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Inflation, interest rate, and firm efficiency: The impact of policy uncertainty

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ABSTRACT

This study investigates the effect of inflation and interest rate on firm efficiency while exploring the role of policy uncertainty. Not a misnomer, macroeconomic conditions matter, and their impact on business strategy are inherently observed directly or indirectly. Yet, there is still a shortage of literature relating inflation and interest rate through the moderating effect of policy uncertainty on firm efficiency. With 92,293 observations from 12,207 US firms, we find that inflation positively affects firm efficiency, and interest rate negatively affects firms' efficiency. Similarly, the moderating effect of policy uncertainty amplifies the significance of inflation and interest rate. Further examination of the moderating impact finds a positive directionality for both macroeconomic conditions for larger firms, firms that pay dividends, firms with a higher cost of goods and services and higher sales, and firms located in the Midwest region. The results are robust to firm-year fixed effects and clustering approaches.

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1. Introduction

Macroeconomic variables remain ever-present. In financial decisions, interest rates and inflation in economies are ardently followed by strategists to guide their actions and efficiency. To companies, the interwoven relationship between inflation and interest rates lies in its effect on loss of purchasing power, adjustments in prices and cost of production, and the fluctuating borrowing rates in the market. However, there remains a gap in the existing literature on the effects of interest rates and inflation on firm efficiency. We examine these impacts and the moderating effect of policy uncertainty.

"Many find it counterintuitive that the Fed would want to push up inflation... However, persistently too low inflation can pose serious economic risks." ---- Chair Jerome H. Powell, August 2020.

This statement by the Fed's Chairman implies that inflation increases are not too bad a phenomenon. The onus lies in how economic policies and their uncertainty can be of benefit or detrimental to firms. Firms can increase profit in periods of demand-pull inflation by increasing sales – through increases in prices – resulting from increases in consumer demands. Even though the flux increase in profits is temporary, particularly when preceded by a recession. With the rise in sales, firms exhibiting such behavior demonstrate their awareness of efficiently allocating and utilizing resources.

On the contrary, firms that face a decrease in sales and profits may be considered inefficient. According to the liquidity preference theory, Keynes (1936) asserts that the interest rate is a monetary phenomenon determined by investment and

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money supply interaction. On the one hand, higher interest rates mean that firms borrow less money to invest and instead fund little or nothing on growth-inducing ventures. Since projected growth is essential in determining a firm's value, higher interest rates can lead investors to believe that their stocks are worthless. On the other hand, low-interest rates may mean that firms can borrow more to invest, leading investors to think they are more valuable. Hence, changes in interests may affect firms' efficient allocations of resources.

These considerations naturally raise an enduring question of whether or not firm efficiency improves with inflation and interest rate. Prior research focused on the relationship between the aggregate stock market and inflation rates (Asness, 2000; Bekaert & Engstrom, 2010; Campbell & Vuolteenaho, 2004; Flannery & James, 1984; Gultekin, 1983; Moosa, 1980; Tezel, 1982), yet, the results are inconclusive. Less attention is paid to inflation. Inflation and interest rate can affect firms' efficiency levels vastly differently. Firms differ in capital structure, asset composition, and the method of reporting income for tax purposes. These variations cause differential effects of inflation and interest rate on their efficiency levels.

For non-financial and utility US firms, for the years 1990 through 2018, we examine the links between interest rates and inflation on firm efficiency and the moderating effect of policy uncertainty. We find inflation to positively impact firm efficiency and interest rates to impact firms' efficiency negatively. The moderating effect of policy uncertainty moderates both directions. Further analyses show that the moderating effect positively boosts inflation and interest rates for larger firms, firms that pay a dividend, firms with a higher cost of goods and services and higher sales, and firms located in the MidWest region. The results are robust to controlling for firm-year fixed effects and clustering for firms and years.

We contribute to the existing literature in the following ways. First, since economies are constantly exposed to policy uncertainties which firms are no exception to, we show that firms seizing opportunities in times of uncertainties can increase their efficiency. Second, larger firms can better make strategic choices in times of uncertainties and seize opportunities, making them more efficient than smaller firms. We conjecture that smaller firms must be proactive and forward-looking to make strategic decisions and choices that will make them more efficient when faced with policy uncertainties. Wu et al. (2020) argue that smaller firms must invest more in times of policy uncertainties.

Third, we contribute to the expectation theory literature. The expectation theory notes that firms and investors can take advantage of the interest rate changes by studying the market dynamics. Here, the inverse relationship between interest rates and firm efficiency suggests that lower rates improve efficiency. Thus, efficient firms can capitalize on market dynamics.

The rest of the paper is structured as follows: the next section looks at the relevant literature and hypothesis development, a discussion of the data, control variables and estimation/methodology we employ, the main results, and a series of robustness checks, including tests for endogeneity. Finally, we conclude by highlighting the main takeaways and opportunities for future research.

2. Literature review and hypothesis development

2.1. Literature review

This section highlights evidence in the related literature and areas that play a vital role in firm efficiency. Specifically, we group the literature into prior studies on inflation, interest rate and the stock market, and EPU and investment.

2.2. Inflation and stock performance

The extant literature on inflationary periods in developed economies has mainly focused on macroeconomic conditions and policy (e.g., Mishkin, 1984; Smith, 2017). Others examine the impact of inflation accounting (Davis-Friday and Rivera, 2000; Noreen & Sepe, 1981; Shoven et al., 1975; Tweedie & Whittington, 2009), valuation (Sharpe, 2002), and corporate finance (Friedl & Schwetzler, 2011; Kang & Pflueger, 2015). Similarly, the empirical papers on the interest rates and businesses also focus on stock performance (Jammazi et al., 2017; Suhaibu et al., 2017; Tripathi & Seth, 2014).

The impact of expected or unexpected inflation on stock returns reflects other economic factors (Day, 1984; Fama, 1981; Geske & Roll, 1983; Modigliani & Cohn, 1979; Nelson, 1976). In particular, given the apparent negative correlation between inflation and future economic output in historical data, the observed negative relationship between inflation and stock returns is associated with a positive relationship between future economic activity and stock returns. Consequently, causation cannot be attributed to the observed relationship between inflation and stock returns. This evidence highlights the view that inflation positively affects the stock market. Thus, if firms can manage their recourses well and make strategic decisions to inform performance during high inflationary periods, such firms can be more efficient than those impacted negatively by the growing inflation.

Lins and Duncan (1980) documented that inflation has different long-term and short-term effects on a firm's financial performance. They indicated that financial results might not change significantly over the long term. Still, companies in the industry can adapt to those that best deal with volatile earnings and seize growth opportunities. Hong (1977) asserts that inflation affects the transfer of wealth between different economic sectors of businesses, households, government, interest rates, and tax policies. If inflation affects corporate profits, these transfers are due to a general price change beyond nom-

inal appreciation. Without the distortions caused by these transfers, the classical theory of macroeconomic equilibrium would require that capital's nominal values rise as quickly as the price level.

Mishkin (2007) notes that when inflation is high, it is suboptimal for a company to invest in additional facilities and equipment. Although both goals are closely linked, policies can target economic growth by directly encouraging companies to invest or encouraging individuals to save to provide firms with more capital. This approach is the stated purpose of supply-side economic policies, aiming to stimulate economic growth by providing tax incentives for companies to invest in facilities and equipment and for taxpayers to save more.

Pidun and Stelter (2010) indicate that inflation rates may reduce the real burden on the debt service and, at the point of rising prices, lead to higher wages, thus increasing disposable income. This result may lead to efficient capital allocation and thus increase firms' efficiency levels. Based on the preceding argument, the most susceptible to inflation will be those firms that cannot efficiently utilize their resources by making strategic decisions and choices to raise prices faster than the inflation rate.

2.3. Interest rate

Interest rate stability is necessary because variations in the rates can create uncertainty in the economy and make it difficult to plan for the future. For instance, fluctuations in interest rates affect consumers' readiness to do business and buy a house. Rising interest rates cause significant capital losses in a company's short-term and long-term investments (Mishkin, 2007). Hence, a higher interest rate increases the real cost of capital and reduces private investment, leading to an inefficient allocation of resources.

An increase in the interest rate's overall effect reduces the money in circulation, keeping the inflation rate low (Saunders & Cornett, 2012). Consequently, lowering interest rates means lowering investment costs, which stimulates investment and increases overall investment, raising firms' efficiency. Lutz (1945) asserts that those at the forefront of making investment decisions deny that interest rate has any role.

Gopinath et al. (2017) show a rapid decline in the real interest rate and capital allocation efficiency in Southern European countries. Breugem et al. (2019) examined how interest rates affect the information on the financial market. They demonstrated how rational investors use the information on interest rates to learn about the stock market's basic principles. They conclude that a higher interest rate reduces the importance of the (noisy) bond supply in the bond clearing mode, thus reducing the signal noise in the bond market.

2.4. EPU and investment

Pástor and Veronesi (2012) define political uncertainty as trepidation about the government's future actions. Bernanke (1983) asserts a delay in investments if uncertainty leads to changes in expected cash flows. Pástor and Veronesi (2012) and Kelly et al. (2016) demonstrate that political uncertainty can lead to higher risk premiums. Likewise, Jens (2017) argues that companies will delay investment until an election if political uncertainty changes the possible return risks or expectations. Bloom et al. (2007) and Bloom (2009) note that these efforts are essential because the uncertainty in perceived economic policies can change market participants' and goods' behavior.

During periods of high uncertainty, companies, consumers, and investors tend to suspend their spending and stop their investment decisions, which slows down the economy (Tandoh et al., 2021). In such circumstances, Bernanke (1983) suggests that companies also suspend employment, which is likely to exacerbate the negative impact of uncertainty on the economy, leading to further economic downturn. Aizenman and Marion (1993), Julio and Yook (2012), and Wang et al. (2014) argue that existing literature provides ample evidence on how economic policy uncertainty can weaken economic development by reducing investment. Yet, there is a gap in the literature that looks at how inflation and interest rates and the moderating effect of policy uncertainty affect firms' efficiency.

2.5. Hypothesis development

2.5.1. Inflation

Kessel (1956) postulates three independent chains of reasoning on how firms benefit from inflation. First, debtors earn from inflation and the assumption that firms are debtors. Entrepreneurs commit to paying fixed dollar obligations in bonds or other debt instruments. Therefore, the amortization of the real value of monetary bonds, which is to the detriment of creditors, is companies' profit. Thus, explaining why companies earn in inflation and the redistribution of wealth. For instance, assuming that the volume of debt and the number of shares outstanding are left unchanged, doubling the price level would mean tripling the value of the stock. If a company has arrears, its capital value will increase in inflationary periods.

Second, inflation causes wages to lag behind prices. This delay in wage-to-price rates is the redistribution of workers' incomes to owners of capital. Lastly, firms make gains by carrying inventories during inflation. These inventories' selling prices are based on current rather than the purchasing prices. Hence, businesses are highly profitable when prices rise.

Thus, firms can allocate resources efficiently and make strategic choices to raise sales, profits, and firm value during an inflationary period. Based on this disposition, we summarize these views, stating the beneficial impact of inflation on the level of firm efficiency.

Hypothesis 1: An increase in inflation increases the level of firm efficiency.

2.5.2. Interest rate

Changes in interest rates have an enormous impact on firm value. For instance, an increase in the effective discount rate after taxes resulting from increases in interest rate will lower its value. If an increase in the discount rate raises fears of a recession or increases the risk premium, the decline in a firm's value will intensify. Therefore, the rising interest rate may reduce firms' efficiently allocating of resources and making tactical choices to gain competitively. Hence, based on this outlook, we summarize the obstructive impact of interest rates on firm efficiency.

Hypothesis 2: All else held constant, an increase in interest rate will reduce a firm's efficiency.

2.5.3. Moderating influences

Thus far, we argue that inflation positively impacts firm efficiency and interest rate negatively impacts firm efficiency, implying that firms are less efficient when there are high-interest rates but efficient with high inflationary pressures. Here, we explore a blended approach in which inflation and interest rates interact with policy uncertainty to affect efficiency. As the business environment evolves, managers' survival demands drive them to optimize the operating structure's efficiency and stand out from the competition (Cheng, 2019). Hence, firms affected by policy uncertainty may tend to be more strategic and tactical to remain competitive and derive more from market pressures.

For instance, prior evidence shows EPU adversely reduces corporate risk-taking (Wen et al., 2021) through firm-risk decision-making (Nguyen & Phan, 2017). Also, policy uncertainty affects the financial system through interest rate, credit provision, and cost of debt (e.g., Ashraf & Shen, 2019; Berger et al., 2020; Liu & Zhong, 2017). Akey and Lewellen (2017) argue that firms' risk appetite depends on the sensitivity of such firms to policy uncertainty, and the degree of their risk-taking depends on the gain or loss of political affiliation.

Other evidence from the effect of policy uncertainty shows that EPU concerns tend to increase investors and regulators' attention (e.g., Loh & Stulz, 2018; Andrei et al., 2021) and is associated with lower earnings management (e.g., Kim & Yasuda, 2021). Hartzmark (2016) indicates that uncertainty and interest rate are fundamental macroeconomic variables that need to be studied together, given their wide-economic impact. It is challenging to examine the effect of uncertainty on economic outcomes alone cleanly.

Therefore, we argue that policy uncertainty will moderate the effect of inflation and interest rate on firms' efficiency. Specifically, we test the following hypothesis:

Hypothesis 3a: Policy uncertainty will moderate the positive effect of inflation on firm efficiency.

Hypothesis 3b: Policy uncertainty will moderate the negative effect of interest rate on firm efficiency.

3. Data and methodology

The primary data sources are COMPUSTAT, CBOE Volatility Index, Federal Reserve Bank, the University of Michigan Survey of Consumers, and Baker et al. (2016) database- www.policyuncertainty.com. The data sample period is 1990 through 2018. Following previous research, we exclude financial firms (SIC 6000–6999) and regulated utilities (SIC 4900–4999), whose capital decisions may reflect unique factors. Afterward, we eliminate duplicates. These exclusions leave us with 12,207 firms and 92,293 firm-year observations. Table 1 summarizes data sources for the firm and economic characteristics variables.

3.1. Dependent Variable: Firm efficiency measure

We construct our measure of firm efficiency (FE) by adopting Demerjian et al. (2012) Data Envelopment Analysis (DEA) methodology. The DEA evaluates a firm's profitability by setting a practical limit based on the level and mix of resources used to produce a product (Trip et al., 2002). We use DEA to compare the sales revenue of each company against a set of benchmarks. This approach compares the sales revenue generated by each firm to a group of inputs, namely the *Net Property, Plant, and Equipment (PP&E); Net Operating Leases; Net R&D; Purchased Goodwill; Other Intangible Assets; Cost of Inventory; and Selling, General, and Administrative Expenses (SG&A).*

In times of uncertainty, efficient firms should understand industry trends, make strategic and tactical decisions than inefficient firms, reliably predict product demand, invest in higher-value projects, and manage their employees more efficiently and effectively. In short, we expect efficient firms to generate higher returns for a given level of resources or, conversely, minimize the resources used for a given level of income.

Thus, we establish effective boundaries by measuring the amount and combination of resources that firms in each industry use to generate revenue. The DEA method (Banker et al., 1984; Charnes et al., 1978; Liu et al., 2013) is exceptionally robust and helpful. To measure efficiency, DEA is used across several disciplines. For instance, Murthi et al. (1996) use DEA analysis to assess marketing performance. Leverty and Grace (2012) apply DEA to test the relative performance of insurance companies. Hermoso-Orzáez et al. (2020) test environmental efficiency by adopting the DEA methodology.

Table 1
Variable Definition and Source.

Name	Definition	Data Source
FE	Firm Efficiency – FE is derived based on Demerjina et al. (2012) methodology. We estimate efficiency using the DEA methodology.	Compustat
ROA	Total asset – ni/at	Compustat
AT	Total assets – at	Compustat
LEV	Leverage - (dltt + dlc)/at	Compustat
DIV	Dividend, a dummy variable = 1 if the firm made a dividend payment and 0 otherwise.	Compustat
TQ	Tobin's Q – (at + (csho*prcc_f)-ceq)/at	Compustat
EPU	Economic policy uncertainty	Economic Policy Uncertainty - Baker et al., 2016
VIX	Chicago Board Options Exchange (CBOE) Volatility Index	Federal Reserve Bank of St. Louis
RGDP	real GDP	Federal Reserve Bank of St. Louis
CC	Current Economic Conditions	Surveys of consumers: University of Michigan
CS	Index of Consumer Sentiment	Surveys of consumers: University of Michigan
CE	Index of Consumer Expectations	Surveys of consumers: University of Michigan
FFR	Effective Federal Funds Rate	Federal Reserve Bank of St. Louis
TB	3-Month Treasury Constant Maturity Rate	Federal Reserve Bank of St. Louis
CPI Core	Consumer Price Index for All Urban Consumers: All Items Less Food & Energy	Federal Reserve Bank of St. Louis
CPI	Consumer Price Index for All Urban Consumers: All Items in the U.S.	Federal Reserve Bank of St. Louis

Note: Table 1 describes the variables used and the data sources for this study.

3.2. Focal independent variables: Economic policy uncertainty, inflation, and interest rate

We use the EPU data by Baker et al. (2016). This EPU data differs from previous uncertainty measures such as volatility index (VIX), stock market volatility, geopolitical risks, economic growth, and political risks. It examines the frequency of newspaper articles that contain terms related to economics, politics, and uncertainty.

The Consumer Price Index (CPI) is our inflation indicator. It shows the inclination or progression of the average price of a basket of goods and services representing the actual consumption of a household. In the United States, the most commonly used general price statistic is CPI. CPI appears to be the subject of monetary policy debate and an indicator of inflation in the existing literature (Blundell et al., 2020). We use the CPI called the All-Items Consumer Price Index for All Urban Consumers. The Bureau of Labor Statistics reports that this index is the broadest form of CPI. Also, for robustness, since food and energy is the underlying driver of inflation, we utilize the All-Items Consumer Price Index for All Urban Consumers less food and energy prices as a proxy for our robustness check.

The Federal fund rate (FFR) is our interest rate variable. FFR and expectations about its trend measure broader credit conditions in the economy (Banegas & Tase, 2020). By influencing funding conditions, FFR has historically been an important monetary policy tool for the Fed to fulfill its twofold role of achieving price stability and employment. Because the Federal Reserve sets targets for federal funds, it is essential to understand the dynamics of reserves and the market for federal funds to plan and implement monetary policy. The FFR serves as our proxy for interest rate, and it has been used widely in the literature as a measure of interest rate (Ajello et al., 2020; Anbil et al., 2020; Banegas & Tase, 2020; Ostapenko, 2020). We also utilize the 3-Month Treasury Bill rate (TB) as an alternative proxy.

3.3. Control Variables:

We include firm and economic characteristics associated with firm efficiency as control variables in our model to reduce the possibility that inflation, interest rate, and EPU capture the effect of these characteristics on firm efficiency. In Particular, we control for the natural logarithm of the following: ROA, AT, TQ, RGDP, CC, CS, and CE, except LEV, which is winsorized at the 1st and the 99th level, and VIX, which is also based on its real values. Table 1 contains the definition and sources for the variables.

3.4. Empirical firm fixed model

The model tested in this study is specified below:

$$FE_{it} = \phi + \beta_1 FFR_t + \beta_2 Ln(CPI_t) + \beta_3 Ln(EPU_t) + \gamma(Ln(FFR_t) \times Ln(EPU_t)) + \psi(Ln(CPI_t) \times Ln(EPU_t)) + \Theta\eta_{it} + \alpha_i + \tau_i + \mu_{it} \quad (1)$$

where i index firms and t indexes time, η_{it} represents potential controls included in the model, Θ is a vector of parameters for the included control variables, α_i are firm fixed effects that capture heterogeneities across firms, τ_i are year fixed effects that control for any aggregate fluctuations of, and μ_{it} is the error term.

4. Results and discussion

4.1. Summary statistics

We present the summary statistics and the correlation matrix in Tables 2 and 3. The statistics include the sample size, mean, standard deviation, maximum and minimum observations, the 25th, 75th percentile, and the median. The dependent variable, firm efficiency (FE), has a mean (standard deviation) value of 0.34 (0.165), indicating that, on average, the firms in our sample are moderately efficient at about 34 % level. A breakdown of efficiency levels based on industries is presented in Appendix A.

The Federal funds rate (FFR) values are 3.204 (2.336). Per the standard deviation, since borrowing rates across banks seems high, banks lending rates to firms will equally be high. Inflation (CPI) values are 186.942 (35.079), suggesting that consumer prices on average are high in the sample period. Policy uncertainty values are 109.716 (28.620) implies that uncertainty remains high on average in the sample period. These statistics are not surprising because the sample period includes major financial and economic crises (e.g., the 9/11 attack, the 2007/2008 financial crisis, etc.).

4.2. Main regression results

We minimize skewness in the sample by transforming all variables except interest rate proxy (FFR) and the control variable volatility (VIX) in the regression models into log values. The results employ the empirical model specified in equation (1). We incorporate the fixed effects and clustering methods to minimize errors within and between the sample groups for additional controls. Table 4 reports the primary regression models. All focal variables maintain their directionality and are statistically significant at a 1 % level.

Columns 1 and 2 examine interest rate (FFR) and inflation (CPI) on firm efficiency. The results from both columns confirm the first two testable hypotheses. Given the consistency of the outputs and adherence to their directionality in the correlation matrix, from column 1, we interpret that a unit increase in FFR reduces firm efficiency by 1.2 %. Similarly, for every 1 % increase in CPI, firm efficiency increases by about 16.9 %.

In column 3, we introduced the policy uncertainty (EPU) variable. The result shows that the elevation of EPU impedes firm efficiency. However, our interest in EPU is its moderating effect on FFR and CPI in column 4. For the moderating effect, we generate a dummy variable based on the median value of EPU, where one denotes high EPU and zero otherwise. The dummy variable (HighEPU) interacts with the continuous variables FFR and CPI.

The interaction term suggests that EPU positively moderates the effect of CPI on firm efficiency. Instead of the coefficient to be 0.834, it is 0.838 (0.834 + 0.004). EPU also moderates the inverse association between FFR and firm efficiency. The coefficient reduces from −0.015 to −0.013 (-0.015 + 0.002). Because EPU moderates the inverse association of lending rates, efficient firms can become strategic and opportunistic in borrowing. The moderation of the positive effect of CPI suggests that firms can become strategic and address underlying factors to allocate their resources efficiently. These results support hypotheses 3a and 3b. Thus, efficient firms can take advantage of policy uncertainties. Although not shown, the evidence is robust for examining firm efficiency from a three-year lag and three-year lead estimations.

Table 2
Summary Statistics.

	N	Mean	Std. Dev.	Min	p25	Median	p75	Max
FE	92293	0.340	0.165	0.104	0.238	0.290	0.382	1.000
ROA	92293	0.076	0.069	0.001	0.031	0.059	0.098	0.416
SIZE	92293	5.889	2.244	0.923	4.292	5.809	7.427	11.295
LEV	92293	0.215	0.193	0.000	0.033	0.188	0.334	0.855
DIV	92293	0.028	0.059	0.000	0.000	0.000	0.031	0.385
TQ	92293	1.946	1.376	0.585	1.132	1.509	2.217	8.921
EPU	92293	109.716	28.620	67.136	83.186	108.189	137.961	157.977
VIX	92293	19.224	5.679	11.090	14.180	17.540	23.320	32.690
RGDP	92293	13620.877	2687.468	9355.355	11031.350	13493.065	15626.030	18687.785
CC	92293	100.236	12.029	69.600	97.200	105.100	106.200	116.000
CS	92293	88.211	11.469	63.700	81.600	89.200	95.200	107.600
CE	92293	80.475	11.616	57.300	70.700	81.900	86.500	102.700
FFR	92293	3.204	2.336	0.090	1.000	3.530	5.300	8.110
TB	92293	3.068	2.255	0.030	0.950	3.480	4.920	7.750
CPI Core	92293	193.345	33.271	135.458	165.558	190.442	221.336	257.563
CPI	92293	186.942	35.079	130.658	156.858	179.867	218.076	251.101

Table 3
Correlation Matrix.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) FE	1.000															
(2) ROA	0.130*	1.000														
(3) SIZE	0.495*	−0.168*	1.000													
(4) LEV	−0.022*	−0.208*	0.223*	1.000												
(5) DIV	0.130*	0.225*	0.136*	−0.011*	1.000											
(6) TQ	0.214*	0.437*	−0.081*	−0.179*	0.137*	1.000										
(7) EPU	0.065*	−0.008	0.154*	0.024*	0.054*	−0.058*	1.000									
(8) VIX	0.000	0.004	−0.007	−0.001	−0.039*	−0.067*	0.355*	1.000								
(9) RGDP	0.138*	0.033*	0.330*	0.013*	0.099*	0.028*	0.416*	−0.008	1.000							
(10) CC	−0.022*	−0.008	−0.062*	0.049*	−0.051*	0.071*	−0.537*	−0.347*	−0.131*	1.000						
(11) CS	−0.021*	−0.010*	−0.074*	0.047*	−0.068*	0.065*	−0.494*	−0.160*	−0.163*	0.960*	1.000					
(12) CE	−0.018*	−0.011*	−0.079*	0.044*	−0.077*	0.058*	−0.444*	−0.028*	−0.176*	0.892*	0.983*	1.000				
(13) FFR	−0.126*	−0.010*	−0.251*	0.010*	−0.084*	−0.001	−0.601*	−0.003	−0.726*	0.499*	0.471*	0.431*	1.000			
(14) TB	−0.128*	−0.011*	−0.256*	0.009*	−0.085*	0.000	−0.618*	−0.043*	−0.743*	0.512*	0.480*	0.438*	0.997*	1.000		
(15) CPI Core	0.146*	0.029*	0.331*	0.015*	0.103*	0.025*	0.465*	−0.021*	0.991*	−0.176*	−0.201*	−0.208*	−0.774*	−0.788*	1.000	
(16) CPI	0.143*	0.030*	0.332*	0.012*	0.108*	0.021*	0.475*	−0.023*	0.986*	−0.228*	−0.260*	−0.269*	−0.779*	−0.794*	0.997*	1.000

*$p < 0.01$.
Note: Tables 2 and 3 present the summary statistics and the correlation matrix. The dependent variable is FE. The independent variables are FFR and CPI. TB and CPI Core are alternative proxies for our independent variables. We include both firm and economic variables known to affect firm efficiency. The variable definitions and sources are in Table 1. All variables reported in Tables 2 and 3 are winsorized at the 1st and 99th percentile.

Table 4
We document that interest rates and inflation impact firm efficiency. Also, policy uncertainty amplifies the effect of interest rates and inflation.

Dependent Variable $=FE_{it}$				
Variable	(1)	(2)	(3)	(4)
FFR	−0.012***		−0.014***	−0.015***
	(0.000)		(0.001)	(0.001)
Ln(CPI)		0.169***	0.773***	0.834***
		(0.007)	(0.076)	(0.080)
Ln(EPU)			−0.035***	−0.089***
			(0.005)	(0.008)
HighEPU* Ln(CPI)				0.004***
				(0.001)
HighEPU*FFR				0.002**
				(0.001)
VIX			0.003***	0.003***
			(0.000)	(0.000)
Ln(RGDP)			−0.963***	−1.011***
			(0.068)	(0.071)
Ln(CC)			−2.356***	−2.132***
			(0.580)	(0.561)
Ln(CS)			5.289***	4.732***
			(1.324)	(1.275)
Ln(CE)			−2.678***	−2.339***
			(0.739)	(0.709)
Ln(ROA)			0.036***	0.037***
			(0.002)	(0.002)
Ln(AT)			0.105***	0.105***
			(0.003)	(0.004)
w(LEV)			−0.037**	−0.038**
			(0.015)	(0.015)
Ln(TQ)			0.085***	0.084***
			(0.004)	(0.004)
Constant	−1.135***	−2.053***	2.460***	2.824***
	(0.002)	(0.034)	(0.226)	(0.238)
Observations	92,293	92,293	90,256	90,256
R-squared	0.009	0.008	0.702	0.702
Number of Firms	12,207	12,207	10,490	10,490
Firm & Year FE	YES	YES	YES	YES

Standard errors in parentheses.
*** p < 0.01, ** p < 0.05, * p < 0.1.
Note: Table 4 presents our main results. We take the natural logarithm of all our variables except FFR, VIX, and LEV to prevent skewness. The dependent variable is FE. The independent variables are Ln(CPI) and FFR. Ln(EPU) is the moderating variable. In columns 1 and 2, we perform a fixed effect regression without controlling for any covariates. In columns 3 and 4, we adopt Correia's (2015) reghdfe package to cluster and perform a fixed effect simultaneously. The sample size is 92,293 for 12,207 U.S. firms. 2037 singleton observations were dropped when we used the reghdfe package.

4.3. Robustness checks

4.3.1. Using different proxies for inflation and interest rate and a quantile regression model

Potential misspecification and collinearity may exist between the variables in Table 4. To minimize concerns, we perform several robustness tests. First, we run alternative regression models with different interest rates and inflation proxies. The proxy variable used for the interest rate is the three-month treasury bill (TB) rate. Sarno and Thornton (2003) stipulate that scholars mostly use TB to substitute for the risk-free asset that many traditional finance theories assume. We use the *Consumer Pon proxiesrice Index for All Urban Consumers: All-Items Less Food & Energy* (CPI Core) as our alternative measure for inflation. By adopting CPI Core, we minimize the influence of volatile prices in the two sectors – food and energy. Column 1 in Table 5 shows the results of the alternative proxies. The directionality and significance of the coefficients are similar to column 4 in Table 4.

Second, to minimize the effect of outliers and influential variables that may impact the results when estimating the average firm efficiency, we employ quantile regression at the 25th and the 75th quantile of firm efficiency. Columns 2 and 3 in Table 5 show the results. Firms at the 25th percentile are more sensitive to EPU moderating effect. The directionality documented in Table 4 remains. However, the amplification of EPU to FFR and CPI is evident between the two quartiles.

The results are robust to additional tests presented in Appendix B. Particularly, by utilizing a dynamic estimation (Arellano-Bond system GMM) and two-stage least squares (2SLS) to alleviate endogeneity concerns, the results still hold in quantitative terms, directionality, and significance.

Table 5
Alternative proxies for interest rates and inflation do not distort the results. Also, the impacts are more pronounced at different efficiency levels.

Dependent Variable = FE_{it}			
	(1)	(2)	(3)
Variable		25th Quant	75th Quant
TB	−0.015***		
	(0.001)		
Ln(CPI Core)	1.597***		
	(0.087)		
Ln(EPU)	−0.109***	−0.149***	0.030**
	(0.008)	(0.011)	(0.015)
HighEPU*TB	0.005***		
	(0.001)		
HighEPU* Ln(CPI Core)	0.002***		
	(0.001)		
VIX	0.004***	0.004***	0.005***
	(0.000)	(0.000)	(0.001)
Ln(RGDP)	−1.566***	−1.080***	−1.053***
	(0.069)	(0.051)	(0.072)
Ln(CC)	−3.654***	1.494**	−6.936***
	(0.542)	(0.761)	(0.964)
Ln(CS)	8.445***	−3.385*	15.901***
	(1.229)	(1.733)	(2.187)
Ln(CE)	−4.560***	2.157**	−8.709***
	(0.685)	(0.968)	(1.220)
Ln(ROA)	0.037***	0.033***	0.035***
	(0.002)	(0.001)	(0.002)
Ln(TA)	0.104***	0.074***	0.118***
	(0.003)	(0.001)	(0.001)
w(LEV)	−0.039***	−0.242***	−0.266***
	(0.015)	(0.007)	(0.009)
Ln(TQ)	0.083***	0.122***	0.159***
	(0.004)	(0.002)	(0.003)
FFR		−0.014***	−0.016***
		(0.001)	(0.002)
Ln(CPI)		1.006***	0.867***
		(0.056)	(0.082)
HighEPU*FFR		0.005***	0.000
		(0.001)	(0.002)
HighEPU* Ln(CPI)		0.007***	−0.003*
		(0.001)	(0.002)
Constant	4.261***	2.745***	2.647***
	(0.224)	(0.185)	(0.246)
Observations	87,910	89,878	89,878
R-squared	0.705		
Number of Firms	10,239		
Firm & Year FE	YES	YES	YES

Standard errors in parentheses.
*** p < 0.01, ** p < 0.05, * p < 0.1.
Table 5 uses alternative proxies for inflation and interest rates in column 1. In particular, we use TB as a proxy for FFR and Ln(CPI Core) as a proxy for Ln(CPI). Also, we present quantile regression models in Columns 2 and 3. This model uses the 25th and 75th percentile of FE. All models show that interest rates and inflation impact firms' efficiency.

4.4. Evidence using inflation for different geographic regions

We believe that the geographic distribution, in order words, dispersion of inflation, is necessary to examine the inflation effect on firm efficiency. One reason for this is the low integration of labor and credit markets. Krugman (2014) indicates that assets and liabilities can be held and stored over a broader spectrum. However, the appropriate deflector of a nominal debt will be location-specific for a household, justifying the need for a regional-specific inflation study. Cecchetti et al. (2002) find significant and unrelenting differences in inflation in the US's metropolitan areas. Beck & Weber (2005) finds a similar disproportion across countries.

Hence, we collect three additional variables for inflation. First, we use CPI data for All Urban Consumers for the four geographic regions: Northeast (NE), Midwest (MW), South, and West, to assess whether inflation reported for the geographic areas could retain or reverse the earlier evidence. Second, CPI data for *Urban Wage Earners and Clerical Workers* (CPI WC). CPI WC measures the spending patterns of workers across the US. CPI WC is estimated as the average change in the prices

paid by urban wage earners and clerical workers (Bureau of Labor Statistics). Third, we include the Producer Price Index (PPI) to capture the average change over time in domestic producers' selling prices for their outputs. These different inflation measures allow us to intuitively validate an unbiased effect of inflation on firm efficiency. All data are from the Bureau of Labor Statistics. Appendix C contains the summary statistics of these variables.

Table 6 presents the results. Like in subsequent tables, we incorporate the fixed effects and clustering methods to minimize errors within and between the sample groups. Columns 1 and 2 include the findings for the *Urban Wage Earners and Clerical Workers* (LnCPI WC) and the Producer Price Index (LnPPI), respectively. Columns 3 to 6 include the different geographic CPI proxies. The results are statistically significant and with the hypothesized directionality. The results reveal that inflation from the MidWest has a higher effect on firm efficiency.

Table 6 validates the results and affirms that inflation impacts firm efficiency as it is not limited to one measure of CPI proxy. Thus, consumers, producers, a particular class of workers, and geographic regions impact the level of firm efficiency. The effect affirms that firms can take advantage of the market during high inflation periods by making strategic choices. Hence, confirms Kessel's (1956) postulation that firms gain through inflation.

4.5. Constrained versus unconstrained firms

We reexamine the testable question using constraint proxies. By constraint, we examine firms' ability to raise external financing needs. The literature utilizes several constraint proxies, comprising firm size, low dividends, the Cleary (1999) index, the Whited and Wu (2006) index, and the Kaplan and Zingales (1997) index. We use firm size and dividend payout as our proxies for financial constraints.

Fazzari et al. (1988) and Hennessy and Whited (2007) use dividend payments as an indicator of external financing because low-dividend-rate firms have little to no internal liquidity to fund investments. Hence, they resort to external resources. Fazzari et al. (1988) note that companies with lower dividend payout rates are more susceptible to liquidity constraints than companies with higher and regular dividend payout rates. We conjecture that constrained firms are less efficient in times of high inflation, interest rates, and economic uncertainty.

Also, we adopt similar methods by Gilchrist and Himmelberg (1995) and Almeida et al. (2004) to classify firms as constrained and unconstrained firms. Firms are ranked and assigned to the groups using the median value in the sample by asset size. The argument for size as an observable indicator of financial constraints is that small business tends to be younger and less well-known and, therefore, more susceptible to capital market failures.

Constrained firms can make precautionary savings to reduce their capital requirements. However, such a strategy weakens its investment activity in volatile times, reducing efficiency. Table 7 presents the results. The first two columns identify firms based on firm size. Columns 3 and 4 depict constrained based on paid dividends. The results are statistically significant and consistent. The results show that constrained firms are less efficient in making strategic choices to affect their capital adjustments when faced with high policy uncertainty. There is no difference in the inflation coefficient for small firms in high and low policy uncertainty by size. The coefficient is −0.539, which suggests that inflation impedes firm efficiency.

In contrast, unconstrained firms are more efficient. These firms can make strategic, tactical decisions and make capital adjustments. By size, the coefficient for large firms is 1.79 (1.782 + 0.009) for inflations effect on firm efficiency. The coefficient is −0.03 (-0.017 + 0.014) for interest rates. The results indicate that constrained firms benefit less from inflation than unconstrained firms. However, constrained firms can take advantage of the opportunity offered through interest rates.

4.6. Demand-Pull versus Cost-Push effect on firm efficiency

In this section, we create two sub-samples. First is the cost-pull sample, where we examine the direct cost of goods' influence on firm efficiency. The second is the demand-side, where we test if sales are an impetus to increasing efficiency. By default, our efficiency proxy uses a frontier estimation technique with inputs like the cost of goods sold and sales as the output. Thus, the efficiency estimates already incorporate these two central financial statement variables. Here, the empirical tests if both or neither drive efficiency. To empirically test, we create four sample panels with a high versus low using the median values of costs of goods sold and sales as the separator.

Table 8 presents the regression results. Both the direct cost of goods and sales impact firm efficiency. Columns 1 and 2 highlight the supply side. Columns 3 and 4 show the sales results. The results retain the significance and directionality of inflation (CPI) and interest rate (FFR). The moderating effect of EPU on interest rate reveals a contrast between the low and high cost of goods firms. For the low cost of goods firms, a reduction in FFR increases efficiency. The coefficient is −0.018 (-0.011–0.007). Whereas, for the high cost of goods firms, a decrease in FFR reduces efficiency. Thus, a puzzle warranting feature examination on corporate leadership characteristics, location, and external mechanisms.

As for inflation, the evidence reveals that inflation positively impacts low and high sales firms. Similar evidence is shown for high and low costs of goods firms. However, the magnitude is more significant for the high costs of goods and high sales firms. In comparison, the effect of inflation on the cost-push side is higher than on the demand-pull side. The results indicate that firms that incur more costs in the production process and increase sales during high uncertainty periods are more efficient. Thus, demand and cost matter to firm efficiency, as efficient firms can better allocate resources and make strategic decisions.

Table 6
The result holds by examining geographical inflation and producer price index as alternative proxies.

Dependent Variable $=FE_{it}$						
Variable	(1)	(2)	(3)	(4)	(5)	(6)
FFR	−0.015***	−0.015***	−0.014***	−0.014***	−0.015***	−0.015***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Ln(CPI WC)	0.637***					
	(0.074)					
Ln(EPU)	−0.087***	−0.116***	−0.070***	−0.084***	−0.086***	−0.086***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
HighEPU*FFR	0.001	0.003***	−0.000	0.001	0.002**	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
HighEPU*Ln(CPI WC)	0.006***					
	(0.001)					
VIX	0.002***	0.003***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Ln(RGDP)	−0.824***	−0.658***	−0.643***	−0.893***	−0.860***	−0.860***
	(0.065)	(0.030)	(0.071)	(0.068)	(0.058)	(0.058)
Ln(CC)	−2.254***	−1.500***	−1.518***	−2.791***	−2.397***	−2.397***
	(0.563)	(0.526)	(0.550)	(0.577)	(0.558)	(0.558)
Ln(CS)	4.940***	3.083***	3.220***	6.188***	5.270***	5.270***
	(1.279)	(1.186)	(1.249)	(1.312)	(1.266)	(1.266)
Ln(CE)	−2.452***	−1.433**	−1.491**	−3.170***	−2.638***	−2.638***
	(0.711)	(0.660)	(0.694)	(0.730)	(0.703)	(0.703)
Ln(ROA)	0.036***	0.036***	0.036***	0.036***	0.036***	0.036***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Ln(AT)	0.103***	0.102***	0.104***	0.104***	0.103***	0.103***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
w(LEV)	−0.005	−0.010	−0.004	−0.004	−0.006	−0.006
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Ln(TQ)	0.087***	0.087***	0.087***	0.087***	0.087***	0.087***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Ln(PPI)		0.739***				
		(0.050)				
HighEPU*Ln(PPI)		0.003***				
		(0.001)				
Ln(NE)			0.402***			
			(0.077)			
HighEPU*Ln(NE)			0.006***			
			(0.001)			
Ln(MW)				0.749***		
				(0.081)		
HighEPU*Ln(MW)				0.006***		
				(0.001)		
Ln(South)					0.686***	
					(0.066)	
HighEPU* Ln(South)					0.005***	
					(0.001)	
Ln(West)						0.686***
						(0.066)
HighEPU*Ln(West)						0.005***
						(0.001)
Constant	2.213***	0.705***	1.698***	2.311***	2.301***	2.301***
	(0.219)	(0.147)	(0.232)	(0.218)	(0.205)	(0.205)
Observations	90,256	90,256	90,256	90,256	90,256	90,256
R-squared	0.700	0.702	0.700	0.700	0.701	0.701
Firm & Year FE	YES	YES	YES	YES	YES	YES

Standard errors in parentheses.
*** p < 0.01, ** p < 0.05, * p < 0.1.
Note: Table 6 presents additional evidence stemming from inflation in geographical regions in the United States. The Northeast (NE), Midwest (MW), West, and South regions are the geographical locations. Here, we observe whether inflation at different locations impacts firm efficiency differently. Also, we find that geographical information on inflation does not change our results. Besides, we include inflation related to the Producer Price Index (PPI) to capture the average changes in prices (inflation) associated with producers' efficiency. PPI inclusion is essential since inflation affects not only consumers but also producers. Lastly, we include the Urban Wage Earners and Clerical Workers (CPI WC). CPI WC captures the change in the average price paid by this category of individuals. CPI WC reflects these persons' spending behavior over time. Also, we incorporate firm and year fixed effects and a clustering approach.

Table 7
The result is unchanged by examining the size and dividend policy.

Dependent Variable $=FE_{it}$				
	(1)	(2)	(3)	(4)
Variable	Small Firms	Large Firms	Paid Dividend (No)	Paid Dividend (Yes)
FFR	−0.011***	−0.017***	−0.011***	−0.019***
	(0.001)	(0.001)	(0.001)	(0.001)
Ln(CPI)	−0.539***	1.782***	0.388***	1.216***
	(0.103)	(0.107)	(0.110)	(0.117)
Ln(EPU)	−0.006	−0.192***	−0.039***	−0.156***
	(0.013)	(0.010)	(0.012)	(0.011)
HighEPU*FFR	−0.011***	0.014***	0.002	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
HighEPU* Ln(CPI)	0.002	0.009***	−0.001	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)
VIX	0.002***	0.005***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)
Ln(RGDP)	0.192**	−1.861***	−0.602***	−1.406***
	(0.092)	(0.095)	(0.096)	(0.104)
Ln(CC)	3.432***	−4.981***	−1.743**	−2.767***
	(0.759)	(0.782)	(0.805)	(0.810)
Ln(CS)	−8.076***	11.300***	3.603**	6.307***
	(1.709)	(1.779)	(1.835)	(1.829)
Ln(CE)	4.555***	−5.819***	−1.821*	−3.092***
	(0.950)	(0.990)	(1.023)	(1.012)
Ln(ROA)	0.032***	0.039***	0.033***	0.041***
	(0.002)	(0.002)	(0.002)	(0.003)
Ln(AT)	0.082***	0.139***	0.097***	0.124***
	(0.005)	(0.006)	(0.004)	(0.007)
w(LEV)	−0.027	−0.073***	−0.034*	−0.051**
	(0.020)	(0.022)	(0.018)	(0.026)
Ln(TQ)	0.077***	0.093***	0.086***	0.077***
	(0.005)	(0.007)	(0.005)	(0.009)
Constant	−0.205	5.086***	2.065***	3.937***
	(0.320)	(0.332)	(0.316)	(0.360)
Observations	39,608	47,447	45,881	40,337
R-squared	0.697	0.680	0.701	0.724
Number of Firms	6,802	5,036	7,535	4,318
Firm & Year FE	YES	YES	YES	YES

Standard errors in parentheses.
*** p < 0.01, ** p < 0.05, * p < 0.1.
Note: In this table, we present additional results by considering the effect of size and dividend policy. For size, we divide the sample by the median value of the total asset. Those above the median value are deemed the large firms and are classified as unconstraint firms, and those that fall below the median value are considered small or constraint firms. The sample is separated based on firms that paid dividends versus those that did not pay dividends for dividend policy. We present the results in columns 1 to 4. As before, we utilize firm and year fixed effect and clustering methodology in all models.

5. Conclusion

For Keynesians, the interest rate (i) determines investment and (ii) is consequently determined by the interaction of money and supply. Inflation and interest over the years are noted to move together. Hence, there is always the possibility of experiencing these two phenomena simultaneously. These considerations naturally raise the enduring question of whether a firm's efficiency levels increase with inflation and interest rate. More generally: what is the statistical relation between inflation, interest rate, and firm efficiency? Regardless of how negative inflation might appear, Kessel (1965) elaborates on how firms could benefit through inflation. Although policy uncertainty plays a vital role in explaining the variation in firm behaviors, there is still a gap in the literature relating policy uncertainty to firm efficiency.

We analyze the possible economic links between interest rates, inflation, and policy uncertainty on firm efficiency. Primarily, we focus on the moderating role of policy uncertainty on interest rates and inflation. Using US financial and macroeconomic data for the sample period 1990 through 2018, we find that inflation positively affects firm efficiency. Interest rates inversely affect firms' efficiency. The moderating effect of policy uncertainty statistically and significantly amplifies the directionality of inflation and the interest rate. Although not shown, the evidence is robust for examining firm efficiency from a three-year lag and three-year lead estimations.

Additional robustness techniques and stylistic examinations validate the results, including alternative proxies for inflation and interest rates, financing capability, and endogeneity tests. These results are robust and consistent when controlled for firms and years effect and clustering for firms and years. We conclude that efficient firms can learn, strategize, and make decisions well in times of uncertainty to take advantage of looming interest rates and inflation.

Table 8
The result is robust after controlling for direct cost and sales.

Dependent Variable $=FE_{it}$				
	(1)	(2)	(3)	(4)
Variable	Low COGS	High COGS	Low Sales	High Sales
FFR	−0.011***	−0.033***	−0.011***	−0.032***
	(0.001)	(0.002)	(0.001)	(0.002)
Ln(CPI)	0.144*	3.320***	0.205**	2.856***
	(0.082)	(0.199)	(0.083)	(0.188)
Ln(EPU)	−0.078***	−0.298***	−0.077***	−0.279***
	(0.009)	(0.018)	(0.009)	(0.019)
HighEPU* Ln(CPI)	0.003***	0.011***	0.004***	0.011***
	(0.001)	(0.001)	(0.001)	(0.001)
HighEPU*FFR	−0.007***	0.054***	−0.007***	0.054***
	(0.001)	(0.003)	(0.001)	(0.003)
VIX	0.004***	0.002**	0.004***	0.001*
	(0.000)	(0.001)	(0.000)	(0.001)
Ln(RGDP)	−0.413***	−3.269***	−0.465***	−2.860***
	(0.074)	(0.170)	(0.074)	(0.162)
Ln(CC)	4.757***	−30.519***	4.841***	−29.538***
	(0.569)	(1.319)	(0.576)	(1.265)
Ln(CS)	−11.066***	69.475***	−11.244***	67.218***
	(1.292)	(2.980)	(1.306)	(2.857)
Ln(CE)	6.331***	−37.864***	6.443***	−36.704***
	(0.720)	(1.653)	(0.727)	(1.583)
Ln(ROA)	0.038***	0.028***	0.036***	0.031***
	(0.002)	(0.005)	(0.002)	(0.005)
Ln(AT)	0.090***	0.155***	0.087***	0.140***
	(0.004)	(0.011)	(0.004)	(0.011)
w(LEV)	−0.018	−0.046	−0.018	−0.070
	(0.015)	(0.054)	(0.015)	(0.052)
Ln(TQ)	0.083***	0.059***	0.083***	0.063***
	(0.004)	(0.016)	(0.004)	(0.015)
Constant	1.709***	8.529***	1.815***	7.642***
	(0.259)	(0.555)	(0.259)	(0.539)
Observations	74,381	13,365	73,798	13,940
R-squared	0.678	0.622	0.662	0.620
Number of Firms	9,674	1,203	9,655	1,265
Firm & Year FE	YES	YES	YES	YES

Standard errors in parentheses.
*** p < 0.01, ** p < 0.05, * p < 0.1.
Note: Here, we examine if demands and costs mitigate the moderating effect of uncertainty, inflation, and the interest rate on firm efficiency. Specifically, we use the cost of goods sold and the sales generated by each firm to explain this analogy. Firms are separated based on the median values of sales and the cost of goods sold. Firm and year fixed effect and as well as clustering approaches were employed.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Summary statistics on firm efficiency based on industry

Industries	N	Mean	SD	P25	P75
Agriculture	383	0.263	0.118	0.194	0.319
Aircraft	620	0.346	0.173	0.230	0.402
Almost Nothing	1151	0.344	0.189	0.236	0.393
Apparel	1556	0.336	0.108	0.264	0.375
Automobiles & Trucks	1830	0.380	0.216	0.243	0.413
Beer & Liquor	629	0.348	0.162	0.231	0.421
Business Service	10904	0.370	0.183	0.250	0.422
Business Supplies	1548	0.303	0.107	0.232	0.338

(*continued on next page*)

Summary statistics on firm efficiency based on industry (*continued*)

Industries	N	Mean	SD	P25	P75
Candy & Soda	357	0.395	0.178	0.275	0.442
Chemicals	2291	0.322	0.117	0.242	0.371
Coal	243	0.303	0.114	0.233	0.354
Communication	3281	0.376	0.195	0.244	0.458
Computers	3297	0.364	0.150	0.264	0.412
Construction	1340	0.331	0.165	0.234	0.354
Construction Materials	2631	0.281	0.093	0.227	0.313
Consumer Goods	1758	0.360	0.147	0.258	0.421
Defense	203	0.332	0.154	0.242	0.353
Electrical Equipment	1542	0.298	0.127	0.233	0.313
Electronic Equipment	5802	0.331	0.137	0.244	0.370
Entertainment	1540	0.274	0.137	0.203	0.307
Fabricated Production	391	0.250	0.059	0.214	0.273
Food Products	2187	0.328	0.147	0.232	0.371
Healthcare	1847	0.277	0.089	0.223	0.308
Machinery	3722	0.300	0.095	0.239	0.333
Measuring & Control Equipment	2122	0.316	0.094	0.252	0.361
Medical Equipment	2830	0.340	0.128	0.256	0.388
Non-Metallic & Industrial Metal Mining	878	0.326	0.187	0.218	0.370
Personal Service	1254	0.297	0.132	0.219	0.341
Petroleum and Natural Gas	6319	0.369	0.229	0.211	0.479
Pharmaceutical Product	3205	0.462	0.253	0.266	0.615
Precious Metals	900	0.293	0.144	0.207	0.355
Printing and Publishing	814	0.350	0.135	0.259	0.410
Recreation	799	0.318	0.114	0.245	0.352
Restaurants, Hotels & Motels	2040	0.261	0.129	0.196	0.277
Retail	5832	0.369	0.155	0.268	0.422
Rubber and Plastic Production	972	0.258	0.067	0.215	0.281
Shipbuilding, Rail & Equipment	217	0.270	0.067	0.225	0.305
Shipping Container	336	0.293	0.083	0.232	0.335
Steel Works Etc	1569	0.308	0.130	0.230	0.333
Textiles	467	0.271	0.059	0.229	0.304
Tobacco Products	154	0.596	0.265	0.368	0.836
Transportation	3626	0.311	0.149	0.223	0.356
Wholesale	4491	0.342	0.168	0.240	0.362
Total	**8,9878**	**0.340**	**0.166**	**0.238**	**0.382**

Note: Appendix A presents the summary statistics of firm efficiency based on the Fama-French 48-industries of non-financial and non-utility firms in the U.S. The statistics included are the mean, standard deviation, 25th and 75th percentile, and the number of observations.

Appendix B. Endogeneity checks

Although we minimize errors by including clustering techniques in the analyses, two potential problems are likely to occur for dynamic panel data — first, the unobservable heterogeneity. Second, limitation controlling for possible endogeneity. We perform an Arellano-Bond (Arellano & Bond, 1991) estimation and a two-stage least square (2SLS) estimation to solve these two problems. Below is the results.

	FFR			Ln(CPI)	
	(1)	(2)	(3)	(4)	(5)
Variable	AB	First Stage	Second Stage	First Stage	Second Stage
FFR	−0.009***		−0.633***		
	(0.001)		(0.096)		
HighEPU		−2.256***	−1.396***	−0.697***	−13.148***
		(0.013)	(0.218)	(0.003)	(1.805)
HighEPU*FFR		0.407***	0.252***		
		(0.003)	(0.039)		
HighEPU*Ln(CPI)				0.136***	2.564***
				(0.001)	(0.352)
Ln(CPI)	0.371***				
	(0.078)				
Ln(EPU)	−0.023***				
	(0.006)				
VIX	0.002***	0.140***	0.088***	−0.002***	−0.042***
	(0.000)	(0.001)	(0.014)	(0.000)	(0.006)
Ln(RGDP)	−0.467***	−4.718***	−3.099***	0.810***	13.953***
	(0.069)	(0.026)	(0.455)	(0.000)	(2.091)
Ln(CC)	−4.005***	−46.657***	−29.033***	1.542***	26.043***
	(0.580)	(1.957)	(4.709)	(0.032)	(4.087)
Ln(CS)	8.682***	135.310***	83.674***	−3.840***	−65.896***
	(1.335)	(4.426)	(13.418)	(0.073)	(10.129)
Ln(CE)	−4.715***	−82.217***	−50.552***	2.141***	37.107***
	(0.751)	(2.468)	(8.117)	(0.041)	(5.645)
Ln(ROA)	0.025***	0.020***	0.052***	−0.000	0.038***
	(0.001)	(0.003)	(0.003)	(0.000)	(0.002)
Ln(AT)	0.090***	−0.000	0.102***	0.000***	0.107***
	(0.005)	(0.002)	(0.001)	(0.000)	(0.001)
w(LEV)	0.069***	0.000	−0.191***	0.002***	−0.154***
	(0.014)	(0.015)	(0.010)	(0.000)	(0.009)
Ln(TQ)	0.040***	−0.019***	0.149***	−0.000	0.161***
	(0.004)	(0.006)	(0.005)	(0.000)	(0.003)
3-Yr Rolling Ave FFR		0.013			
		(0.008)			
3-Yr Rolling Ave CPI				0.005***	
				(0.001)	
Constant	1.324***	15.529***	9.291***	−1.764***	−30.230***
	(0.271)	(0.235)	(1.519)	(0.008)	(4.495)
Observations	53,718	92,293	92,293	92,293	92,293
R-squared		0.840		0.993	
Number of Firms	7,839				
Firm & Year FE	YES	YES	YES	YES	YES

Standard errors in parentheses.

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

Note: Appendix B presents results resulting from endogeneity checks. We also run endogeneity checks using two main approaches: the Arellano-Bond (AB) estimation and the two-stage least squares (2SLS) estimation. The instrumental variables used for the 2SLS estimation is the three-year rolling average of inflation and interest rate. In the first stage of the 2SLS, we individually regress inflation and interest rate on their respective three-year rolling average. Also, we control for industry and year dummies in the first stage regression. We then regress firm efficiency on the first stage's outcomes in the second stage. We included a one-year lag of the dependent variable for the Arellano-Bond estimation. The Arellano-Bond estimation results are presented in Column 1, whereas the second stage results for the 2SLS using FFR and CPI as

endogenous variables are presented in Columns 3 to 5. The Post-estimation test revealed that the instruments are valid and not weak. In Columns 3 to 5, we employ a clustering approach while also utilizing the fixed effect methodology.

Appendix C. Summary statistics for geographical inflation data

	N	Mean	Std. Dev.	Min	P25	Median	P75	Max
Ln(CPI WC)	92293	5.194	0.187	4.86	5.038	5.17	5.366	5.502
Ln(PPI)	92293	5.050	0.128	4.841	4.956	5.011	5.157	5.315
Ln(NW)	92293	5.266	0.197	4.915	5.097	5.238	5.455	5.580
Ln(MW)	92293	5.177	0.178	4.847	5.030	5.164	5.338	5.457
Ln(South)	92293	5.184	0.186	4.851	5.034	5.155	5.353	5.492
Ln(West)	92,293	5.184	0.186	4.851	5.034	5.155	5.353	5.492

Note: We show the summary statistics of the inflation from the different geographical locations in the U.S. Also, we include the statistics for PPI and inflation related to Urban wage earners and Clerical workers. We took the natural logarithm of all these variables to prevent skewness. The statistics shown are mean, standard deviation, minimum, maximum, the 25th, 75th percentile, the median, and the number of observations.

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