e^{+06}$	0.143	0.350	0	1	482,896	0.0989	0.298	0	1
High-Middle-Inc	$1.408e^{+06}$	0.256	0.436	0	1	482,896	0.267	0.443	0	1
High-Income	$1.408e^{+06}$	0.594	0.491	0	1	482,896	0.632	0.482	0	1

Note: Restrictions of TDTA, LTDTA and LTDTD <10.00 are imposed.

Source: FactSet and World Bank Data Repository

than 10.00 then the global means of TDTA, LTDTA and LTDTD are 0.254, 0.134 and 0.485. By excluding the extreme cases of debt usage, analysis can be better focused on the goals of this research. The data summary also indicates a link between income class and other factors. Amongst income classes, companies in upper-middle- and lower-middle-income countries have higher leverage with shorter debt maturities than companies in low- and high-income countries. The private firms have larger leverage with longer deb maturity than the public firms. The larger the companies the smaller the leverage, and the shorter the debt maturity.

Table 1) summarizes the data for the corporate finance model. In this approach there are eight key independent variables to consider. The fixed asset variable represents the company's long-term tangible assets that are mainly used in its operations. Sales for commercial companies includes the sales of goods and services that are discounted by cash, trade costs, sales taxes, and exercise taxes. For financial companies, sales refers to total operating revenue[9]. The return on assets and gross income variables are proxies for firm profitability. The total assets variable

[9]For banks, sales include interest and fees on loans, interest on Federal Funds and bank deposits, lease financing, income from trading accounts, foreign exchange income, investment securities gains/losses, trust income, and commissions. For the insurance companies, sales are premium earned, investment income, and gains/losses on the pre-tax sale of securities.

Table 2—Data Summary for Monetary Economics Model

Variables	N	mean	sd	min	max
country_id	1,944	5	2.583	1	9
year	1,944	2,010	5.189	2,001	2,018
month	1,944	6.500	3.453	1	12
year, month	1,944	599.5	62.37	492	707
one_year	1,664	1.290	1.607	-1.215	6.334
five_year	1,930	2.136	1.661	-1	7.494
GDP	1,944	60,859	162,107	469.0	551,958
CPI	1,943	120.5	14.69	96.23	157.5
mkt_index	1,944	8,092	9,663	48.06	59,715
log CPI	1,943	4.784	0.121	4.567	5.060
Log GDP	1,944	8.322	1.902	6.151	13.22
TDTA	1,944	0.251	0.0663	0.000108	0.995
LTDTA	1,944	0.181	0.0652	0.000108	0.404
LTDTD	1,944	0.684	0.168	0.0307	1.485

Note: Restrictions of TDTA, LTDTA and LTDTD <10.00 are imposed.

Source: FactSet and World Bank Data Repository

reflects the firm size. The GDP per capita variable is used as the indicator of both the economic and institutional development of a country. The dummy variable for a Global Financial Crisis (GFC) takes the value of 1 if the period is between 2008Q2 and 2009Q2, otherwise takes the value of 0. The unconventional monetary policy (UMP) dummy variable assigns 1 for the period after 2008Q2 and assigns 0 otherwise. Each variable's definitions and data sources are available from the author on request. The descriptive statistics obtained from this data are aligned with the existing literature assuring that there are no major issues.

Table 2) summarizes the data for the monetary economics model. In this approach there are several main independent variables. The variables measure inflation, calculated with consumer price index (CPI), nominal GDP, capital structure, interest rates and major financial market indices for each country selected. The capital structure measures are clustered at the country level for each quarter and then interpolated to monthly data. The monthly nominal GDP variable is also interpolated from quarterly nominal GDP. In the VAR model, CPI and nominal GDP are in natural log terms. Following VAR constructions of Gertler and Karadi and Lhuissier and Szczerbowicz, one-year rates and five-year rates of the government bonds are used to calculate the interest rates for both conventional and unconventional periods [Gertler and Karadi (2011)][Lhuissier and Szczerbowicz (2018)]. It is believed that interest rates of the government bonds incorporate the expectations of future interest rates. Due to the fact that unconventional monetary policy targets both short-term rates (one-year rate) and long-term rates (ten-year rate), an average five-year rate is employed as the unconventional policy indicator. Financial market index for each country is: S&P/TSX for Canada, CAC40 for France, DAX for Germany, FISE MIB for Italy, Nikkei225 for Japan, FTSE100 for the UK and S&P500 for the US. Table 2 shows the summary statistics for the monetary economics variables.

IV. Model Design

The corporate finance and monetary economics approaches each examine economic variables differently. While the corporate finance approach disentangles the cross-sectional variations in unconventional monetary policy on capital structure, the monetary economics approach reveals the structural differences in dynamic effects of conventional and unconventional monetary shocks on corporate financing decisions.

For the corporate finance approach, a simple linear regression with various capital structure measures, firm characteristics and country characteristic data are constructed. Since capital structure is persistent, the presence of the autocorrelation across periods makes ordinary least squares estimations biased. Instead, a feasible generalized least squares estimation with fixed effects and Prais-Winsten estimators for the serially correlated error terms is employed. Two time dummy variables are included in the regression model to account for the effects of both the global financial crisis and the introduction of unconventional monetary policy. The simple regression model is the following:

$$(1)\quad Y_{ijt} = \alpha + \beta \cdot FirmControls_{ijt} + \gamma \cdot CountryControl_{jt} + \mu_0 \cdot GFC_t + \mu_1 \cdot UMP_t + f_i + \epsilon_{ijt}$$

where Y_{ijt} is a capital structure measure, either TDTA, LTDTA or LTDTD for firm i in country j at time t. $FirmControls_{ijt}$ are FATA, ROA, STA, GITA, and TA. $CountryControl_{jt}$ is the natural log term of GDP per capita. GFC_t and UMP_t are dummy variables. f_i is the fixed effect within each sample of firms and countries. ϵ_{ijt} is the error term. The error term is white noise and assumed to follow a first order autocorrelation. The coefficients of interest are μ_0 and μ_1.

For the monetary economics approach, impulse response functions are analyzed using a simple reduced VAR and structural VAR (SVAR). The model includes variables measuring the CPI, GDP, capital structure, interest rates, and financial market indices for the G7 countries. The country selections are based on the operation of their monetary policy. The reduced-form VAR model is the following:

$$(2)\quad Y_t = \sum_{i=1}^{\rho} B_i Y_{t-i} + \alpha_y + \epsilon_t,\ t = 1, 2, ..., T,$$

where Y_t is an $n \times 1$ vector of endogenous variables at time t, B_i is an $n \times n$ coefficient matrix, Y_{t-i} is the i lagged variable of Y_t, α_y is the constant term of an endogenous variable y, ρ is the number of lags, ϵ_t is the forecast error term[10], n is the number of endogenous variable, and T is the sample size. The general form of the SVAR is given by:

[10]The forecast error term, ϵ_t, is assumed to be white noise

$$AY_t = \sum_{i=1}^{\rho} C_i Y_{t-i} + \epsilon_t,\ t = 1, 2, ..., T \tag{3}$$

where A is an $n \times n$ coefficient matrix capturing the contemporaneous relationships among variables in Y_t, C_i is an $n \times n$ coefficient matrix, and the rest matches equation 2. For the post estimation analysis, the error term is transformed to a linear combination of mutually orthogonal 'structural' shocks. Assuming the variance-covariance of the error terms to be an identity matrix, let B be the $n \times n$ identifiable matrix:

$$\epsilon_t = Bu_t \tag{4}$$

$$E\big[u_t u_t^{'}\big] = I. \tag{5}$$

By substituting the equation 4 into the equation 3, the SVAR becomes:

$$AY_t = \sum_{i=1}^{\rho} C_i Y_{t-i} + Bu_t,\ t = 1, 2, ..., T \tag{6}$$

where u_t is the linearly independent structural shocks. Assuming A is invertible, the reduced-form of SVAR can be obtained by multiplying the equation 6 by A^{-1}.

$$Y_t = \sum_{i=1}^{\rho} A^{-1} C_i Y_{t-i} + A^{-1} B u_t \tag{7}$$

Following 'recursive' identification, A is set to be a unit lower-triangular matrix and B is set to be a diagonal matrix. Cholesky ordering sets the endogenous variables in Y_t based on the impact that the endogenous variable has on other endogenous variables. The most influential endogenous variable comes first and the least influential endogenous variable comes last. In the case of this research, the endogenous variables are ordered as CPI, GDP, debt measures, interest rates, and then financial market indicators. The impulse response function can be derived from equation 7 using the lag operator L (which is defined as $L^p x_t = x_{t-p}$). The impulse response function for SVAR is:

$$Y_t = (I - A^{-1} \sum_{i=1}^{\rho} C_i L^i)^{-1} A^{-1} B u_t. \tag{8}$$

Since the focus of this research is the effects of unconventional monetary policy on capital

structure, VAR models are run on two different periods for conventional and unconventional monetary policy. Each country has different conventional and unconventional periods. Using equation 6 and assumptions about matrices A and B, the SVAR model in this research is constructed as follows:

$$(9)\quad \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ -a^{21} & 1 & 0 & 0 & 0 \\ -a^{31} & -a^{32} & 1 & 0 & 0 \\ -a^{41} & -a^{42} & -a^{43} & 1 & 0 \\ -a^{51} & -a^{52} & -a^{53} & -a^{54} & 1 \end{bmatrix} \begin{bmatrix} CPI_t \\ nGDP_t \\ Capital\ Structure\ Measure_t \\ Interest\ Rate_t \\ Financial\ Market\ Index_t \end{bmatrix} =$$

$$\sum_{i=1}^{\rho} \begin{bmatrix} c_{t-i}^{11} & c_{t-i}^{12} & c_{t-i}^{13} & c_{t-i}^{14} & c_{t-i}^{15} \\ c_{t-i}^{21} & c_{t-i}^{22} & c_{t-i}^{23} & c_{t-i}^{24} & c_{t-i}^{25} \\ c_{t-i}^{31} & c_{t-i}^{32} & c_{t-i}^{33} & c_{t-i}^{34} & c_{t-i}^{35} \\ c_{t-i}^{41} & c_{t-i}^{42} & c_{t-i}^{43} & c_{t-i}^{44} & c_{t-i}^{45} \\ c_{t-i}^{51} & c_{t-i}^{52} & c_{t-i}^{53} & c_{t-i}^{54} & c_{t-i}^{55} \end{bmatrix} \begin{bmatrix} CPI_{t-i} \\ nGDP_{t-i} \\ Capital\ Structure\ Measure_{t-i} \\ Interest\ Rate_{t-i} \\ Financial\ Market\ Index_{t-i} \end{bmatrix} + \begin{bmatrix} b_t^{11} & 0 & 0 & 0 & 0 \\ 0 & b_t^{22} & 0 & 0 & 0 \\ 0 & 0 & b_t^{33} & 0 & 0 \\ 0 & 0 & 0 & b_t^{44} & 0 \\ 0 & 0 & 0 & 0 & b_t^{55} \end{bmatrix} \begin{bmatrix} u_t^1 \\ u_t^2 \\ u_t^3 \\ u_t^4 \\ u_t^5 \end{bmatrix},$$

where a^{zw} is the estimated coefficients to account for the contemporaneous relationships between the variable z and the dependent variable in equation w, c_{t-i}^{zw} is the estimated coefficients for the i lagged variable z in equation w, ρ is the number of lags, and b_t^{zw} is the coefficient for the forecast term u_t^z. For z and w, the number 1, 2, 3, 4 and 5, refer to CPI, nominal GDP, capital structure measure, interest rate, and financial market index, respectively. The capital structure measure is either TDTA, LTDTA or LTDTD. The interest rate is the one-year rate and five-year rate of government bonds for the conventional and unconventional periods, respectively. The financial market index varies amongst countries. The lag selections are based on Akaike's[11] and Bayesian[12] information criteria. The number of lags used in SVAR are different across monetary policy schemes and countries. The number of lags used for each SVAR are given in the appendix.

V. Results

The corporate finance model and monetary economic model both investigate the effects of unconventional monetary policy on how firms are financed from different approaches. The variation

[11] According to [Akaike (1998)], Akaike's information criteria is defined as

$$AIC = -2\ln L + 2K$$

where L is the maximized log-likelihood of the model and K is the number of estimated parameters.

[12] According to [Schwarz (1978)], Baysian information criteria is defined as

$$BIC = -2\ln L + K\ln N$$

where L is the maximized log-likelihood of the model, K is the number of estimated parameters, and N is the sample size.

in unconventional monetary policy effects from corporate finance method sheds light on potential explanations relating monetary policy effects to capital structure during a global financial crisis and in its aftermath. Cross-country variations assess the portability of capital structure theories after the intervention of unconventional monetary policy. The impulse response functions from the monetary economic method provides insight into the structural difference between the conventional and unconventional shocks on corporate financing decisions. Each will be discussed in turn.

A. The Effects of Monetary Policy During Crisis

The results of the estimated effects of both the global financial crisis and unconventional monetary policy at the global level, using the corporate finance approach, are presented in table 3. The estimated effects of the global financial crisis (GFC) and unconventional monetary policy (UMP) on capital structure for different groups are presented in columns 9 and 11 of table 3.

Table 3 indicates that both the crisis and unconventional policy affected the firms' capital structure. While the global financial crisis induced firms to deleverage their long-term capital, UMP encouraged firms to take more debt in the short and long term. These results conform to the existing literature. When uncertainty rose significantly after the global financial crisis, many firms were reluctant to take more long-term debt. What is profound from table 3 is that TDTA increased during the crisis periods and the effects of unconventional monetary policies are larger than the effects of the crisis on capital structure in general. The decrease in LTDTA and LTDTD are 0.2 basis points (bps) and 1.65 bps, respectively. TDTA increased by 0.163 bps during the crisis. Even after a decade following the global financial crisis and the introduction of unconventional policy, the results suggest that unconventional monetary policy increased corporate leverage above pre-crisis levels. This finding might partially explain why some major central banks exited or are exiting from unconventional policy. The overuse of unconventional monetary policy might lead to excessive risk-taking behaviour by firms. Mitigating these risks by exiting from unconventional policy seems a reasonable monetary policy response.

The GFC impacted both TDTA and LTDTA for countries that faced a systemic banking crisis by 0.507 bps and 0.805 bps. There was a spillover effect of a decrease in long-term debt to the countries that did not experience a systemic crisis. On average, firms lowered their LTDTA by 0.534 bps and LTDTD by 2.36 bps even for countries that did not suffer a banking crisis. This spillover effect demonstrates the interconnectivity of the banking system and activities around the world. Unconventional monetary policy, on the other hand, had a larger impact on the countries that did not face a banking crisis. The estimated unconventional policy effect on TDTA, LTDTA, and LTDTD for the non-crisis countries was 2.94 bps, 1.29 bps, and 1.67 bps. For the crisis countries these effects were 0.991 bps, 0.167 bps, and 0.208 bps respectively. Unconventional monetary policy had a statistically significant effect on all leverage measures for non-crisis countries. This result could indicate that additional capital went to non-crisis countries as the return on capital was higher in these countries than in crisis countries. Most of the countries that had a banking crisis went into recession and interest rates were artificially low to stimulate the economy. The lower interest rates should have encouraged firms to borrow more, however, the rapid increase in uncertainty in the economy discouraged the global financial crisis countries to take on more debt.

Table 3—Estimation Results on Unconventional Monetary Policy for the Global Financial Crisis

Variable	Obs	Mean	Std Dev	Min	Max	Obs	GFC		UMP		FE
							Est	Std Err	Est	Std Err	
Global											
Global Average											
td/ta	884,594	0.351253	23.49294	-0.01282	11967.59	270,270	0.000866	(0.00414)	-0.0152**	(0.00751)	Yes
ltd/ta	539,225	34.41963	17804.39	-0.1035	9252552	242,463	0.00800	(0.00505)	0.00732*	(0.00380)	Yes
ltd/td	497,493	42.1865	17421.59	-3.23467	8792784	218,125	30.68	(65.55)	-48.47	(54.51)	Yes
Global Average with Restrictions											
td/ta	482,996	0.254	0.254	-0.0128	9.478	217,666	0.00163**	(0.000797)	0.0252***	(0.00157)	Yes
ltd/ta	482,996	0.134	0.182	-0.103	8.350	217,666	-0.00221**	(0.000892)	0.00958***	(0.00137)	Yes
ltd/td	482,996	0.486	0.467	-3.235	9.997	217,666	-0.0165***	(0.00393)	0.0103***	(0.00329)	Yes
GFC Experience											
without GFC shock											
td/ta	372,378	0.241	0.206	-0.0128	8.835	155,867	0.000209	(0.000753)	0.0294***	(0.00153)	Yes
ltd/ta	372,378	0.106	0.141	-0.103	8.350	155,867	-0.00534***	(0.000863)	0.0129***	(0.00151)	Yes
ltd/td	372,378	0.398	0.420	-3.235	9.960	155,867	-0.0236***	(0.00418)	0.0167***	(0.00384)	Yes
with GFC shock											
td/ta	110,518	0.296	0.371	5.24e-07	9.478	61,799	0.00507**	(0.00215)	0.00991**	(0.00390)	Yes
ltd/ta	110,518	0.230	0.256	0	8.316	61,799	0.00805***	(0.00236)	0.00167	(0.00304)	Yes
ltd/td	110,518	0.782	0.496	0	9.997	61,799	-0.00261	(0.00925)	0.00208	(0.00669)	Yes
Income Classes											
Low											
td/ta	779	0.171	0.147	1.51e-05	0.669	556	-0.00474	(0.00817)	0.00561	(0.0161)	Yes
ltd/ta	779	0.128	0.133	0	0.563	556	-0.0132	(0.0106)	0.0117	(0.0181)	Yes
ltd/td	779	0.636	0.396	0	4.903	556	0.120	(0.0741)	0.0719	(0.0565)	Yes
Lower Middle											
td/ta	47,742	0.276	0.237	-0.0128	5.915	15,582	0.000301	(0.00388)	0.0220***	(0.00651)	Yes
ltd/ta	47,742	0.135	0.188	-0.103	5.606	15,582	0.0139**	(0.00665)	-0.0120	(0.0114)	Yes
ltd/td	47,742	0.454	0.461	-3.235	9.917	15,582	-0.00959	(0.0285)	0.00509	(0.0409)	Yes
Upper Middle											
td/ta	129,088	0.256	0.224	4.82e-06	8.835	56,730	0.00238	(0.00159)	0.0218***	(0.00292)	Yes
ltd/ta	129,088	0.0835	0.126	0	8.350	56,730	-0.00849***	(0.00132)	0.0219***	(0.00194)	Yes
ltd/td	129,088	0.298	0.403	0	9.953	56,730	-0.0183***	(0.00662)	0.0250***	(0.00617)	Yes
High											
td/ta	305,387	0.250	0.269	-0.0120	9.478	144,798	0.00248***	(0.000956)	0.0194***	(0.00193)	Yes
ltd/ta	305,387	0.156	0.196	0	8.316	144,798	0.00145	(0.00112)	0.00656***	(0.00160)	Yes
ltd/td	305,387	0.570	0.470	0	9.997	144,798	-0.0159***	(0.00469)	0.0139***	(0.00366)	Yes

Note: *** p<0.01, ** p<0.05, * p<0.1.

Source: FactSet and World Bank Data Repository

Unconventional monetary policy was statistically significant for TDTA in lower-middle income countries and for all capital structure measures in the upper-middle and high-income countries. Firms in upper-middle income countries lowered their long-term debt during the crisis but raised their TDTA, LTDTA, and LTDTD during unconventional policy periods. As the unconventional monetary policy effect on these firms' leverage ratios was larger than the deleveraging effect on long-term debt from the crisis, the firms in the upper middle-income countries were taking on greater leverage than their pre-crisis levels. When the default probabilities were rising for the companies in the upper-middle income countries, investors might have taken the capital out from these companies or banks hesitated to lend capital to these companies during the crisis. However, when the global economy started recovering from the global financial crisis, investors who sought higher yields than the low-interest rates available in the high-income countries might

have invested more into those riskier countries.

For the case of high-income countries, both the crisis and unconventional policy had positive effects on capital structure measures. Unconventional monetary policy influenced the firms that were located in the high-income countries to increase their leverage in the short and long term by 1.94 bps and 0.656 bps. Their debt maturity increased by 1.39 bps as well. It is surprising to see that unconventional policy effects are bigger on TDTA than LTDTA. Following the theory of 'filling-gaps', unconventional policy should have a larger impact on LTDTA than TDTA. The 'filling-gaps' hypothesis argues that while the central bank is acting as a long-term liquidity provider by purchasing long-term debt securities, firms issue more long-term debt to meet the higher demand. Further research is required to understand this contradiction between the theory and the empirical findings.

There are variations in the effects of the global financial crisis and unconventional monetary policy across countries. Some countries endured both, either or neither of the crisis or unconventional policy effects. Both signs and the direction of the effects for the crisis and unconventional policy vary by country. The countries that had statistically significant unconventional monetary policy effects on all leverage ratios are Brazil, China, France, Japan, and the Philippines. Countries with significant unconventional monetary policy effects on both TDTA and LTDTA are Canada, Chile, Czech Republic, Estonia, Mexico, and Turkey. The countries with statistically significant unconventional monetary policy effects only on TDTA or LTDTA are Argentina, Bangladesh, Finland, Germany, India, Ireland, Netherlands, New Zealand, Portugal, South Korea, and Spain. As studies on the effect of unconventional monetary policy on the real economy and firms' capital structure are still in the developmental stage, the factors behind these cross-country variations are ambiguous. However, the presence of these variations shed light on the need for further investigation on why different countries experienced different impacts from unconventional policy. These findings might contribute to the literature by explaining why countries follow different recovery pathways from financial crises. [Demirguc-Kunt et al. (2015)] have researched the cross-country factors for the global crisis effects on firms' capital structure. They found that the crisis effects are more significant in countries with less sophisticated financial infrastructure, weaker banking systems, less sophisticated legal systems, fewer protections for investors, limited availability of credit information and higher barriers for bank entries.

Unconventional monetary policy affected private, public and holding companies but not other types of companies. All capital structure measures for the public companies are affected by unconventional policy, which increased TDTA, LTDTA, and LTDTD by 2.52 bps, 1.02 bps, and 1.12 bps respectively. For holding and private companies, unconventional policy encouraged these companies to take on more debt for the short and long term. In fact, TDTA and LTDTA rose by 5.19 bps and 4.98 bps for holding companies and by 4.37 bps and 4.49 bps for private companies. Unconventional monetary policy had a greater impact on private companies' capital structure for both TDTA and LTDTA than the impact on public companies' capital structure. Considering this result, the higher debt of private companies could be related to the fact that private companies experienced larger reductions in these capital structure measures during the global financial crisis. In order to recover their leverage ratios to the pre-crisis levels, private companies needed to increase their leverage during unconventional policy periods more than

public companies. Looking at this phenomenon through the policy perspective, it might suggest that the indirect effects of unconventional monetary policy in lowering interest rates via bond purchases in the economy might have larger impacts on firms' capital structure than the direct effects of purchasing the bonds that were issued by the private companies.

In regard to differences in unconventional monetary policy effects across various firm sizes, only the debt maturity of medium and large firms are affected. Unconventional policy induced large firms to higher TDTA, LTDTA, and LTDTD by 2.56 bps, 0.811 bps, and 1.32 bps respectively. These results might be because of the unique source of funding for large firms. Larger firms, especially publicly listed firms, have easier access to capital markets, which is an alternative source of funding. The capital market serves as a 'Spare Tire' for large firms to mitigate the risks of shocks due to crisis [Demirguc-Kunt et al. (2015)]. This spare tire hypothesis is also clear in the findings of this research. The crisis shock on LTDTA for medium-sized firms is larger than its effect for large-sized firms. The large firms' reliance on capital markets enlarged the exposure of their capital structure to the market. As unconventional policy impacts capital markets, large firms bore more significant effects of this than any other size of the firm. In the case of unconventional monetary policy, large firms are motivated to take more debt in the short and long term.

Some unconventional monetary policy specifically targets certain sectors as a liquidity injection. The central banks' QE is a program to purchase government bonds. The central banks' quantitative and qualitative easing (QQE) or credit easing (CE) is a program to purchase corporate bonds, ETFs of specific sectors or other particular indices. These purchasing programs target the selected sectors. Although major central banks who employ unconventional policy do not disclose the target sectors, the results indicate unconventional policy affects some sectors but not others. The sectors that have statistically significant UMP impacts on all three capital structure measures are Finance, Producer Manufacturing, and Utilities. The sectors that have statistically significant UMP impacts on both TDTA and LTDTA are Consumer Durables, Consumer Services, Distribution Services, Electronic Technology, Process Industries, and Transportation. The sectors that have statistically significant UMP impacts only on either TDTA or LTDTA are Communications, Consumer Non-Durables and Non-Energy Minerals. Both the country and industry level results discussed above are available on request from the author.

B. Portability of Capital Structure Theories

In order to examine the portability of capital structure theories, the results by country from the corporate finance approach were compared against the findings from past studies. Portability in this context means that the capital structure theories hold across time and through different monetary policy schemes. The estimation from regressions using the corporate finance method select each countries is shown in table 4.

Table 4—Estimation Results by Country

Variables	FATA	ROA	STA	GITA	TA	Log GDP	Constant
Canada							
td/ta	0.0583***	-0.000332***	-0.0396***	-0.00206	-7.76e-07	0.0255***	-0.0379***
	(0.00758)	(7.60e-05)	(0.00463)	(0.0105)	(8.85e-07)	(0.00270)	(0.00307)
ltd/ta	0.0651***	-8.90e-05	0.0132*	0.00170	-7.40e-06***	0.00852***	0.0817***
	(0.0109)	(0.000118)	(0.00673)	(0.0167)	(1.04e-06)	(0.00236)	(0.00547)
ltd/td	0.0220	0.000581	0.00943	0.0186	-3.96e-06	0.0537***	0.204***
	(0.0531)	(0.000708)	(0.0355)	(0.124)	(3.62e-06)	(0.0118)	(0.0698)
France							
td/ta	-0.182***	-0.000885	-0.128***	-0.0623	8.55e-07	0.0454***	-0.0531***
	(0.0382)	(0.00110)	(0.0203)	(0.128)	(1.25e-06)	(0.00476)	(0.00737)
ltd/ta	-0.168**	0.00250	-0.0914*	-0.0302	-1.77e-06	0.0335***	-0.00750
	(0.0724)	(0.00238)	(0.0485)	(0.332)	(2.35e-06)	(0.00877)	(0.0272)
ltd/td	-0.602**	0.0136*	-0.140	0.772	-1.16e-05	0.0892***	0.108
	(0.237)	(0.00794)	(0.173)	(1.254)	(7.70e-06)	(0.0303)	(0.135)
Germany							
td/ta	0.0275***	-0.000933***	-0.0322***	-0.0104	-2.00e-07**	0.0161***	0.0339***
	(0.00951)	(9.15e-05)	(0.00355)	(0.00722)	(8.64e-08)	(0.00204)	(0.00193)
ltd/ta	0.0346***	-0.000471***	0.00267	0.0288**	-3.06e-07***	0.00656***	0.0657***
	(0.0134)	(0.000143)	(0.00535)	(0.0118)	(1.15e-07)	(0.00182)	(0.00365)
ltd/td	0.0274	-3.19e-06	-0.0238	0.168	-5.16e-07	0.0409***	0.278***
	(0.0749)	(0.000991)	(0.0347)	(0.111)	(5.39e-07)	(0.0106)	(0.0585)
Italy							
td/ta	0.0137	-0.00367***	-0.0567***	-0.00673	1.28e-06***	0.0388***	-0.122***
	(0.0123)	(0.000128)	(0.0110)	(0.0204)	(3.34e-07)	(0.00279)	(0.00378)
ltd/ta	0.0647***	-0.000279*	-0.00256	-0.00396	-1.20e-06***	0.0183***	-0.0296***
	(0.0146)	(0.000163)	(0.0133)	(0.0266)	(4.05e-07)	(0.00257)	(0.00558)
ltd/td	0.196***	0.00169*	0.198***	0.0710	-3.90e-06*	0.0270**	0.190***
	(0.0721)	(0.000896)	(0.0684)	(0.154)	(2.08e-06)	(0.0117)	(0.0373)
Japan							
td/ta	0.0277***	-0.00212***	-0.0319***	7.98e-06	-2.86e-08	0.0125***	0.0804***
	(0.00177)	(4.04e-05)	(0.00112)	(6.46e-05)	(5.12e-08)	(0.000817)	(0.000812)
ltd/ta	0.0223***	-0.000734***	0.0117***	-8.38e-05	-2.61e-07***	0.00435***	0.0212***
	(0.00231)	(5.08e-05)	(0.00134)	(8.66e-05)	(6.86e-08)	(0.000497)	(0.00107)
ltd/td	0.0109	-0.000173	0.0292***	-0.000411	-3.56e-07	0.0391***	-0.0538***
	(0.0150)	(0.000300)	(0.00733)	(0.000672)	(4.31e-07)	(0.00220)	(0.00978)
The United Kingdom							
td/ta	0.0143	-0.000701*	-0.165***	-0.00391	-1.84e-06	0.0643***	-0.148***
	(0.0313)	(0.000399)	(0.0273)	(0.0270)	(1.41e-06)	(0.0120)	(0.00656)
ltd/ta	0.0926**	-0.000538	-0.0185	0.0365	-3.27e-06*	0.0268***	-0.0195
	(0.0439)	(0.000626)	(0.0410)	(0.0501)	(1.91e-06)	(0.00786)	(0.0185)
ltd/td	0.216	0.0108***	-0.0196	-0.0961	-2.38e-05***	0.101***	-0.0773
	(0.167)	(0.00246)	(0.166)	(0.240)	(6.80e-06)	(0.0310)	(0.116)
The United States							
td/ta	-0.00326***	-1.09e-05**	0.0346***	0.0588***	7.58e-08	0.0236***	-0.0221***
	(0.000607)	(5.19e-06)	(0.00229)	(0.00492)	(2.68e-07)	(0.00199)	(0.00231)
ltd/ta	-0.00433***	-2.99e-05***	0.0142***	0.0772***	-2.68e-06***	0.0178***	0.0329***
	(0.000407)	(6.92e-06)	(0.00233)	(0.00558)	(2.33e-07)	(0.00125)	(0.00297)
ltd/td	-9.81e-05	6.34e-07	0.0117	0.0692***	-1.41e-06***	0.0684***	0.0613**
	(0.000674)	(3.54e-05)	(0.00726)	(0.0268)	(5.28e-07)	(0.00403)	(0.0259)

Note: *** p<0.01, ** p<0.05, * p<0.1.

Source: FactSet and World Bank Data Repository

Tangibility is measured by fixed assets to total assets (FATA). Although there are exceptions, fixed assets to total assets are positively correlated with TDTA, LTDTA, and LTDTD for the majority of countries. Some countries have negative coefficients on FATA for TDTA. In rare cases, the coefficients on FATA for LTDTA and LTDTA are also negative. Hence, the hypothesis of maturity matching of assets and liabilities are partially portable but not for all countries. Profitability mainly has a negative impact on leverage ratios, especially on TDTA. The profitability is reflected in return on assets (ROA) and gross income to total assets (GITA). The results support the argument from Myers and Majulf and indicate that Pecking-Order Hypothesis (POH) is portable [Myers and Majluf (1984)]. This result also suggests that there is asymmetric information after the global financial crisis and the introduction of unconventional monetary policy. Growth opportunities represented by sales to total assets (STA) are mostly negatively related to capital structure. As Myers points out, profitable firms forego positive net

present value projects [Myers (1977)]. Debt overhang exists in unconventional policy periods as well. Size in terms of total assets (TA) mainly has a negative effect on leverage ratios. This result questions existing theories. The estimated total assets impacts on capital structure do not align with the results from [Demirguc-Kunt et al. (2015)]. These differences might reveal that unconventional monetary policy changed the relationship of size and leverage of firms or affected international competitiveness. The findings indicate that most capital structure theories are applicable during periods of unconventional policy. However, the capital structure and size of the firms does not interact in the same manner ex-ante and ex-post of unconventional policy. This signals a need for future research on the portability of capital structure theories among different monetary policy schemes.

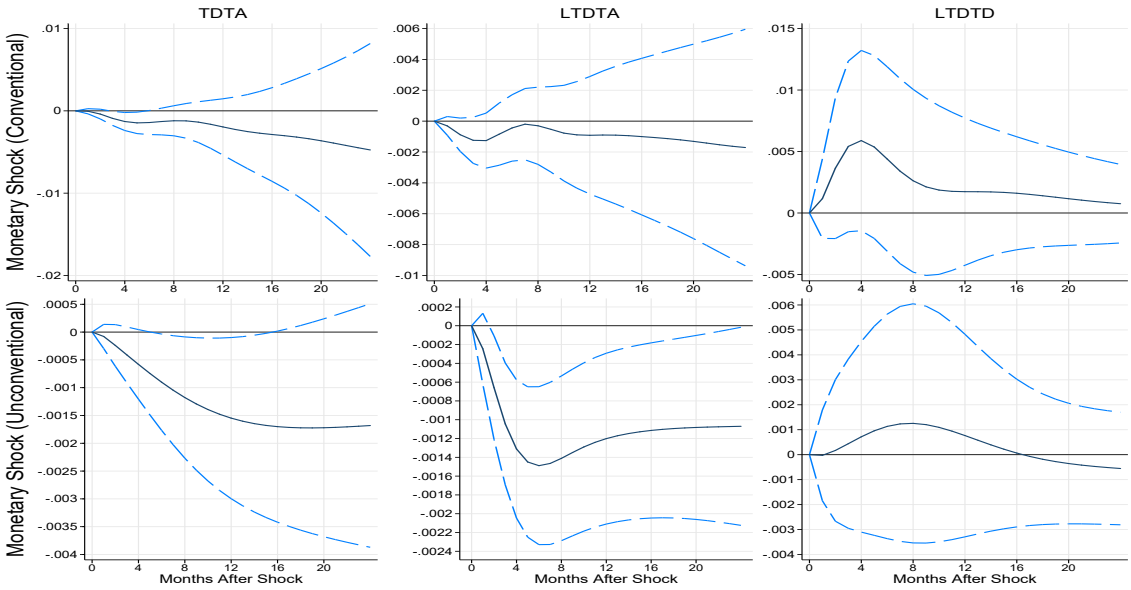
C. The Impact of Conventional vs. Unconventional Policy Shocks on Capital Structure

The estimated effects of conventional and unconventional monetary policy shocks on the capital structure for the horizon of 24 months are shown in figure 1-8. They exhibit the response of variables to the impulse of a one standard deviation increase in the orthogonal structural shock u_t^z in equation 9. The transmission of monetary policy shocks to the capital structure measures vary amongst countries and across conventional and unconventional periods. The types of unconventional policy employed shows clear cross-country variation. The unconventional policy shocks seem to have more gradual, consistent and persistent effects on corporate leverage than the conventional policy shocks. The discussion here is centred on the response of capital structure measures to the impulse response of monetary policy.

The figures indicate the responses of TDTA, LTDTA and LTDTD to a monetary shock for 24 months after the shock. The solid navy line represents the median response. The 95% confidence interval bands (i.e. $\pm$ two standard deviations from the median response) of the response is shown in dotted blue lines. The first and second row show the impulse responses during conventional and unconventional periods, respectively. The first column is the response of TDTA to the impulse of the monetary shock. The second column is the response of LTDTA. The third column is the response of LTDTD. TDTA is total debt to total assets. LTDTA is long-term debt to total assets. LTDTD is long-term debt to total debt. TDTA, LTDTA and LTDTD, are the national average for each month. These national averages are computed after the restrictions of TDTA, LTDTA and LTDTD<10.00 are imposed. The impulse of monetary shock is the one standard deviation increase in the structural shock of the monetary policy indicator equation in SVAR. The vertical axis indicates the percentage change of each responding variable, while the horizontal axis is the months after the shock. Results are reviewed in the order of Canada, France, Germany, Italy, Japan, Sweden, Switzerland, the United Kingdom, and then the United States. [13]

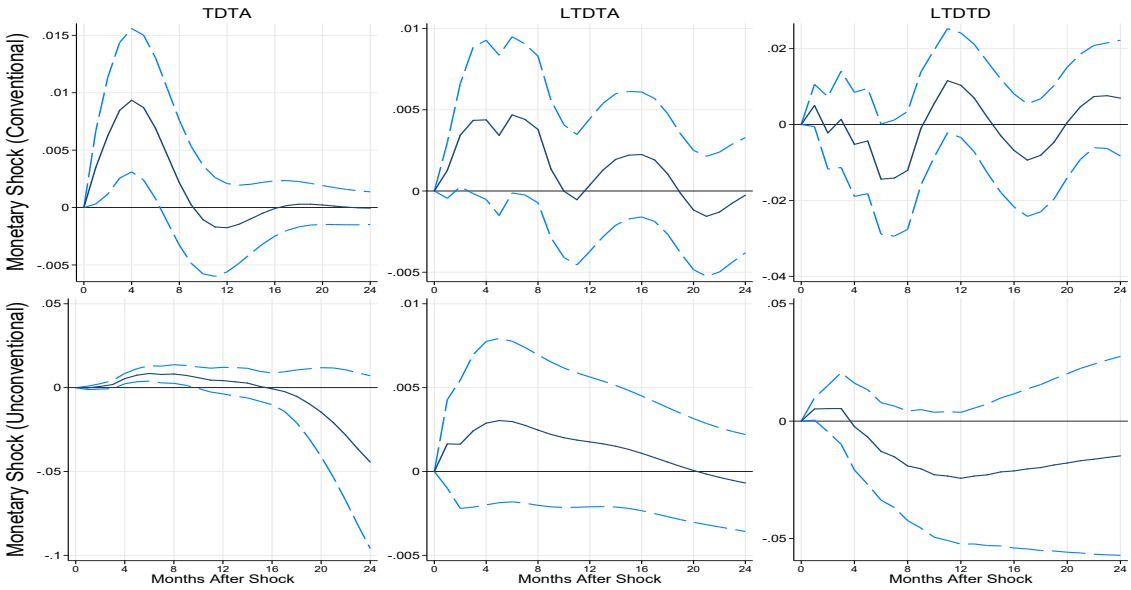
[13]For Canada and the US, the conventional periods are from 2001M1 to 2008M9 and the unconventional periods are from 2008M10 to 2018M12. For France, Germany, and Italy, the conventional periods are from 2001M1 to 2015M1 and the unconventional periods are from 2015M2 to 2018M12. For Japan, the conventional periods are from 2001M1 to 2010M6 and the unconventional periods are from 2010M7 to 2018M12. For Sweden, the conventional periods are from 2001M1 to 2014M12 and the unconventional periods are from 2015M1 to 2018M12. For Switzerland and the UK, the conventional periods are from 2001M1 to 2008M12 and the unconventional periods are from 2009M1 to 2018M12.

Figure 1. Impulse Responses in Canada



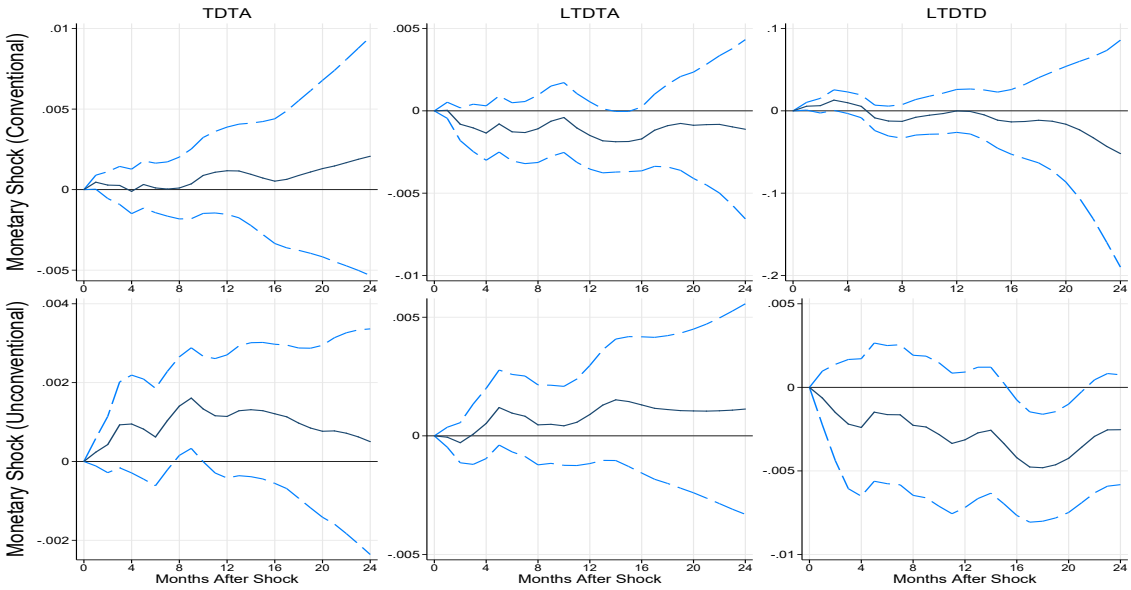
The Bank of Canada implemented unconventional monetary policies in April 2009. The impulse responses in figure 1 indicate different movements ex-ante and ex-post of the introduction of unconventional policy. The first row in figure 1 shows the impulse response for the conventional period and the second row for the unconventional period. During the conventional period, monetary policy tightening decreases TDTA and LTDTA gradually over the span of 24 months, whereas during the unconventional periods, TDTA and LTDTA react to the impulse much quicker for the first 12 months. The response of LTDTD after 16 months from the shock demonstrates the opposite response for conventional and unconventional periods. Following the global financial crisis, firms deleveraged their long-term debt and lowered debt maturity [Demirguc-Kunt et al. (2015)]. The debt maturity measure, LTDTA, rises within the first quarter after the monetary shock. The increase in LTDTD is larger for conventional periods than for unconventional periods. Both TDTA and LTDTA decline for the initial four months after the shock then start rising. The responses of all capital structure measures indicate that the interactions of monetary policy and capital structure differ across different policy schemes, conventional and unconventional. Compared with other countries, the responses of leverage ratios are relatively moderate in Canada.

Figure 2. Impulse Responses in France



The European Central Bank conducted forward guidance in 2013 followed by the introduction of negative interest rate in 2014 and large-scale asset purchase programme in 2015 [Hartmann and Smets (2018)]; [Constncio (2018)]. For France, the capital structure responds to conventional and unconventional monetary policy differently. While there are fluctuations in firms financing decisions after a conventional policy shock, firms tend to respond more smoothly for the unconventional policy shock. For TDTA, the ratio slowly increases for the first 5 months, then decreases at an increasing rate in the unconventional case. TDTA seems to have no response 16 months after a conventional monetary policy shock. For LTDTA, companies adjust their long-term debt multiple times within 2 years after a contractionary conventional policy. The impulse response of unconventional monetary tightening on LTDTA is absorbed within 20 months. The enterprises initially expand their long-term debt by 0.25 bps for a quarter, then gradually slow their expansion of LTDTA. The debt maturity, does not chase the LTDTA response. LTDTD rises for the first 4 months by 0.1 bps then reduces by 0.25 bps in unconventional periods. After a year from an unconventional monetary policy shock, the reduction of the firm's debt maturity slows down. The relatively more stable responses in the unconventional period might have resulted from forward guidance (FG). Once the future path of the countries' monetary policy is described in FG, firms might adjust their behaviour accordingly. The response of TDTA and LTDTA for conventional periods conflicts with the economic theory. It is believed that contractionary monetary policy discourages enterprises to acquire additional debt.

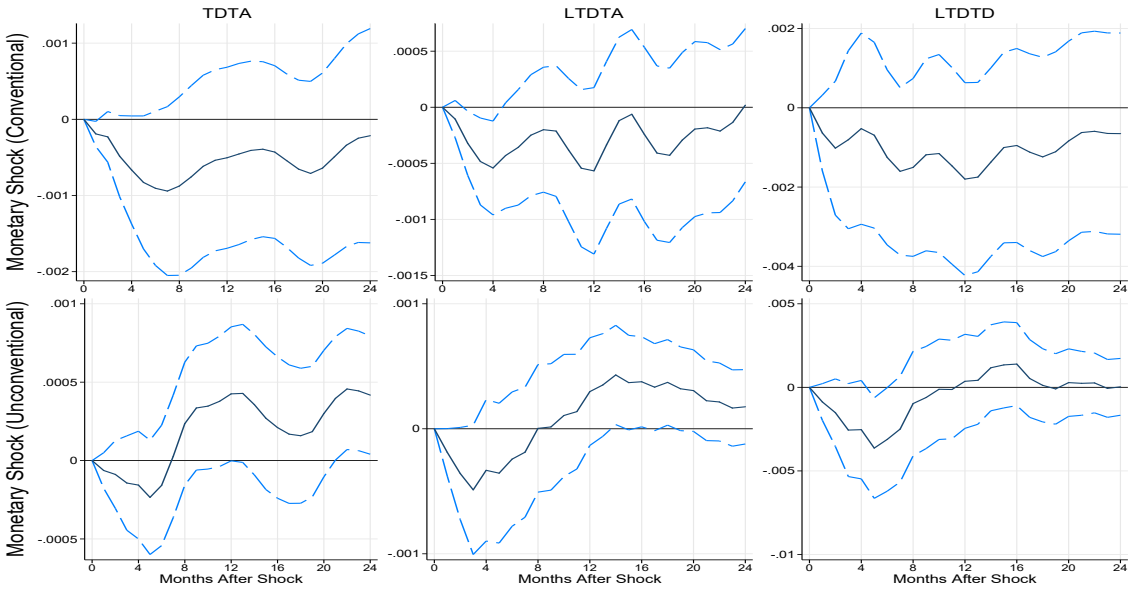
FIGURE 3. IMPULSE RESPONSES IN ITALY



For Italy, the patterns of leverage responses are analogous across the monetary policy schemes. The magnitude of responses tend to be larger during the conventional period than in the unconventional period. There are divergences in the responses of TDTA and LTDTD after 16 months. TDTA rises relatively faster after 16 months from the surprise of conventional policy tightening. However, after 16 months from an unconventional policy shock, the change in TDTA decreases indicating that firms slow down the pace of taking more debt. Similarly, deleveraging LTDTD accelerates after 20 months from a conventional policy shock, whilst deleveraging LTDTD decelerates 16 months after the contractionary unconventional policy shock. LTDTA, on the other hand, decreases from conventional policy shocks and increases from unconventional policy shocks.

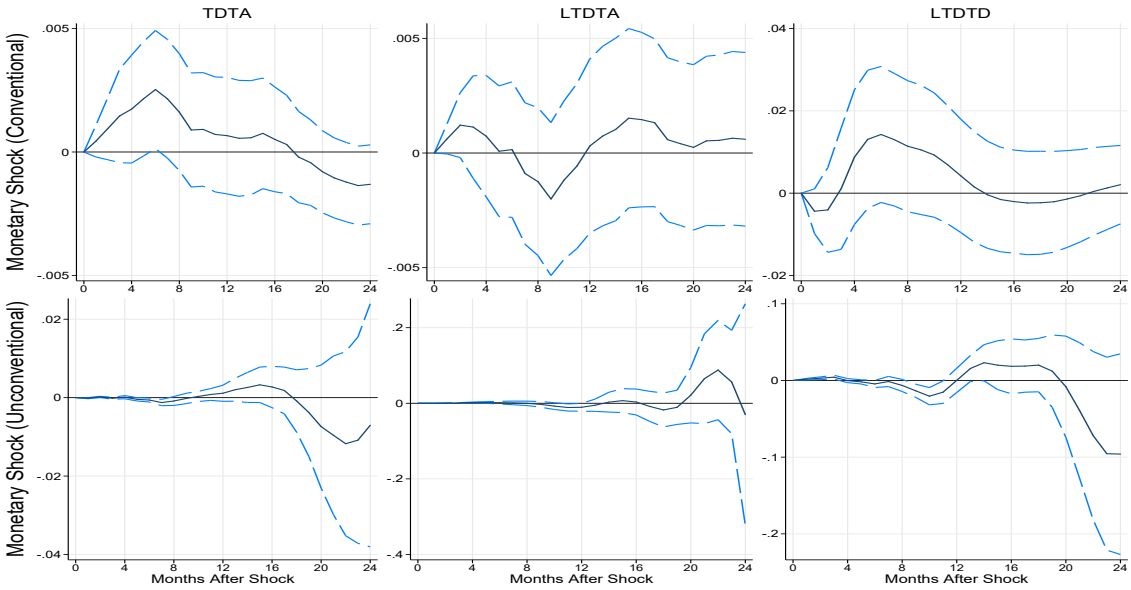
Germany, shares the same monetary policy with France and Italy, hence its figures have been omitted. One point of divergence is the relationship of leverage response to the impact of monetary policy. During the two years after the shock, all three capital structure measures react in the opposite direction. During the conventional periods, TDTA, LTDTA, and LTDTD increase by 0.125 bps, 0.18 bps, and 0.2 bps at their peak, respectively. During the unconventional period, changes in TDTA and LTDTA fluctuate between 0.7 bps, plus or minus, for both leverage ratios. These fluctuations are also reflected in LTDTD. LTD increases by 0.35 bps roughly for three months then decreases by 0.2 bps for 16 months.

Figure 4. Impulse Responses in Japan



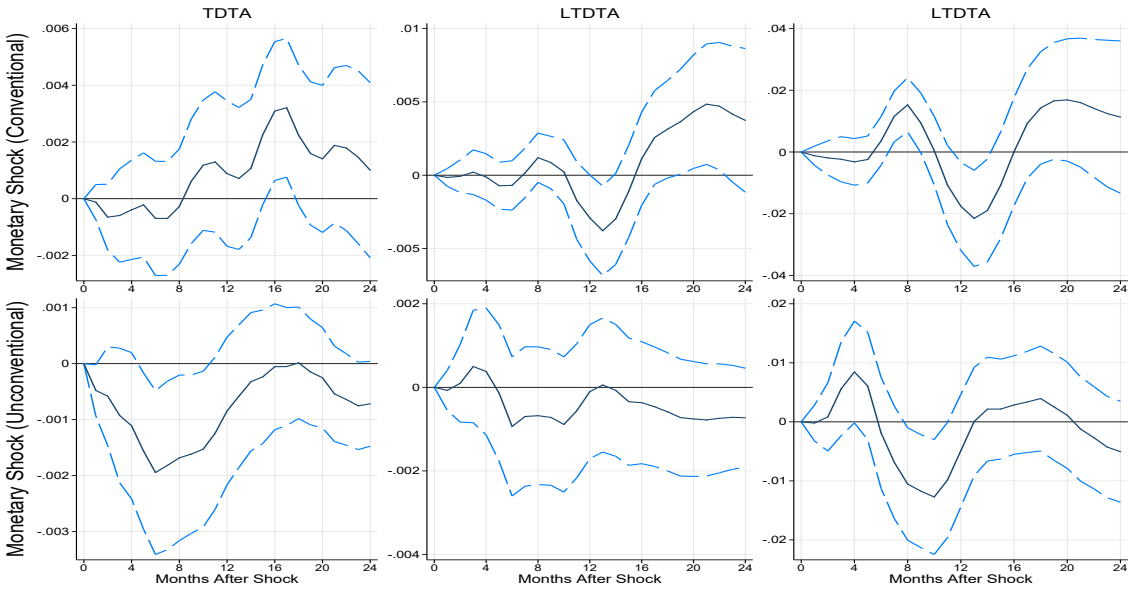
Japan was the front-runner in implementing unconventional monetary policy. The Bank of Japan (BoJ) implemented an unconventional-like policy in 2006 as the country was already struggling with low-interest rates from the "Lost Decades". The response to the global financial crisis was relatively minimal as the BoJ conducted forward guidance and a few asset purchases from 2010 to 2012. From 2013, the BoJ started to employ unconventional policy extensively with a massive scale of asset purchases and introduced yield curve controls (YYC) with negative interest rates (NIR) after central bank reserves. The capital structure responses to CMP shock follow classical economic theory. By tightening the policy rates, firms reduce their debt. The monetary shocks almost fade away in 2 years. Changes in TDTA and LTDTD seem to converge to 0 after 2 years from the shock. On the other hand, the capital structure measures increased 6-12 months after the unconventional policy shock. TDTA declined for the first 7 months by 0.02 bps at the peak then started rising by 0.05 bps. The decrease in LTDTA diminished in 8 months and then continued to rise afterward. The response of LTDTD fluctuates over 20 months.

Figure 5. Impulse Responses in Sweden



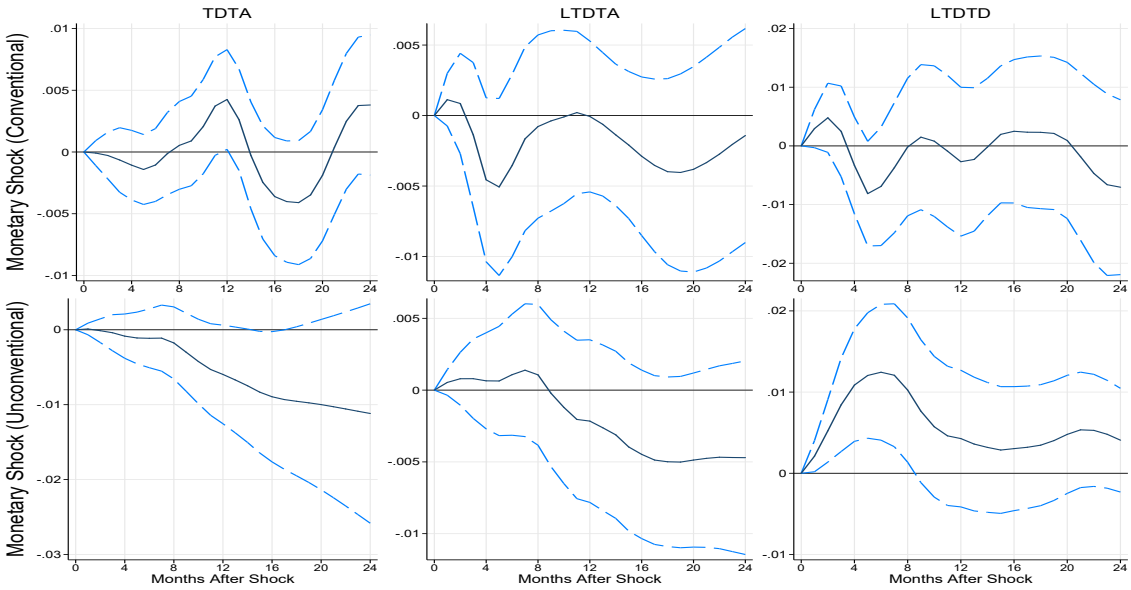
Riksbank, the central bank of Sweden, officially switched their monetary policy from conventional to unconventional in February 2015 [Rezende (2017)]. Riksbank's unconventional monetary policy consists of three programs: forward guidance, quantitative easing and a negative interest rate policy. In the conventional period, TDTA increases in 6 months by 0.25 bps but decreases in 2 years by 0.125 bps. The response from a conventional policy shock fluctuates for LTDTA around ± 0.2 bps and for LTDTD between -0.5 bps and +18 bps. There were no notable responses in capital structure until 8 months after the unconventional policy shock. The dynamism of policy transmission changes with unconventional monetary policy. TDTA reveals a 10 bps decline in almost 2 years after the impulse of unconventional monetary policy. Firms increase their LTDTA by 8 bps in 2 years after UMP shock. LTDTD fluctuates ± 2bps for 14 months after the UMP shock then declines by 10 bps in 2 years. The responses of capital structure measures are significantly larger for unconventional than for conventional policy shocks.

Figure 6. Impulse Responses in Switzerland



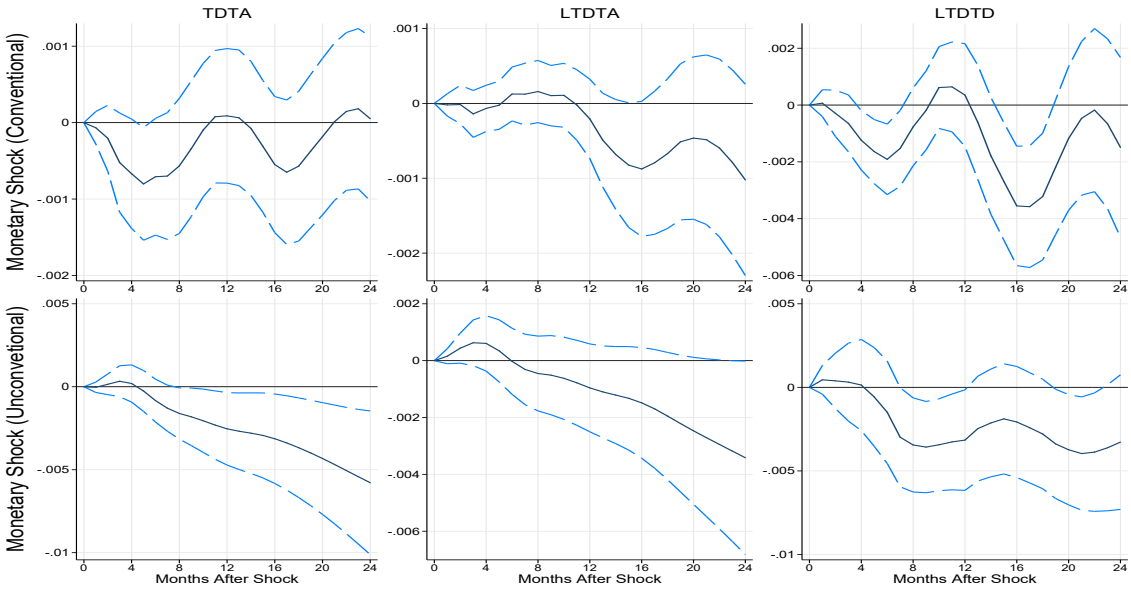
The Swiss National Bank (SNB) announced the introduction of unconventional monetary policy, in September 2011. However, since March 2009, the SNB intervened in foreign exchange markets and commenced a massive-scale foreign currency purchase [Maechler (2016)]. The SNB kept the minimum exchange rate set against the Euro until January 2015 [Jordan (2016)]. At the beginning of 2015, the SNB started charging a negative interest rate of 0.75% to on-site deposits at the central bank. This paper uses the date that the SNB initiated a large-scale foreign currency purchase as the start of the unconventional period. The response of firms' leverage to conventional and unconventional policy shocks follows similar patterns but their magnitude varies across policy schemes. The conventional policy shocks are generally larger than the unconventional policy shocks. TDTA levels decline but go back to pre-shock levels for conventional monetary tightening. However, TDTA continues to decrease even two years after an unconventional policy shock. This is evidence of the long-lasting effect of unconventional monetary policy on TDTA. The same is true for LTDTA, which does not return to the pre-shock level even 2 years after the unconventional policy shock. The effect of monetary policy shocks on a firms capital structure is smaller in the short run but more persistent for unconventional monetary policy.

FIGURE 7. IMPULSE RESPONSES IN THE UK



The literature suggests there were three phases of unconventional monetary policy in the UK [Dell'Ariccia et al. (2018)]. The first stage was the establishment of large-scale quantitative easing programs between 2009 and 2012 to recover from the global financial crisis. The second stage was forward guidance to commit no further policy tightening for 2013-2014. Lastly, there was another round of QE due to concerns about "Brexit." The responses of capital measures were larger and less volatile for unconventional policy shocks than for conventional policy shocks. While there were some recoveries of leverage ratios from the unexpected shock in conventional periods, leverage responses in unconventional periods do not indicate any recovery except in LTDTD. Analogous to Switzerland, unconventional monetary policy effects are long-lasting for both TDTA and LTDTA. The forward guidance signals the future policy rate, hence, there were fewer fluctuations in both TDTA and LTDTA for the unconventional period. The QE might be successful in providing liquidity, but the impulse-response functions during UMP indicate that QE does not act as a buffer to mitigate the impact on firms financing decisions.

Figure 8. Impulse Responses in the US



The Federal Reserve (Fed) reacted to the global financial crisis quicker than any other central bank. The Fed started to implement unconventional monetary policy including quantitative easing and forward guidance in November 2008. The Fed terminated its unconventional policy in late 2014 and since October 2017 their balance sheet has been shrinking as existing securities matured [Kuttner (2018)]. The responses of capital structure for unconventional periods are somewhat similar to the case of the UK. The impulse response may indicate that these two countries experienced analogous unconventional monetary policy effects on firms' capital structure. This result seems reasonable as the US and the UK employed identical unconventional policies and share many common country/institutional factors. In unconventional periods there was a consistent deleveraging of TDTA and LTDTA. LTDTD demonstrates a moderate recovery for certain periods, but the ratio is near 0.5 bps lower than the pre-shock level by the second year following the shock. For unconventional monetary policy shocks, companies in the US were not able to recover from the seemingly persistent unconventional policy effects on their capital structure.

The response of capital structure measures to the conventional and unconventional policy shocks are different in every country. The results indicate that there is a structural change in an economy after unconventional policy is introduced. The cross-country variations in the responses of firm leverage to an unconventional policy shock show that the effects and transmission mechanisms vary depending on the types of unconventional monetary policy (ex. FG,

QE and NIR etc.) and on the country's economic conditions. The gradual, consistent, and persistent responses of capital structure measures to unconventional policy shocks compared to conventional policy shocks might indicate that the intended reactions can be obtained by the successful implementation of unconventional monetary policy. The different impulse responses amongst France, Germany, and Italy despite sharing identical monetary policy shows that country characteristics play an important role in disseminating monetary policy shocks on firm leverage ratios. The analogous patterns of impulse responses during unconventional periods between the UK and the US, albeit with different monetary policies and country characteristics, suggest the possibility that the reaction of firm financing decisions to monetary policies can be managed with unconventional monetary policy.

VI. Conclusion

A rise in the use of unconventional monetary policy changed the dynamic relationship between monetary policy and firm financing decisions. To study this, empirical settings from corporate finance and monetary economics were applied to the firm- and country-level data. The corporate finance approach revealed variation in the effect of unconventional monetary policy on capital structure. This variation can be partially explained by country-, sector-, and firm-specific factors. The unconventional policy effects were significant for large private companies in upper-middle-income countries that did not experience the global financial crisis. Furthermore, classical capital structure theories were applicable and portable across policy schemes, conventional and unconventional. By using SVAR it was determined that the transmission of monetary policy shocks on firm capital structure is different amongst conventional and unconventional periods for each country. There are country specific factors that affect the transmission mechanisms of unconventional monetary policy in the economy. The common attributes in the response of corporate leverage ratios to an unconventional monetary policy shock might reveal that the effects of monetary policy on firm capital structure is better managed with unconventional monetary than conventional monetary policy. Answers are now available for the three questions posed in the introduction: firstly it is clear that the unconventional monetary policy induced higher corporate leverages after the global financial crisis; secondly most of the capital structure theories are still applicable; and thirdly the reactions of firms' financing decisions to unconventional policy shocks are more moderate, constant and long-lasting than to conventional policy shocks.

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APPENDIX

Table A1—Data Summary

	Without Restrictions			With Restrictions		
	Freq.	Percent	Cum.	Freq.	Percent	Cum.
With/ Without GFC shock						
No GFC shock	1,037,200	74.58	74.58	372,378	77.11	77.11
GFC shock	353,600	25.42	100	110,518	22.89	100
Income Classes						
Low	10,530	0.75	0.75	779	0.16	0.16
Lower Middle	201,771	14.33	15.08	47,742	9.89	10.05
Upper Middle	360,045	25.57	40.64	129,088	26.73	36.78
High	835,839	59.36	100	305,287	63.22	100
Company Types						
Holding Company	8,100	0.58	0.58	1,326	0.27	0.27
Joint Venture	567	0.04	0.62	48	0.01	0.28
Non Profit Organization	2,349	0.17	0.78	212	0.04	0.33
Private Company	76,707	5.45	6.23	2,807	0.58	0.91
Public Company	1,253,718	89.03	95.26	463,874	96.06	96.97
Subsidiary	66,744	4.74	100	14,629	3.03	100
Company Sizes						
Small	161,676	11.48	11.48	28,928	5.99	5.99
Medium	159,894	11.35	22.84	38,977	8.07	14.06
Large	1,086,615	77.16	100	414,991	85.94	100

Source: FactSet and World Bank Data Repository

Table A2—Lag Selections

	TDTA		LTDTA		LTDTD	
	Con	Unconv	Con	Unconv	Con	Unconv
Canada	4	2	4	2	2	2
France	8	8	8	8	7	8
Germany	3	8	3	8	7	8
Italy	8	8	8	8	8	8
Japan	8	8	8	6	8	6
Sweden	8	8	8	8	5	8
Switzerland	8	8	8	8	8	8
The United Kingdom	8	8	5	8	8	8
The United States	8	5	8	5	8	7

Note: Lags are selected according to Akaike's and Bayesian information criteria. TDTA is total debt to total assets. LTDTA is long-term debt to total assets. LTDTD is long-term debt to total debt. Con indicates conventional periods. Unconv refers to unconventional periods. Each number represents the number of monthly lags.

Source: Author's calculation