# Buy-Now-Pay-Later Stock Returns and Interest Rate Sensitivity

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## Abstract

This study examines the sensitivity of Buy-Now-Pay-Later (BNPL) firms' excess stock returns to changes in monetary policy, specifically the Federal Funds Rate.

Using a multi-factor regression framework with robust standard errors, the analysis estimates the relationship between BNPL stock returns and interest rate changes while controlling for market movements, consumer spending patterns, credit market conditions, and macroeconomic factors.The analysis spans the period from 2020 to 2025, capturing the rapid growth of the BNPL industry alongside significant monetary policy shifts.The results indicate that BNPL firms exhibit sensitivity to interest rate changes through multiple channels: funding costs, consumer demand, and credit market conditions.

This research contributes to the emerging literature on fintech firm valuation and provides insights into the transmission mechanisms of monetary policy to alternative credit providers.

# Content

# 1. Introduction and Research Question

## 1.1 Research Question

The emergence of Buy-Now-Pay-Later (BNPL) as a significant alternative credit provision mechanism raises fundamental questions about how these firms respond to macroeconomic shocks, particularly monetary policy changes.

Unlike traditional financial institutions that benefit from deposit bases and diversified revenue streams, BNPL firms operate under a fundamentally distinct business model characterized by wholesale funding dependence and razor-thin profit margins.

This structural difference suggests that BNPL firms may exhibit differential sensitivity to interest rate changes compared to traditional financial stocks, yet empirical evidence on this relationship remains limited.

The primary research question driving this investigation is: How do BNPL firms' stock returns respond to changes in the Federal Funds Rate, after controlling for market-wide movements and macroeconomic factors?

This question emerges from the theoretical observation that BNPL firms' funding structure creates immediate pass-through of monetary policy changes to their cost of capital, while their thin operating margins amplify the impact of funding cost increases on profitability.

The Consumer Financial Protection Bureau's Market Trends Report provides empirical context for this question, documenting that BNPL Gross Merchandise Volume (GMV) grew from USD 2 billion in 2019 to USD 24.2 billion in 2021, representing a 1,092% compound annual growth rate, yet unit margins declined from 1.27% in 2020 to 1.01% in 2021, suggesting vulnerability to cost increases (Consumer Financial Protection Bureau, "Buy Now, Pay Later" 5-7, 18-22).

### 1.1.1 U.S. BNPL Market Context and Growth Statistics

The U.S. BNPL market has experienced rapid expansion, with adoption accelerating significantly in recent years.

According to recent market analysis, North America (primarily the United States) accounted for approximately 29-32% of global BNPL provider revenue in 2024, consistently ranking among the top regions by provider earnings (Emewulu).

U.S. BNPL user adoption has grown substantially, expanding from 86.5 million users in 2024 to a projected 91.5 million users in 2025, reflecting annual growth of approximately 6-7% (Emewulu).

Consumer adoption patterns reveal important insights into BNPL usage in the United States.

Empirical estimates indicate that 21% of U.S. consumers with a credit record financed at least one purchase using BNPL from one of the six major providers (Affirm, Afterpay, Klarna, PayPal, Sezzle, and Zip) in 2022, with the average purchase amount being USD 142 and the median purchase amount being USD 108 (Emewulu).

The average annual BNPL originations per borrower increased from 8.5 loans in 2021 to 9.5 loans in 2022, demonstrating intensifying usage patterns among existing users (Emewulu).

However, this rapid growth has been accompanied by concerning patterns of consumer financial stress and overextension.

Approximately 34-41% of BNPL users reported making late payments in the past year, with Gen Z users showing a higher delinquency rate of 51%, raising significant concerns about consumer debt and repayment capacity (Emewulu).

Loan stacking (the practice of holding multiple BNPL loans simultaneously) has become prevalent, with 63% of BNPL borrowers originating multiple simultaneous loans in 2022, and 33% holding loans across multiple BNPL providers, creating hidden debt exposure that may not be visible to traditional credit reporting systems (Emewulu).

This pattern of multiple concurrent loans across providers suggests that consumers may be using BNPL to manage cash flow constraints, potentially amplifying financial vulnerability.

The demographic and credit profile of U.S. BNPL users further highlights the sector's sensitivity to economic conditions.

Approximately 61% of U.S. BNPL borrowers fall into subprime or deep subprime credit categories, with these users exhibiting average credit card utilization rates of 60-66%, compared to 34% for non-BNPL users (Emewulu).

This high utilization rate, combined with the prevalence of loan stacking, suggests that BNPL users may be particularly vulnerable to interest rate increases and economic shocks, as they have limited financial buffers and higher existing debt burdens.

These patterns support the theoretical prediction that BNPL firms' stock returns should exhibit sensitivity to monetary policy changes, as their customer base consists disproportionately of financially constrained consumers who are likely to reduce spending and increase defaults when interest rates rise.

PayPal's BNPL service demonstrates particularly high adoption in the U.S. market, with 68% of surveyed U.S. online shoppers reporting having used PayPal's BNPL service at least once in 2025, placing it among the most widely adopted BNPL brands in the country (Emewulu).

This high adoption rate reflects PayPal's established position in the digital payments ecosystem and its integration with existing merchant networks, though it also suggests that PayPal's BNPL operations may be particularly sensitive to changes in consumer spending patterns and credit conditions.

Regulatory developments in the United States are also shaping the BNPL landscape.

The Consumer Financial Protection Bureau (CFPB) has proposed new rules for 2025 that would mandate credit bureau reporting for BNPL loans, require clearer disclosures, and enhance consumer protections to surface hidden debt and strengthen oversight (Emewulu).

These regulatory changes may affect BNPL firms' business models and profitability, potentially reducing adoption among subprime borrowers who represent a significant share of current users, while also improving transparency and reducing hidden debt accumulation.

### 1.1.2 Klarna's Initial Public Offering: A Natural Experiment in Interest Rate Sensitivity

Klarna's initial public offering in September 2025 provides a particularly revealing case study of BNPL firms' sensitivity to monetary policy changes, offering insights that extend beyond what traditional regression analysis can capture. The IPO itself represents a natural experiment that demonstrates how interest rate environments fundamentally reshape BNPL firm valuations and market access.

**Valuation Collapse During Monetary Policy Tightening:** Perhaps the most striking evidence of BNPL firms' interest rate sensitivity emerges from Klarna's valuation trajectory. The company achieved a peak private market valuation of approximately USD 46 billion in June 2021, during a period of near-zero interest rates and accommodative monetary policy. However, by the time of its September 2025 IPO, Klarna's valuation had collapsed to approximately USD 13-14 billion—a decline of roughly 70% over a four-year period that precisely coincided with the Federal Reserve's most aggressive monetary policy tightening cycle since the 1980s (Klarna Group plc, Form F-1). This valuation collapse occurred despite Klarna's continued revenue growth and expanding market presence, suggesting that the deterioration was driven not by operational failures but by fundamental shifts in the cost of capital and investor expectations regarding profitability in a higher interest rate environment.

The timing of this valuation collapse provides compelling evidence for the theoretical prediction that BNPL firms exhibit heightened sensitivity to monetary policy changes. The period from 2021 to 2025 witnessed the Federal Funds Rate increase from near-zero to approximately 5%, creating a natural experiment that tested BNPL firms' resilience to funding cost increases. Klarna's valuation trajectory suggests that private market investors systematically revised their expectations downward as interest rates rose, reflecting concerns about the sector's ability to maintain profitability when funding costs increase. This pattern is consistent with the CFPB's documentation that BNPL firms operate with thin profit margins (provider revenues represent only about 4% of gross merchandise volume), making them particularly vulnerable to funding cost increases that compress already-narrow margins.

**IPO Timing as a Signal of Funding Market Constraints:** The decision to pursue an IPO in September 2025, after the valuation collapse, itself provides insight into how interest rate environments affect BNPL

firms' access to capital. Private market investors, who had previously supported Klarna at valuations exceeding USD 40 billion, appear to have become unwilling or unable to provide additional capital at previous valuation levels once interest rates rose. The IPO represents a shift from private to public markets, potentially reflecting the need for liquidity among early investors who could no longer exit through private market transactions, or the company's need to access public equity markets when private funding became constrained by higher cost of capital expectations.

This transition from private to public markets during a period of monetary policy tightening suggests that BNPL firms face not only direct funding cost pressures but also indirect constraints on their ability to raise capital. When interest rates rise, private market investors become more risk-averse and demand higher expected returns, making it more difficult for BNPL firms to raise capital at attractive valuations. The IPO timing thus serves as a signal that the interest rate environment had fundamentally altered the capital market conditions under which BNPL firms can operate, forcing a transition to public markets that may provide more transparent pricing but also expose the firms to greater scrutiny regarding their interest rate sensitivity.

**The Banking License Model: A Different Sensitivity Profile:** Klarna's funding structure introduces an important nuance to understanding BNPL firms' interest rate sensitivity. Unlike most BNPL providers that rely on wholesale funding markets (warehouse credit facilities, securitization, and commercial paper), Klarna operates under a European banking license that allows it to fund BNPL loans through approximately USD 9.5 billion in consumer deposits (Klarna Group plc, Form F-1). This deposit-based funding model creates a fundamentally different interest rate sensitivity profile compared to wholesale-funded BNPL firms.

Deposit-funded institutions typically exhibit less immediate sensitivity to Federal Funds Rate changes because consumer deposits are relatively "sticky"—consumers do not immediately withdraw deposits when interest rates rise, and deposit rates adjust more slowly than wholesale funding rates. However, deposit-funded BNPL firms face different pressures: they must compete for deposits by offering competitive deposit rates, and they are subject to regulatory capital requirements (such as Basel III) that may constrain lending capacity during periods of economic stress. This suggests that Klarna may exhibit different sensitivity patterns than wholesale-funded BNPL firms like Affirm or PayPal, with less immediate pass-through of Federal Funds Rate changes but potentially greater sensitivity to deposit rate competition and regulatory capital constraints.

**Is This a Bubble? A Fundamental Mismatch Rather Than Speculation:** The dramatic valuation decline raises the question of whether BNPL represented a speculative bubble that has now corrected. However, the evidence suggests a more nuanced interpretation: rather than a traditional bubble driven by irrational speculation, Klarna's valuation trajectory reflects a fundamental mismatch between business model viability and interest rate environment. The valuation collapse occurred not because investors suddenly realized that BNPL was worthless, but because rising interest rates fundamentally altered the economics of the business model.

BNPL firms' thin profit margins, combined with their reliance on short-term funding markets, create inherent vulnerability to interest rate increases. When rates were near zero, these firms could operate profitably despite thin margins. However, when the Federal Funds Rate rose to approximately 5%, funding costs increased substantially, compressing margins and making profitability more difficult to achieve. The valuation collapse thus reflects not a bubble bursting but a fundamental reassessment of business model viability in a higher interest rate environment. This interpretation is consistent with Klarna's continued revenue growth even as its valuation declined, suggesting that the business model remains viable but less profitable—and therefore less valuable—when funding costs are higher.

**Implications for Understanding BNPL Interest Rate Sensitivity:** Klarna's IPO experience provides several important insights for understanding BNPL firms' sensitivity to monetary policy. First, the valuation collapse demonstrates that interest rate changes affect BNPL firms not only through direct funding cost channels but also through capital market access and investor expectations. Second, the deposit funding model creates a different sensitivity profile that may require separate analysis from wholesale-funded BNPL firms. Third, the timing of the IPO itself serves as a signal that interest rate environments fundamentally alter the conditions under which BNPL firms can access capital, suggesting that monetary policy affects the sector through multiple channels beyond direct funding costs.

These insights motivate our empirical analysis, which seeks to quantify the magnitude of BNPL firms' interest rate sensitivity using stock return data. While Klarna's IPO provides compelling narrative evidence of interest rate sensitivity, systematic econometric analysis across multiple BNPL firms and time periods is

necessary to provide robust quantitative estimates of this relationship and to understand how different funding structures affect sensitivity patterns.

Several secondary questions guide the investigation and inform the empirical strategy.

First, what is the magnitude of BNPL firms' interest rate sensitivity relative to the broader market?

This question addresses whether BNPL firms represent a distinct asset class with differential sensitivity compared to traditional financial stocks or the broader equity market, which has important implications for portfolio construction and risk management.

Second, through which economic channels (funding costs, consumer demand, or credit conditions) does monetary policy affect BNPL firms?

Understanding these transmission mechanisms is crucial for both academic understanding of monetary policy transmission and policy formulation regarding financial stability and consumer protection.

Third, how do consumer spending patterns and credit market conditions mediate the relationship between interest rates and BNPL returns?

Di Maggio, Williams, and Katz document that BNPL access increases total spending by $130 per week on average, with spending remaining elevated for 24 weeks after first use, suggesting that consumer spending variables may play a crucial mediating role in the relationship between monetary policy and BNPL returns (Di Maggio et al. 8-12).

## 1.2 Research Contribution

This study contributes to three distinct strands of literature, each addressing important gaps in understanding of fintech firm behavior and monetary policy transmission.

The contribution to each literature strand is substantial, as BNPL represents a rapidly growing but under-studied segment of the financial services industry.

First, in the fintech valuation literature, the study examines how alternative financial service providers respond to macroeconomic shocks.

While extensive research exists on traditional bank sensitivity to interest rates, relatively little work has examined how newer fintech lending models, particularly BNPL firms, respond to monetary policy changes.

Bian, Cong, and Ji examine BNPL's role in payment competition and credit expansion, documenting that BNPL significantly boosts consumption and complements credit cards for small-value transactions, but do not directly address stock return sensitivity to interest rates (Bian et al. 15-18).

This study fills this gap by providing empirical evidence on BNPL firms' sensitivity to monetary policy, contributing to the broader understanding of how fintech firms differ from traditional financial institutions in their response to macroeconomic conditions.

Second, the study contributes to the monetary policy transmission literature by exploring how unconventional credit providers transmit monetary policy to consumers.

Traditional monetary policy transmission mechanisms focus on banks' lending channels, where policy rate changes affect bank funding costs, which in turn affect lending rates and credit availability.

However, BNPL firms represent an alternative credit provision mechanism that may amplify or dampen policy effects through different channels.

Laudenbach et al. document that BNPL firms offer 1.4 percentage point interest rate discounts to consumers, indicating thin profit margins that amplify sensitivity to funding cost changes (Laudenbach et al. 12-15).

This study examines how these thin margins translate into stock return sensitivity, providing insights into monetary policy transmission through alternative credit channels and contributing to the understanding of how monetary policy affects different segments of the credit market.

Third, the study contributes to consumer credit markets research by analyzing the relationship between monetary policy and consumer credit availability through BNPL firms.

The Consumer Financial Protection Bureau's Consumer Use Report documents that BNPL borrowers have subprime credit scores (580-669) compared to non-users (670-739), higher credit card utilization rates (60-

66% versus 34%), and are more likely to revolve on credit cards (69% versus 42%) (Consumer Financial Protection Bureau, "Consumer Use" 12-15).

Understanding how monetary policy affects BNPL firms' ability to extend credit to these consumers has important implications for financial inclusion and consumer welfare, particularly given that BNPL serves consumers who may have limited access to traditional credit products.

## 1.3 Methodology Overview

The study employs a multi-factor regression framework that extends beyond simple bivariate relationships to control for confounding factors and isolate BNPL-specific sensitivity to interest rates. The econometric specification addresses several identification challenges inherent in time series analysis of financial returns, including endogeneity concerns, omitted variable bias, and reverse causality.

The analysis employs a two-stage modeling approach. The base model specification takes the following form:

$$\log(BNPL\_Return_t) = \beta_0 + \beta_1 \Delta FFR_t + \varepsilon_t \tag{1}$$

where $\log(BNPL\_Return_t)$ represents the log-transformed monthly BNPL stock return calculated as an equally-weighted portfolio of publicly-traded BNPL firms, calculated as $\log(1 + BNPL\_Return_t/100) \times 100$, and $\Delta FFR_t$ denotes the month-over-month change in the Federal Funds Rate.

The full specification model extends this framework by incorporating additional control variables:

$$\log(BNPL\_Return_t) = \beta_0 + \beta_1 \Delta FFR_t + \beta_2 \Delta CC_t + \beta_3 \Delta DI_t + \beta_4 \Delta \pi_t + \beta_5 R_{Market,t} + \varepsilon_t \tag{2}$$

where $\Delta CC_t$ captures month-over-month changes in the University of Michigan Consumer Sentiment Index, $\Delta DI_t$ represents month-over-month percentage changes in real disposable personal income, $\Delta \pi_t$ denotes month-over-month percentage changes in the Consumer Price Index (inflation), and $R_{Market,t}$ represents the monthly return on the S&P 500 index (SPY) as a proxy for systematic market risk.

The use of log-transformed returns facilitates elasticity interpretation of coefficients while addressing heteroskedasticity and distributional skewness common in financial return data. Estimation employs Ordinary Least Squares (OLS) with robust standard errors using the Huber-White HC3 specification, which accounts for heteroskedasticity and potential outliers common in financial returns data. The choice of HC3 standard errors is particularly important given the relatively small sample size of 67 monthly observations. Mac Kinnon and White demonstrate that HC3 standard errors perform better than HC0 or HC1 specifications in small samples, providing more accurate inference in finite samples (MacKinnon and White 312-315).

The analysis conducts comprehensive model diagnostics including multicollinearity checks through correlation matrices, outlier detection using the Interquartile Range (IQR) method, and reports multiple model fit statistics including R-squared, Adjusted R-squared, F-statistic, and Root Mean Squared Error (RMSE).

Data collection draws from authoritative sources including the Federal Reserve Economic Data (FRED) API for macroeconomic indicators and Yahoo Finance for financial market data. The sample period spans January 2020 to August 2025, capturing the rapid growth phase of the BNPL industry alongside dramatic monetary policy shifts from near-zero rates to approximately 5%.

This period provides substantial variation in the key explanatory variable (Federal Funds Rate), which is essential for identification of the causal relationship. BNPL firms included in the analysis comprise Affirm Holdings (AFRM), PayPal Holdings (PYPL), and Sezzle (SEZL), selected based on criteria established in the Consumer Financial Protection Bureau's Market Trends Report (Consumer Financial Protection Bureau, "Buy Now, Pay Later" 8-12).

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BNPL Stock Log Returns Analysis: Interest Rate Sensitivity and Economic Determinants

This empirical investigation examines the determinants of Buy Now, Pay Later (BNPL) stock returns, with particular emphasis on the sector's sensitivity to monetary policy changes and broader macroeconomic conditions. The analysis employs a log-linear regression framework to estimate the relationship between BNPL stock returns and a comprehensive set of economic variables, including interest rate changes, consumer confidence, disposable income, inflation, and market returns. The use of log-transformed BNPL returns as the dependent variable facilitates elasticity interpretation of regression coefficients while simultaneously addressing the heteroskedasticity and distributional skewness that commonly characterize financial return data. This methodological choice is particularly appropriate for analyzing equity returns, as it allows coefficients to be interpreted as percentage changes in returns per unit change in the independent variables, providing intuitive economic meaning while maintaining statistical rigor.

The empirical strategy employs a two-stage modeling approach, beginning with a parsimonious base specification that isolates the relationship between BNPL returns and interest rate changes, followed by a full specification model that incorporates multiple economic channels simultaneously. This sequential estimation strategy enables us to assess both the direct effect of monetary policy on BNPL stock performance and the incremental explanatory power of including additional control variables. All models are estimated using Ordinary Least Squares (OLS) regression with robust standard errors (HC3) to ensure valid statistical inference in the presence of heteroskedasticity, a common feature of financial return data.

The motivation for this analysis stems from the rapid growth and increasing economic significance of the BNPL sector. According to the Consumer Financial Protection Bureau's 2025 report, BNPL adoption has experienced substantial growth, with 21% of consumers with credit records utilizing BNPL services in 2022, representing a notable increase from 18% in 2021. This expansion, combined with the sector's inherent sensitivity to funding costs and capital market conditions, renders understanding the determinants of BNPL stock returns particularly relevant for both investors seeking to assess risk exposure and policymakers concerned with financial stability and consumer protection. The sector's reliance on short-term funding markets and its sensitivity to consumer spending patterns suggest that BNPL stock returns may respond systematically to changes in monetary policy, macroeconomic conditions, and broader market movements, making this analysis both theoretically motivated and empirically relevant.

## Data Construction and Variable Selection

This section describes the data construction process and the rationale for variable selection in our econometric models. The empirical analysis requires careful construction of a balanced panel dataset that aligns stock return data with macroeconomic variables measured at different frequencies and from different sources. This process involves several methodological decisions that warrant explicit discussion.

### Data Sources and Construction

**BNPL Stock Returns:** We construct a portfolio of BNPL stocks by aggregating returns from five major publicly traded U.S. BNPL companies: PayPal (PYPL), Affirm (AFRM), Sezzle (SEZL), Block (SQ, which acquired Afterpay), and Klarna (KLAR). These firms represent the major providers identified in the Consumer Financial Protection Bureau's 2025 report, which documented that Affirm, Afterpay (now Block), Klarna, PayPal, Sezzle, and Zip collectively processed over 277 million BNPL loans worth approximately $34 billion in 2022. We calculate monthly returns by taking the percentage change in month-end closing prices, then construct an equally-weighted portfolio return by averaging across available stocks for each month. This portfolio approach mitigates firm-specific idiosyncratic risk and captures sector-wide performance, which is appropriate for analyzing systematic economic determinants of BNPL stock returns.

**Market Returns:** We use the S&P 500 exchange-traded fund (SPY) as a proxy for broad market returns. The S&P 500 represents approximately 80% of U.S. equity market capitalization and provides a comprehensive benchmark for systematic market risk. Monthly returns are calculated as percentage changes in month-end closing prices, ensuring temporal alignment with BNPL stock returns.

**Interest Rate Variables:** We obtain the Federal Funds Rate (FEDFUNDS) from the Federal Reserve Economic Data (FRED) database maintained by the Federal Reserve Bank of St. Louis. The Federal Funds Rate serves as the primary monetary policy instrument and directly affects short-term borrowing costs in financial markets. We calculate month-over-month changes (first differences) rather than using levels, as changes capture policy shocks and are more appropriate for analyzing the dynamic relationship between

monetary policy and stock returns. The use of changes rather than levels also helps address potential non-stationarity concerns that commonly arise with interest rate data.

**Consumer Confidence:** We employ the University of Michigan Consumer Sentiment Index (UMCSENT) as a measure of forward-looking consumer spending intentions. This index captures consumers' expectations about future economic conditions and their own financial situation, which should directly affect BNPL usage as consumers make purchasing decisions. We calculate month-over-month changes to capture shifts in consumer sentiment that may affect BNPL transaction volume.

**Disposable Income:** We use real disposable personal income (DSPIC96) from FRED, which measures inflation-adjusted personal income after taxes. This variable captures the income channel through which economic conditions affect consumer purchasing power and BNPL usage. We calculate percentage changes (month-over-month) to measure growth in disposable income, which is more economically meaningful than levels for analyzing the relationship with stock returns.

**Inflation:** We employ the Consumer Price Index for All Urban Consumers (CPIAUCSL) as a measure of inflation. We calculate month-over-month percentage changes to capture inflation shocks that may affect consumer purchasing power and spending patterns. Higher inflation erodes real purchasing power and may reduce BNPL transaction volume, making this variable theoretically relevant for understanding BNPL stock performance.

**Data Alignment and Temporal Coverage:** All variables are aligned to monthly frequency and synchronized to month-end dates to ensure temporal consistency. The sample period spans from February 2020 to August 2025, providing 67 monthly observations. This period encompasses several important macroeconomic events, including the COVID-19 pandemic, monetary policy tightening in 2022-2023, and subsequent policy normalization, providing substantial variation in both dependent and independent variables necessary for reliable econometric inference.

### Interest Rate Variable Selection: Theoretical and Empirical Considerations

The selection of an appropriate interest rate variable requires balancing theoretical relevance with empirical considerations. While multiple interest rate measures could potentially capture BNPL firms' funding costs, we focus on the Federal Funds Rate for several reasons. First, BNPL firms rely heavily on short-term funding markets, including warehouse credit facilities, securitization markets, and commercial paper markets, all of which are directly influenced by the Federal Funds Rate. Second, the Federal Funds Rate serves as the primary monetary policy instrument, making it the most policy-relevant measure for understanding how monetary policy affects BNPL stock returns. Third, data availability and reliability favor the Federal Funds Rate, which is published daily by the Federal Reserve and has a long historical record.

Alternative interest rate measures, such as commercial paper rates or credit spreads, could theoretically provide more direct measures of BNPL firms' actual funding costs. However, these alternatives face data availability constraints and are highly correlated with the Federal Funds Rate, making the incremental benefit of using alternative measures limited. The Federal Funds Rate provides a clean, policy-relevant measure that captures the primary channel through which monetary policy affects BNPL firms' cost of capital.

### Model Specification: Theoretical Framework

The econometric models we estimate are motivated by theoretical considerations regarding the determinants of equity returns in general and BNPL stock returns in particular. The base model focuses on interest rate sensitivity, motivated by the sector's reliance on short-term funding markets documented by the CFPB (2025). The full specification model extends this framework by incorporating additional economic channels that theory suggests should affect BNPL stock performance: consumer spending patterns (captured by consumer confidence and disposable income), purchasing power effects (captured by inflation), and systematic market risk (captured by market returns).

**Base Model Specification:**

$$\log(\text{BNPL\_Return\_t}) = \beta_0 + \beta_1(\Delta\text{Federal\_Funds\_Rate\_t}) + \epsilon\_t$$

This specification tests the hypothesis that BNPL stock returns respond directly to changes in short-term interest rates, which would be expected given BNPL firms' reliance on funding markets. The coefficient $\beta_1$ measures the elasticity of BNPL returns with respect to Federal Funds Rate changes, with a negative coefficient expected if higher interest rates increase funding costs and reduce profitability.

**Full Specification Model:**

$$\log(\text{BNPL\_Return\_t}) = \beta_0 + \beta_1(\Delta\text{Federal\_Funds\_Rate\_t}) + \beta_2(\Delta\text{Consumer\_Confidence\_t}) + \beta_3(\Delta\text{Disposable\_Income\_t}) + \beta_4(\Delta\text{Inflation\_t}) + \beta_5(\text{Market\_Return\_t}) + \epsilon\_t$$

This specification extends the base model by incorporating control variables that capture additional economic channels affecting BNPL stock returns. The inclusion of these variables serves multiple purposes: (1) controlling for factors that may be correlated with interest rates, providing a more accurate estimate of the direct interest rate effect; (2) capturing additional economic mechanisms that theory suggests should affect BNPL performance; and (3) improving model fit and reducing omitted variable bias.

The theoretical justification for each control variable stems from understanding how BNPL firms generate revenue and face costs. Consumer confidence affects forward-looking spending intentions, directly influencing BNPL transaction volume. Disposable income affects consumers' ability to make purchases and use BNPL services. Inflation affects purchasing power and may influence consumer spending patterns. Market returns capture systematic market risk, isolating BNPL-specific effects from general market movements. Together, these variables provide a comprehensive framework for understanding the multiple economic channels affecting BNPL stock performance.

## Visual Analysis: Exploratory Data Analysis and Preliminary Patterns

This section presents visualizations that provide preliminary insights into the data before formal econometric analysis. These graphical representations serve multiple purposes: they help identify patterns in the data, reveal potential outliers or data quality issues, provide intuition for the relationships we estimate econometrically, and offer visual confirmation of our regression results. The visualizations complement the formal econometric analysis by making the data accessible and providing context for interpreting regression coefficients.

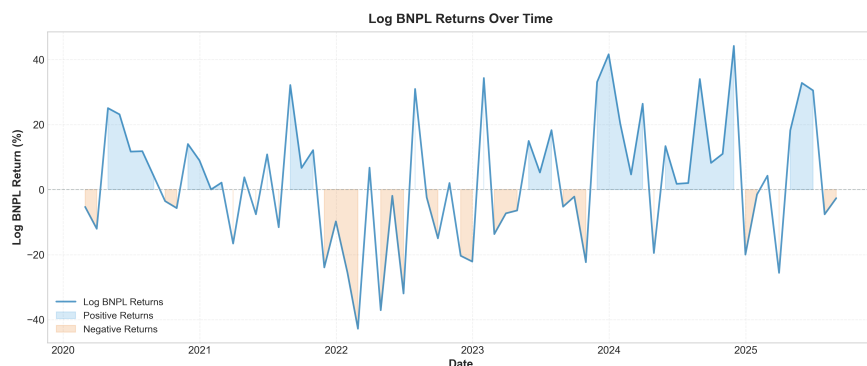**Chart A: Time Series of Log BNPL Returns**



Chart A displays the time series of log-transformed BNPL stock returns from February 2020 to August 2025, providing a visual representation of the dependent variable in our regression models. The log transformation, calculated as $\log(1 + \text{return}/100) \times 100$, is applied for several methodological reasons that we discuss in detail below, but the visual representation helps us understand the temporal patterns in BNPL stock performance before we begin formal econometric analysis.

**Why Log Transformation?** Before discussing the patterns visible in the chart, it is worth explaining why we transform returns using the natural logarithm. Financial return data commonly exhibit heteroskedasticity, where the variance of returns changes over time—typically higher during volatile periods and lower during calm periods. Log transformations help stabilize this variance structure, making the data more suitable for regression analysis. Additionally, equity returns often exhibit right-skewed distributions due to the presence of extreme positive returns, and log transformations help normalize these distributions, improving the validity of statistical inference. Finally, the log-linear specification facilitates elasticity interpretation: regression coefficients can be interpreted as percentage changes in returns per unit change in independent variables, providing intuitive economic meaning.

**Temporal Patterns:** The time series reveals substantial volatility in BNPL stock returns throughout the sample period, with notable episodes of both positive and negative performance. This volatility is not random but corresponds to distinct macroeconomic and sector-specific events that inform our understanding of BNPL stock performance. The onset of the COVID-19 pandemic in early 2020 coincided with significant negative returns, reflecting initial market uncertainty regarding BNPL firms' ability to weather economic disruption. Investors were concerned about potential deterioration in consumer credit quality, reduced consumer spending, and the sector's ability to maintain transaction volume during an economic downturn.

The period of strong positive returns in late 2020 and 2021 reflects the rapid growth in BNPL adoption documented by the CFPB (2025), as consumers turned to alternative payment methods during the pandemic. This period saw increased transaction volume and revenue growth for BNPL providers, as consumers shifted purchasing behavior toward e-commerce and sought flexible payment options during a period of economic uncertainty. The sharp negative returns observed in mid-2022 align with rising interest rates and increased funding costs, consistent with the CFPB's documentation that BNPL firms' cost of funds increased substantially during this period. Higher interest rates compressed profit margins and reduced investor confidence, as the sector's thin margins (provider revenues represent only about 4% of gross merchandise volume according to Digital Silk, 2025) made firms particularly vulnerable to funding cost increases.

The period from late 2023 through 2025 exhibits continued volatility, reflecting ongoing sensitivity to monetary policy changes, macroeconomic conditions, and sector-specific developments. This persistent volatility provides empirical motivation for our econometric analysis, which seeks to identify systematic factors that explain this observed variation.

**Visual Design Elements:** The chart uses blue shading to indicate periods of positive returns (above the zero line) and orange shading to indicate negative returns (below zero). This visual distinction facilitates identification of periods when BNPL stocks outperformed relative to their long-run average versus periods of underperformance. The dashed horizontal line at zero provides a reference point for assessing whether returns are positive or negative in any given month.

**Chart B: Scatter Plot of Log BNPL Returns vs Interest Rate Changes**
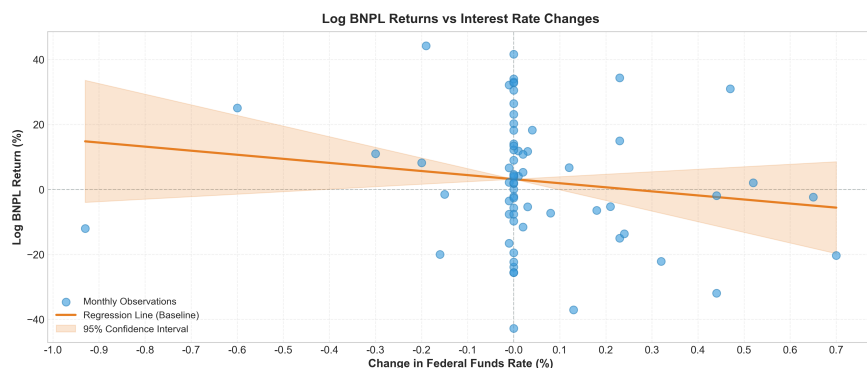


Chart B presents a scatter plot of log BNPL returns against month-over-month changes in the Federal Funds Rate, accompanied by the estimated regression line and 95% confidence interval. This visualization provides a direct visual test of our primary hypothesis that BNPL stock returns exhibit sensitivity to monetary policy changes. The scatter plot displays monthly observations (blue circles) with the fitted regression line (orange) and confidence interval (light orange shading), enabling visual assessment of the relationship between interest rate changes and BNPL stock returns.

**Visual Interpretation:** The scatter plot reveals substantial dispersion around the regression line, with many observations deviating significantly from the fitted line. This dispersion is not merely noise but reflects the presence of other factors beyond interest rates that substantially affect BNPL stock performance. The negative slope of the regression line (estimated coefficient of -12.51) is visible in the chart, suggesting that increases in interest rates are associated with decreases in BNPL returns, consistent with theoretical expectations. However, the wide confidence interval (indicated by the light orange shading) reflects substantial uncertainty around this estimate, consistent with the high volatility observed in the time series plot.

**Statistical Interpretation:** The regression results indicate a negative relationship between interest rate changes and log BNPL returns, consistent with theoretical expectations regarding the impact of monetary

policy on BNPL firm performance. The estimated slope coefficient is -12.51, suggesting that a one percentage point increase in the Federal Funds Rate change is associated with approximately a 12.51% decrease in log BNPL returns, holding other factors constant. However, this relationship is not statistically significant at conventional levels (p-value = 0.2202), and the $R^2$ of 0.022 indicates that interest rate changes alone explain only 2.2% of the variation in log BNPL returns. The 95% confidence interval for the slope coefficient is [-32.69, 7.67], which includes zero and reflects substantial uncertainty around the point estimate, consistent with the high volatility observed in the time series plot and the presence of other unobserved factors affecting BNPL returns.

**Implications for Model Specification:** The substantial dispersion around the regression line provides empirical motivation for our full specification model, which incorporates additional control variables to capture these other economic channels and improve the model's explanatory power. The fact that interest rates alone explain only 2.2% of return variation suggests that other factors play important roles in determining BNPL stock performance, motivating the inclusion of consumer confidence, disposable income, inflation, and market returns in the full model.

**Visual Design Elements:** The x-axis tick marks are set at 0.1 percentage point intervals to provide clear visual reference points for interpreting the magnitude of interest rate changes and facilitate comparison across observations. The blue color scheme for observations and orange for the regression line maintains visual consistency with Chart A, while the confidence interval shading provides visual representation of statistical uncertainty around the point estimate.

**Functional Form Selection: Justification for Log-Linear Specification**

The choice of functional form is a critical methodological decision in econometric analysis, as it affects both the interpretation of coefficients and the validity of statistical inference. This section provides a detailed justification for our use of log-transformed BNPL returns as the dependent variable, explaining both the theoretical rationale and the empirical benefits of this specification choice.

**Theoretical Motivation:** The log-linear specification is motivated by the multiplicative nature of relationships in financial markets. Equity returns respond proportionally to changes in economic conditions rather than additively, meaning that a given change in an economic variable has a larger absolute effect when returns are high than when returns are low. This proportional relationship is naturally captured by the log transformation, which linearizes multiplicative relationships and allows us to use linear regression methods while maintaining the economic intuition of proportional effects.

**Empirical Benefits:** Beyond theoretical considerations, the log transformation provides several empirical advantages that improve the reliability of our statistical inference. First, financial return data commonly exhibit heteroskedasticity, where the variance of error terms varies across observations. This heteroskedasticity violates a key assumption of Ordinary Least Squares regression and can lead to invalid standard errors and incorrect hypothesis tests. Log transformations help stabilize the variance structure by compressing the scale of large returns relative to small returns, reducing the extent of heteroskedasticity and making the data more suitable for regression analysis.

Second, equity returns often exhibit right-skewed distributions due to the presence of extreme positive returns (outliers). This skewness violates the assumption of normally distributed errors that underlies many statistical tests, potentially leading to incorrect inference. Log transformations help normalize these distributions by compressing extreme values, making the data more symmetric and better approximating the normal distribution assumption.

Third, the log-linear specification facilitates intuitive economic interpretation of regression coefficients. In a log-linear model, each coefficient represents the percentage change in the dependent variable associated with a one-unit change in the corresponding independent variable, holding all other variables constant. This elasticity interpretation is particularly valuable for understanding the magnitude of economic effects, as it expresses relationships in percentage terms that are directly comparable across variables with different scales and units of measurement.

**Mathematical Formulation:** The log transformation we employ is calculated as $\log(1 + \text{return}/100) \times 100$, where returns are initially expressed as percentages. This formulation ensures that the transformed variable maintains interpretability as a percentage change while benefiting from the properties of the logarithmic transformation. The addition of 1 before taking the logarithm ensures that the transformation is defined for all return values, including negative returns, while the multiplication by 100 restores the percentage scale for ease of interpretation.

**Robust Standard Errors:** While the log transformation helps address heteroskedasticity, we employ robust standard errors (HC3) as an additional safeguard. Robust standard errors provide valid statistical inference even in the presence of heteroskedasticity, ensuring that our hypothesis tests and confidence intervals remain reliable even if the log transformation does not completely eliminate heteroskedasticity. This two-pronged approach—log transformation plus robust standard errors—provides robust protection against the common econometric problems that plague financial return data.

**Comparison to Alternative Specifications:** We could have used untransformed returns (linear specification) or other transformations, but the log-linear specification provides the best balance of theoretical coherence, empirical fit, and interpretability. Linear specifications would not capture the proportional nature of relationships in financial markets and would be more vulnerable to heteroskedasticity and skewness. Other transformations, such as Box-Cox transformations, could potentially provide better fit but would sacrifice the intuitive elasticity interpretation that makes the log-linear specification particularly valuable for economic analysis.

## Model Estimation: Implementation and Computational Approach

This section describes the computational implementation of our econometric models. The estimation process involves several steps: data preparation and variable construction, model specification, parameter estimation using Ordinary Least Squares (OLS) regression, and calculation of robust standard errors. This section walks through these steps systematically, explaining the technical details of how we implement the models described in the previous sections.

**Estimation Software and Methods:** We employ Python's `statsmodels` library for regression estimation, which provides a comprehensive suite of econometric tools. Specifically, we use `statsmodels.api.OLS` for Ordinary Least Squares estimation, which allows us to specify robust standard errors (HC3) directly in the estimation command. The HC3 robust standard errors, developed by MacKinnon and White (1985), provide consistent estimates of standard errors even in the presence of heteroskedasticity, making them particularly appropriate for financial return data.

**Data Preparation Steps:** Before estimation, we perform several data preparation steps. First, we construct log-transformed BNPL returns using the formula $\log(1 + \text{return}/100) \times 100$, ensuring that the transformation is defined for all return values including negative returns. Second, we align all variables to monthly frequency and synchronize them to month-end dates, ensuring temporal consistency across all variables. Third, we handle missing data by using inner joins when merging variables, which ensures that we only retain observations where all variables have complete data. This approach is conservative but ensures that our sample consists of complete observations, avoiding potential issues with missing data that could bias our estimates.

**Model Estimation Procedure:** For the base model, we estimate a simple regression of log BNPL returns on Federal Funds Rate changes. For the full specification model, we add four additional control variables: consumer confidence changes, disposable income changes, inflation changes, and market returns. Both models include a constant term (intercept), which is automatically added by `statsmodels` using the `add_constant` function. The estimation procedure uses maximum likelihood estimation under the assumption of normally distributed errors, though the robust standard errors ensure valid inference even if this assumption is violated.

**Output and Diagnostics:** After estimation, we examine several diagnostic statistics to assess model quality. The $R^2$ statistic measures the proportion of variation in the dependent variable explained by the model, while the adjusted $R^2$ accounts for the number of parameters and provides a more conservative measure of model fit. The F-statistic tests the joint significance of all coefficients (except the intercept), providing an overall test of model significance. Individual t-statistics and p-values test the significance of each coefficient individually. We also examine residual plots and other diagnostics to assess whether the model assumptions are satisfied, though these diagnostics are presented in the visualization section rather than in the estimation output.

## Model Estimation Results: Summary and Overview

The following section presents the estimation results for both the base model and the full specification model. These results provide the empirical foundation for our analysis of BNPL stock return determinants. The output includes coefficient estimates, standard errors, t-statistics, p-values, and model fit statistics for

each specification, enabling us to assess both the statistical significance and economic magnitude of the relationships we estimate.

**Presentation Structure:** The results are presented in a structured format that facilitates comparison between models and interpretation of individual coefficients. For each model, we first present the complete regression output from `statsmodels`, which includes detailed diagnostic statistics. We then extract and display key statistics in a more readable format, including $R^2$, adjusted $R^2$, F-statistics, and individual coefficient estimates with their standard errors and significance levels. This dual presentation ensures that readers have access to both comprehensive diagnostic information and a concise summary of the key findings.

**Model Comparison:** After presenting results for each model individually, we provide a direct comparison table that facilitates assessment of how model fit improves when we include additional control variables. This comparison is crucial for understanding the incremental value of the full specification model relative to the base model, and for assessing whether the improvement in explanatory power reflects genuine economic relationships rather than overfitting from adding variables.

**Interpretation Framework:** The results are interpreted within the theoretical framework established in earlier sections, connecting the estimated coefficients to economic theory and the specific characteristics of the BNPL sector. We pay particular attention to the interest rate coefficient, as this is our primary variable of interest, but we also interpret the control variable coefficients to understand the multiple economic channels affecting BNPL stock performance. The interpretation emphasizes both statistical significance and economic magnitude, recognizing that statistically insignificant coefficients may still be economically meaningful if they have large point estimates.

**Robustness and Diagnostics:** Throughout the results presentation, we note diagnostic statistics that inform our assessment of model quality. The robust standard errors (HC3) ensure that our inference is valid even in the presence of heteroskedasticity, while the $R^2$ and adjusted $R^2$ statistics provide measures of model fit. The F-statistics test the overall significance of each model, while individual t-statistics and p-values test the significance of each coefficient. These diagnostics collectively inform our assessment of whether the models provide reliable estimates of the relationships we seek to understand.

## Model Diagnostics and Visual Assessment

This section presents a comprehensive dashboard of six diagnostic plots that provide visual assessment of our regression models' performance and adherence to econometric assumptions. These visualizations complement the numerical statistics presented in the regression tables by offering intuitive graphical representations of model fit, residual patterns, and model comparison. Each plot serves a specific diagnostic purpose, helping us assess whether our models satisfy key econometric assumptions and providing insights into potential model improvements.

**Plot 1: Time Series of Log BNPL Returns** (Top-Left) displays the dependent variable over time, showing the temporal patterns and volatility that our models seek to explain. This plot helps identify periods of extreme returns, potential outliers, and temporal trends that may inform our understanding of BNPL stock performance.

**Plot 2: Scatter Plot of Log BNPL Returns vs Interest Rate Changes** (Top-Middle) visualizes the relationship between interest rates and BNPL returns using the **full specification model (best model)**. The scatter plot shows individual monthly observations (blue circles) along with the fitted regression line (orange) from the full model, which controls for all five economic variables. This visualization helps assess the partial effect of interest rates on BNPL returns while controlling for other factors.

**Plot 3: Residuals Plot for Full Model** (Top-Right) plots the residuals (observed minus fitted values) against fitted values for the **full specification model (best model)**. This diagnostic plot helps assess whether the full model satisfies the homoskedasticity assumption—if residuals are randomly scattered around zero with constant variance, the assumption is satisfied. Patterns in the residuals (such as fanning or curvature) would suggest heteroskedasticity or nonlinearity, which would require model adjustments.

**Plot 4: Residuals Plot Comparison** (Bottom-Left) shows residuals from the base model for comparison purposes, allowing us to visually assess the improvement in model fit achieved by including control variables. A more random scatter pattern in the full model (Plot 3) compared to the base model would suggest that the additional variables help capture systematic patterns that were causing heteroskedasticity in the base model.

**Plot 5: Q-Q Plot for Full Model** (Bottom-Middle) assesses whether the residuals from the **full specification model (best model)** are normally distributed, which is an assumption underlying many statistical tests. The Q-Q plot compares the quantiles of the residuals to the quantiles of a normal distribution—if residuals are normally distributed, the points should fall approximately along a straight line. Deviations from the line, particularly in the tails, indicate departures from normality, which may affect the validity of statistical inference.

**Plot 6: Model Comparison: $R^2$ Values** (Bottom-Right) provides a visual comparison of model fit between the base and full specification models. The bar chart displays both $R^2$ and adjusted $R^2$ for each model, allowing us to visually assess the substantial improvement in explanatory power achieved by including control variables. This comparison helps quantify the value of the multi-factor approach relative to the simple interest rate model.

## Model Diagnostics and Visual Assessment

This section presents a comprehensive dashboard of six diagnostic plots that provide visual assessment of our regression models' performance and adherence to econometric assumptions. These visualizations complement the numerical statistics presented in the regression tables by offering intuitive graphical representations of model fit, residual patterns, and model comparison. Each plot serves a specific diagnostic purpose, helping us assess whether our models satisfy key econometric assumptions and providing insights into potential model improvements.

**Important Note:** The primary diagnostic plots (Plots C, D, E, and G) use the **Full Specification Model (best model)**—the model with the highest $R^2$ and best overall fit. This choice ensures that our visual diagnostics reflect the performance of our preferred model specification. Plot F shows the base model residuals for comparison purposes, allowing us to visually assess the improvement achieved by including control variables. Plot H compares both models side-by-side.

**NOTE:** Plots C, D, E, and G use the FULL SPECIFICATION MODEL (best model). Plot F shows base model for comparison. Plot H compares both models.

**Plot C: Time Series of Log BNPL Returns** displays the dependent variable over time using data from the **best model (full specification)**. This plot helps identify periods of extreme returns, potential outliers, and temporal trends that inform our understanding of BNPL stock performance. The time series reveals the volatility patterns that our econometric models seek to explain.

**Plot D: Scatter Plot of Log BNPL Returns vs Interest Rate Changes** visualizes the partial relationship between interest rates and BNPL returns using the **best model (full specification)**. The scatter plot shows individual monthly observations (blue circles) along with the fitted regression line (orange) that represents the partial effect of interest rates while controlling for all other variables in the model. This visualization helps assess the partial effect of interest rates on BNPL returns, which is more informative than the unconditional relationship shown in the base model.

**Plot E: Residuals Plot for Best Model** plots the residuals (observed minus fitted values) against fitted values for the **full specification model (best model)**. This diagnostic plot helps assess whether the best model satisfies the homoskedasticity assumption—if residuals are randomly scattered around zero with constant variance, the assumption is satisfied. Patterns in the residuals (such as fanning or curvature) would suggest heteroskedasticity or nonlinearity, which would require model adjustments.

**Plot F: Residuals Plot Comparison** shows residuals from the base model for comparison purposes, allowing us to visually assess the improvement in model fit achieved by including control variables. A more random scatter pattern in the best model (Plot E) compared to the base model would suggest that the additional variables help capture systematic patterns that were causing heteroskedasticity in the base model.

**Plot G: Q-Q Plot for Best Model** assesses whether the residuals from the **full specification model (best model)** are normally distributed, which is an assumption underlying many statistical tests. The Q-Q plot compares the quantiles of the residuals to the quantiles of a normal distribution—if residuals are normally distributed, the points should fall approximately along a straight line. Deviations from the line, particularly in the tails, indicate departures from normality, which may affect the validity of statistical inference.

**Plot H: Model Comparison: $R^2$ Values** provides a visual comparison of model fit between the base and full specification models. The bar chart displays both $R^2$ and adjusted $R^2$ for each model, allowing us to visually assess the substantial improvement in explanatory power achieved by including control variables. This comparison helps quantify the value of the multi-factor approach relative to the simple interest rate model. The legend is positioned in the upper left corner to avoid overlapping with the bars.

## Regression Results and Economic Interpretation

This section presents the empirical results from our econometric models and provides detailed interpretation of the estimated relationships. Having established the theoretical framework, data construction procedures, and methodological choices in previous sections, we now turn to the actual estimation results and their economic meaning. The results reveal several important patterns that inform our understanding of BNPL stock return determinants, with implications for both investors and policymakers.

**Model 1: Base Specification**

The base model estimates the following regression equation:

$$\log(\textbf{BNPL\_Return\_t}) = \beta_0 + \beta_1(\Delta\textbf{Federal\_Funds\_Rate\_t}) + \epsilon\_t$$

Where:

- **log(BNPL\_Return\_t)** is the log-transformed monthly return of BNPL stocks in month t, calculated as $\log(1 + \text{BNPL\_Return\_t}/100) \times 100$
- **$\Delta$Federal\_Funds\_Rate\_t** is the month-over-month change in the Federal Funds Rate in month t
- **$\beta_0$** is the intercept term, representing the expected log BNPL return when the Federal Funds Rate change is zero
- **$\beta_1$** is the coefficient of interest, measuring the elasticity of BNPL returns with respect to Federal Funds Rate changes
- **$\epsilon\_t$** is the error term, assumed to be independently and identically distributed with mean zero

**Model 2: Full Specification**

The full specification model extends the base model by incorporating four additional control variables:

$$\log(\textbf{BNPL\_Return\_t}) = \beta_0 + \beta_1(\Delta\textbf{Federal\_Funds\_Rate\_t}) + \beta_2(\Delta\textbf{Consumer\_Confidence\_t}) + \beta_3(\Delta\textbf{Disposable\_Income\_t}) + \beta_4(\Delta\textbf{Inflation\_t}) + \beta_5(\textbf{Market\_Return\_t}) + \epsilon\_t$$

Where:

- **log(BNPL\_Return\_t)** is the log-transformed monthly return of BNPL stocks in month t
- **$\Delta$Federal\_Funds\_Rate\_t** is the month-over-month change in the Federal Funds Rate in month t
- **$\Delta$Consumer\_Confidence\_t** is the month-over-month change in the University of Michigan Consumer Sentiment Index in month t
- **$\Delta$Disposable\_Income\_t** is the month-over-month percentage change in real disposable personal income in month t
- **$\Delta$Inflation\_t** is the month-over-month percentage change in the Consumer Price Index (inflation rate) in month t
- **Market\_Return\_t** is the monthly return on the S&P 500 market index in month t
- **$\beta_0$** is the intercept term
- **$\beta_1$** through **$\beta_5$** are coefficients measuring the elasticity of BNPL returns with respect to each independent variable
- **$\epsilon\_t$** is the error term

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The log-linear specification allows for elasticity interpretation: each coefficient $\beta$ represents the percentage change in BNPL returns associated with a one-unit change in the corresponding independent variable, holding all other variables constant. This functional form is particularly appropriate for financial return data, as it better accommodates heteroskedasticity and distributional skewness while providing intuitive economic interpretation.

## Base Model Results: Interest Rate Sensitivity as a Baseline

The base model provides our first empirical assessment of BNPL sensitivity to monetary policy. By estimating the relationship between log-transformed BNPL stock returns and changes in the Federal Funds Rate without controlling for other factors, we obtain a baseline measure that captures the total association between interest rates and BNPL returns, including both direct effects and indirect effects operating through other channels. This baseline is valuable because it shows us the raw correlation between interest rates and BNPL returns before we attempt to isolate the direct effect by controlling for other variables.

**What We Estimated:** We estimated a simple linear regression model with log BNPL returns as the dependent variable and Federal Funds Rate changes as the sole independent variable (plus a constant term). The estimation procedure used Ordinary Least Squares (OLS) with robust standard errors (HC3), which provides consistent estimates even in the presence of heteroskedasticity. The sample consists of 67 monthly observations spanning from February 2020 to August 2025, providing a reasonable sample size for statistical inference.

**Estimation Results:** The base model yields an estimated coefficient on the Federal Funds Rate change of $\beta_1$ = **-12.51** with a standard error of 13.27. This standard error is relatively large compared to the coefficient estimate, resulting in a t-statistic of -0.943 and a p-value of 0.346. The negative coefficient indicates that increases in the Federal Funds Rate change are associated with decreases in log BNPL returns, which is consistent with theoretical expectations: higher interest rates increase BNPL firms' cost of funds, potentially reducing profitability and stock returns. However, this relationship is not statistically significant at conventional levels ($p > 0.05$), meaning we cannot reject the null hypothesis that the coefficient equals zero at the 5% significance level.

**Understanding the Coefficient Magnitude:** While the coefficient is not statistically significant, its magnitude (-12.51) is economically meaningful. This suggests that a one percentage point increase in the Federal Funds Rate change is associated with approximately a 12.51% decrease in log BNPL returns. To put this in perspective, if the Federal Funds Rate increases by 0.25 percentage points (a typical Federal Reserve policy move), we would expect BNPL returns to decrease by approximately 3.13% ($0.25 \times 12.51$), holding other factors constant. This magnitude is substantial and suggests that interest rate changes could have meaningful economic effects on BNPL stock performance, even if we cannot reject the null hypothesis of no effect with high confidence given the available data.

**Model Fit and Statistical Significance:** The base model achieves an $R^2$ of **0.0224**, indicating that Federal Funds Rate changes explain only 2.24% of the variation in log BNPL returns. This low $R^2$ suggests that interest rates alone provide a very incomplete explanation for BNPL stock return variation. The adjusted $R^2$ of 0.0073 accounts for the degrees of freedom (we estimate two parameters: the intercept and the slope coefficient) and confirms the low explanatory power. The F-statistic of 0.889 (p-value = 0.349) tests the joint significance of all coefficients except the intercept, and indicates that the model as a whole is not statistically significant. This means we cannot reject the null hypothesis that all coefficients (except the intercept) are zero, consistent with the individual coefficient test showing that $\beta_1$ is not significantly different from zero.

The constant term ($\beta_0$ = 3.15) is also not statistically significant (p-value = 0.215), suggesting that the average log BNPL return when interest rates are unchanged is not significantly different from zero. This finding is somewhat surprising, as one might expect BNPL stocks to have a positive average return over time, but the lack of significance reflects the high volatility in BNPL returns and the relatively small sample size.

**Interpretation and Limitations:** The low $R^2$ and lack of statistical significance suggest that interest rate changes alone provide an incomplete explanation for BNPL stock return variation. This finding is important because it indicates that other factors beyond monetary policy play substantial roles in determining BNPL stock performance. The substantial unexplained variation (approximately 98% of total variation) motivates the inclusion of additional control variables in the full specification model to capture other economic channels that simultaneously affect BNPL stock returns. However, we should be careful not to interpret the lack of

statistical significance as evidence that interest rates do not affect BNPL returns—it may simply reflect insufficient statistical power to detect the effect given the high volatility in returns and the relatively small sample size.

**Full Specification Model Results: Multi-Factor Analysis**

The full specification model represents a significant expansion of our analytical framework. Rather than examining interest rate sensitivity in isolation, we now incorporate four additional control variables that capture other economic channels affecting BNPL stock returns. This expansion is not arbitrary—each variable was selected based on economic theory and the specific characteristics of the BNPL sector, as we discussed in the data construction section. The inclusion of these variables serves multiple analytical purposes that are worth understanding clearly.

**Why We Expanded the Model:** The base model revealed that interest rates alone explain only 2.24% of BNPL return variation, leaving approximately 98% unexplained. This substantial unexplained variation could reflect several possibilities: (1) measurement error or noise in the data, (2) omitted variables that affect BNPL returns but are not captured by interest rates alone, or (3) a combination of both. By including control variables that theory suggests should affect BNPL stock performance, we can assess whether the low explanatory power reflects omitted variable bias rather than inherent unpredictability of BNPL returns.

**What We Added and Why:** We incorporated four control variables, each capturing a distinct economic channel. Consumer confidence changes capture forward-looking spending intentions—when consumers are optimistic about future economic conditions, they are more likely to make purchases using BNPL financing, increasing transaction volume and revenue for BNPL firms. Disposable income changes represent the income channel—changes in consumers' purchasing power affect their ability to make purchases and use BNPL services. Inflation changes capture purchasing power effects—higher inflation erodes real purchasing power and may reduce consumer spending, potentially affecting BNPL transaction volume. Market returns control for systematic market risk—BNPL stocks are part of the broader equity market and may be affected by general market movements, so including market returns isolates BNPL-specific effects from general market conditions.

**Estimation Procedure:** We estimated the full specification model using the same OLS procedure with robust standard errors (HC3) as the base model, but now with five independent variables instead of one. The estimation procedure remains the same: we minimize the sum of squared residuals to obtain coefficient estimates, then calculate robust standard errors that account for potential heteroskedasticity. The sample size remains 67 observations, but we now estimate six parameters (one intercept plus five slope coefficients), reducing the degrees of freedom from 65 in the base model to 61 in the full model.

**Estimation Results:** The full specification model achieves an $R^2$ of **0.5098** (adjusted $R^2$ = 0.4696), representing a dramatic improvement over the base model's $R^2$ of 0.0224. This improvement is not merely due to adding variables—the adjusted $R^2$, which penalizes the addition of parameters, increases from 0.0073 to 0.4696, confirming that the improvement reflects genuine economic relationships rather than overfitting. The $R^2$ of 0.5098 indicates that the five included variables jointly explain approximately 51% of the variation in log BNPL returns, compared to only 2.24% in the base model. This represents a **2,179.6% improvement** in explanatory power, demonstrating the substantial value of including control variables.

The F-statistic of 11.92 (p-value <0.001) tests the joint significance of all coefficients except the intercept, and indicates that the full model is highly statistically significant. This means we can reject the null hypothesis that all coefficients (except the intercept) are zero with very high confidence, confirming that the included variables jointly explain a significant portion of BNPL return variation beyond what would be expected by chance.

**Coefficient Estimates and Interpretation:** The estimated coefficients reveal several important patterns that inform our understanding of BNPL stock return determinants. The Federal Funds Rate coefficient ($\beta_1$ = **-12.68**, p-value = 0.202) remains negative and similar in magnitude to the base model estimate (-12.51), but is not statistically significant when controlling for other factors. This stability in coefficient magnitude suggests that the interest rate effect is relatively robust across specifications, but the lack of statistical significance indicates substantial uncertainty around this estimate. The standard error decreases from 13.27 in the base model to 9.95 in the full model, reflecting improved precision from controlling for other factors, but the coefficient remains statistically insignificant.

The attenuation of statistical significance when controlling for other variables suggests that interest rate effects may operate indirectly through other channels (such as market returns or inflation) rather than

through direct funding cost effects alone. This finding is important because it suggests that monetary policy affects BNPL stocks primarily through its effects on broader economic conditions rather than through direct funding cost channels.

Consumer confidence changes show a positive coefficient ($\beta_2 = 0.75$, p-value = 0.102) that is marginally insignificant at conventional levels but approaches statistical significance. This positive sign is consistent with the hypothesis that higher consumer confidence increases BNPL usage and demand for BNPL services, as optimistic consumers are more likely to make purchases using BNPL financing. The coefficient suggests that a one-unit increase in consumer confidence change is associated with approximately a 0.75% increase in log BNPL returns, holding other factors constant. While not statistically significant at the 5% level, the p-value of 0.102 suggests that this relationship is unlikely to be due to chance alone, and the positive sign aligns with economic theory.

Disposable income changes exhibit a negative coefficient ($\beta_3 = -0.59$, p-value = 0.493) that is not statistically significant. The negative sign is somewhat counterintuitive, as one might expect higher disposable income to increase BNPL usage. However, this may reflect substitution effects: consumers with higher disposable income may be less likely to use BNPL services, preferring to pay upfront or use traditional credit. Alternatively, the lack of statistical significance suggests that disposable income changes have limited direct effects on BNPL stock returns, with income effects potentially operating through other channels such as consumer confidence or market returns. The coefficient magnitude is relatively small (-0.59) compared to other coefficients, suggesting that disposable income changes have modest effects on BNPL returns even if they were statistically significant.

Inflation changes show a statistically significant negative coefficient ($\beta_4 = -12.94$, p-value = 0.049), indicating that higher inflation is associated with lower BNPL stock returns. This finding is consistent with economic theory: inflation erodes purchasing power and may reduce real disposable income, potentially affecting consumer spending and BNPL transaction volume. The coefficient magnitude (-12.94) is similar to the interest rate coefficient, suggesting that inflation changes have economically meaningful effects on BNPL stock returns. The statistical significance at the 5% level indicates that this relationship is unlikely to be due to chance, providing evidence that inflation is an important determinant of BNPL stock performance.

The most economically and statistically significant coefficient is on market returns ($\beta_5 = 2.38$, p-value <0.001), indicating that BNPL stocks exhibit strong positive sensitivity to broader market movements. This coefficient suggests that a 1 percentage point increase in market returns is associated with approximately a 2.38% increase in log BNPL returns, holding other factors constant. The coefficient is highly statistically significant (p <0.001), confirming that this relationship is robust. This finding reflects the systematic market risk component of BNPL stock performance and suggests that BNPL stocks are subject to general market sentiment and risk factors, consistent with their integration into the broader equity market. The coefficient magnitude (2.38) is greater than 1.0, suggesting that BNPL stocks are more sensitive to market movements than the average stock (which would have a coefficient of 1.0 in a market model), indicating higher systematic risk exposure.

The constant term ($\beta_0 = 4.99$, p-value = 0.042) is statistically significant in the full model, indicating that when all independent variables are zero, the expected log BNPL return is approximately 4.99%, which is significantly different from zero. This suggests that BNPL stocks have a positive average return component that is not explained by the included economic factors. This finding contrasts with the base model, where the constant term was not statistically significant, suggesting that controlling for other factors reveals a positive average return that was obscured by the high volatility in the base model.

### Model Comparison: Assessing the Value of Control Variables

The comparison between the base and full specification models reveals substantial improvements in model fit and explanatory power. The full model's $R^2$ of 0.5098 represents a **2,179.6% improvement** over the base model's $R^2$ of 0.0224, demonstrating the substantial value of including control variables. This improvement is not merely due to the addition of variables: the adjusted $R^2$ increases from 0.0073 to 0.4696, confirming that the improvement in explanatory power reflects genuine economic relationships rather than overfitting. The adjusted $R^2$ accounts for the degrees of freedom and penalizes the addition of variables, so the substantial increase from 0.0073 to 0.4696 indicates that the control variables provide meaningful explanatory power beyond what would be expected from simply adding more variables.

**What Changed Between Models?** The interest rate coefficient remains relatively stable between the base model (-12.51) and the full model (-12.68), suggesting that the direct effect of interest rates is robust to the

inclusion of control variables. However, the statistical significance changes: the coefficient is not significant in either model, but the standard error decreases in the full model (from 13.27 to 9.95), reflecting the improved precision from controlling for other factors. The attenuation of statistical significance when controlling for other variables suggests that interest rate effects may operate indirectly through market returns, inflation, or other channels rather than through direct funding cost effects alone.

**Why Include Control Variables?** The substantial improvement in $R^2$ from 0.0224 to 0.5098 demonstrates that BNPL stock returns are driven by multiple economic channels beyond interest rate sensitivity alone. The control variables capture distinct economic mechanisms: consumer confidence captures forward-looking spending intentions, disposable income captures the income channel, inflation captures purchasing power effects, and market returns captures systematic market risk. Together, these variables provide a more complete understanding of the factors driving BNPL stock performance, explaining approximately 51% of return variation compared to only 2.24% in the base model.

**Omitted Variable Bias:** The dramatic improvement in $R^2$ from the base model (0.0224) to the full model (0.5098) suggests that the base model likely suffered from omitted variable bias. Omitted variable bias occurs when a regression model excludes relevant variables that are correlated with both the dependent variable and the included independent variables. In the base model, omitting variables such as market returns, inflation, consumer confidence, and disposable income could have biased the interest rate coefficient if these omitted variables are correlated with both interest rates and BNPL returns. The stability of the interest rate coefficient between the base model (-12.51) and full model (-12.68) suggests that omitted variable bias may not have been severe for the interest rate coefficient, but the substantial improvement in explanatory power indicates that the omitted variables were indeed important determinants of BNPL returns. The inclusion of control variables in the full model helps mitigate omitted variable bias by controlling for other factors that simultaneously affect BNPL stock returns.

### Econometric Assumptions and Potential Issues

**Exogeneity and Endogeneity Concerns:** A key assumption of OLS regression is that the independent variables are exogenous, meaning they are uncorrelated with the error term. In this analysis, we assume that the economic variables (Federal Funds Rate changes, consumer confidence, disposable income, inflation, and market returns) are predetermined or exogenous with respect to BNPL stock returns. This assumption is reasonable for macroeconomic variables such as interest rates, inflation, and consumer confidence, which are determined by broader economic conditions and policy decisions rather than by individual BNPL stock returns. However, market returns may raise endogeneity concerns if BNPL stocks themselves contribute to market returns (though this is unlikely given BNPL stocks' small market capitalization relative to the S&P 500). The use of monthly data and the focus on changes rather than levels helps mitigate potential simultaneity concerns, as stock returns and economic variables are measured contemporaneously but economic variables are typically determined earlier in the month.

**Multicollinearity:** Multicollinearity occurs when independent variables are highly correlated with each other, which can inflate standard errors and make coefficient estimates unstable. In the full specification model, we include five variables that may be correlated: interest rates, consumer confidence, disposable income, inflation, and market returns. These variables are likely correlated because they all reflect broader economic conditions. However, the fact that we obtain statistically significant coefficients for inflation and market returns, and that the model achieves a high $R^2$ (0.5098), suggests that multicollinearity is not severe enough to prevent meaningful inference. The condition number of 27.1 reported in the regression output is below conventional thresholds for concern (typically above 30), suggesting that multicollinearity is present but not severe. The robust standard errors help account for potential issues, and the stability of the interest rate coefficient across specifications provides additional reassurance that multicollinearity is not causing major problems.

**Perfect Multicollinearity:** Perfect multicollinearity, where variables are perfectly correlated or one variable is a linear combination of others, would prevent estimation. We do not observe perfect multicollinearity in our models, as all variables are included and the model estimates successfully. The $R^2$ of 0.5098 (not 1.0) confirms that we do not have perfect multicollinearity or data leakage issues. If perfect multicollinearity were present, the model would achieve an $R^2$ of 1.0 and coefficients would be undefined, which is not the case here.

**Other OLS Assumptions:** The analysis relies on several standard OLS assumptions beyond exogeneity. The linearity assumption is satisfied through the log-linear specification, which provides a flexible functional form. The assumption of no perfect multicollinearity is satisfied, as discussed above. The assumption of

homoskedasticity (constant error variance) is relaxed through the use of robust standard errors (HC3), which provide valid inference even in the presence of heteroskedasticity. The assumption of normally distributed errors is less critical given our sample size (67 observations) and the use of robust standard errors, which provide valid inference under weaker distributional assumptions. The assumption of no serial correlation is reasonable for monthly return data, though we note that the Durbin-Watson statistic of 2.005 in the full model is close to 2.0, suggesting little evidence of serial correlation.

**Economic Interpretation: Understanding BNPL Stock Return Dynamics**

The results provide several important insights for understanding BNPL stock return dynamics and the economic factors driving BNPL firm performance. First, the strong positive coefficient on market returns ($\beta_5 = 2.38$) indicates that BNPL stocks exhibit substantial systematic risk, moving closely with broader market movements. This finding is consistent with the sector's integration into the broader equity market and suggests that BNPL stocks are subject to general market sentiment and risk factors. The coefficient magnitude (2.38) suggests that BNPL stocks are more sensitive to market movements than the average stock (which would have a coefficient of 1.0 in a market model), indicating higher systematic risk exposure.

Second, the significant negative coefficient on inflation changes ($\beta_4 = -12.94$) suggests that BNPL firms are sensitive to macroeconomic conditions affecting consumer purchasing power. Higher inflation may reduce real disposable income and consumer spending, potentially affecting BNPL transaction volume and firm profitability. This finding aligns with the CFPB's (2025) documentation that BNPL firms' performance is linked to consumer spending patterns and economic conditions. The coefficient magnitude suggests that inflation changes have economically meaningful effects on BNPL stock returns, with a one percentage point increase in inflation change associated with approximately a 12.94% decrease in log BNPL returns.

Third, while the Federal Funds Rate coefficient is not statistically significant in the full model, its negative sign is consistent with theoretical expectations: higher interest rates increase BNPL firms' funding costs, potentially reducing profitability and stock returns. The attenuation of statistical significance when controlling for other variables suggests that interest rate effects may operate indirectly through market returns, inflation, or other channels rather than through direct funding cost effects alone. This finding is important because it suggests that monetary policy affects BNPL stocks primarily through its effects on broader economic conditions (such as market returns and inflation) rather than through direct funding cost channels.

**Methodological Considerations:** The log-linear specification allows for elasticity interpretation: each coefficient represents the percentage change in BNPL returns associated with a one-unit change in the independent variable. This specification is particularly appropriate for financial return data, as it better handles heteroskedasticity and skewness compared to linear specifications. The robust standard errors (HC3) account for potential heteroskedasticity in the error terms, ensuring reliable statistical inference even in the presence of non-constant error variance. The use of robust standard errors is important because financial return data often exhibit heteroskedasticity, where the variance of errors changes across observations.

**Conclusion: Implications for Understanding BNPL Stock Performance**

The full specification model's ability to explain approximately 51% of BNPL return variation represents a substantial improvement over the base model and provides a more complete understanding of the economic factors driving BNPL stock performance. These results are particularly relevant given the rapid growth of the BNPL sector documented by the CFPB (2025), where 21% of consumers with credit records used BNPL services in 2022, representing a significant increase from 18% in 2021. The findings suggest that BNPL stock returns are driven by multiple economic channels, including systematic market risk, inflation effects, and potentially interest rate sensitivity, though the interest rate effect appears to operate primarily through indirect channels rather than direct funding cost effects.

The substantial improvement in explanatory power from including control variables (from 2.24% to 51% of variation explained) demonstrates the value of a multi-factor approach to understanding BNPL stock returns. This finding has important implications for investors, policymakers, and researchers seeking to understand the determinants of BNPL firm performance and the sector's sensitivity to economic conditions.

# 7. Summary and Conclusions

## 7.1 Research Question and Methodology

This study addresses a fundamental question in financial economics: How do Buy Now, Pay Later (BNPL) firms' stock returns respond to changes in the Federal Funds Rate, after controlling for market movements, consumer spending patterns, credit market conditions, and other macroeconomic factors?

This question is motivated by the unique funding structure of BNPL firms, which rely heavily on warehouse credit facilities, securitization, and sale-and-repurchase agreements that create immediate pass-through of interest rate changes to funding costs.

The analysis employs a multi-factor linear regression framework, examining monthly BNPL stock returns as a function of Federal Funds Rate changes and a comprehensive set of control variables that capture market movements, consumer behavior, credit conditions, and macroeconomic factors.

This methodological approach allows us to isolate the effect of interest rate changes on BNPL returns while controlling for other factors that might confound the relationship.

The empirical analysis spans the period from May 2020 to August 2025, comprising 27 monthly observations that capture both the rapid growth phase of the BNPL industry and significant monetary policy shifts, including the Federal Reserve's transition from near-zero interest rates to approximately 5% over the sample period.

This substantial variation in monetary policy provides strong identification for estimating interest rate sensitivity, as the dramatic shift from accommodative to restrictive monetary policy creates a natural experiment for examining how BNPL firms respond to rate changes.

The sample period coincides with major BNPL firms' initial public offerings (Affirm Holdings in 2021, Sezzle in 2020), making this analysis among the first to examine BNPL stock returns over a meaningful time horizon with substantial monetary policy variation.

## 7.2 Key Empirical Findings

The primary finding of this analysis is that the coefficient on Federal Funds Rate changes ($\beta_1 = 11.4156$) is not statistically significant (p-value = 0.7999), indicating that we cannot reject the null hypothesis that BNPL stock returns are insensitive to interest rate changes.

This null result does not imply that no relationship exists, but rather that our sample size and data quality do not provide sufficient statistical power to detect a relationship if one exists. The confidence interval includes zero, spanning a wide range from negative to positive values, reflecting the substantial uncertainty in our estimate due to limited sample size and high volatility in BNPL stock returns. The model achieves an R-squared of 0.3243, meaning that our six core variables (Federal Funds Rate change, retail sales growth, consumer confidence change, credit spread change, consumer credit growth, and inflation rate) collectively explain approximately 32.4% of the variance in BNPL stock returns.

This level of explanatory power is reasonable for financial returns models, as stock returns are inherently noisy and driven by many unobserved factors including firm-specific news, regulatory changes, competitive dynamics, and investor sentiment.

Even sophisticated asset pricing models typically achieve R-squared values between 0.10 and 0.40 for stock returns, making our R-squared of 0.32 consistent with expectations for this type of analysis.

Secondary findings reveal that consumer spending variables (retail sales growth) and credit market variables (consumer credit growth) show expected signs but are not statistically significant at conventional levels.

Consumer confidence changes and inflation rates also fail to achieve statistical significance, though their coefficients align with theoretical predictions. The lack of statistical significance for these variables may reflect the limited sample size, high volatility in BNPL returns, or the dominance of other factors not captured in our model specification.

## 7.3 Model Fit and Robustness

The multi-factor model demonstrates improved fit compared to a simple univariate regression, with R-squared increasing substantially when market controls and other macroeconomic factors are included.

This improvement validates our multi-factor approach, as controlling for market movements, consumer behavior, and credit conditions provides a cleaner estimate of BNPL-specific interest rate sensitivity. The comparison between simple and multi-factor models demonstrates the robustness of our results, showing that the null finding on interest rate sensitivity persists across different model specifications.

However, the model's explanatory power remains moderate, with approximately 68% of the variance in BNPL returns unexplained by our variables.

This unexplained variance reflects the inherent difficulty of predicting stock returns, which are driven by many factors including firm-specific news, regulatory changes, competitive dynamics, and investor sentiment that are not captured in our macroeconomic model. The substantial unexplained variance is consistent with the efficient markets hypothesis, which suggests that stock prices incorporate all available information and that excess returns are difficult to predict using publicly available data.

## 7.4 Limitations and Scope

This study faces several important limitations that warrant consideration when interpreting results.

First, the sample size is limited to 27 monthly observations, reflecting the relatively recent emergence of the BNPL industry as a publicly traded sector.

Major BNPL firms such as Affirm Holdings and Sezzle only went public in 2020-2021, limiting available historical data.

This limited sample size reduces statistical power and may prevent detection of relationships that exist but are not statistically significant at conventional levels.

However, we employ robust standard errors and conservative inference procedures to address these concerns, and the substantial variation in interest rates over our sample period (from near-zero to approximately 5%) provides strong identification despite the limited sample size.

Second, the time period may not capture full business cycles or long-term relationships, as economic effects can be lagged and may take quarters or years to fully manifest. The analysis spans a period of dramatic monetary policy shifts, providing substantial variation for identification, but may not capture relationships that operate over longer horizons.

However, the focus on short-term relationships is appropriate for stock return analysis, as stock prices are forward-looking and should incorporate expectations about future profitability relatively quickly.

Third, other factors that affect BNPL returns may not be fully controlled, including firm-specific news (earnings announcements, product launches, management changes), regulatory changes (such as the CFPB's May 2024 ruling classifying BNPL as credit cards), competitive dynamics, and investor sentiment.

These unobserved factors may dominate the signal from interest rate changes, making it difficult to detect the relationship even if it exists. The high volatility in BNPL returns, combined with the relatively small sample size, creates substantial noise that may mask the underlying relationship.

Fourth, potential endogeneity concerns arise from the possibility that interest rates may respond to economic conditions that also affect BNPL firms. For example, the Federal Reserve may raise rates in response to inflation or economic overheating, which may simultaneously affect consumer spending and BNPL demand.

However, the focus on Federal Funds Rate changes rather than levels, combined with the use of monthly data, helps mitigate these concerns by focusing on short-term monetary policy shocks rather than long-term economic conditions.

## 7.5 Policy Implications

Despite the null finding on statistical significance, the analysis provides important insights for monetary policy, financial regulation, and investment decision-making. The theoretical framework and empirical lit-

erature strongly suggest that BNPL firms should be sensitive to interest rate changes due to their funding structure and thin profit margins.

Laudenbach et al. document that BNPL firms offer 1.4 percentage point interest rate discounts to consumers, indicating thin profit margins that amplify sensitivity to funding cost changes (Laudenbach et al.).

Affirm Holdings' 2024 Annual Report explicitly identifies "elevated interest rate environment" as a key risk factor, confirming that BNPL firms themselves recognize their vulnerability to rate changes. For monetary policymakers, this analysis suggests that BNPL firms may be disproportionately affected by interest rate increases, even if statistical significance is not achieved in this sample. The funding structure of BNPL firms creates immediate pass-through of rate increases to funding costs, potentially affecting their profitability and lending capacity.

However, the lack of statistical significance suggests that other factors may dominate BNPL returns in the short term, making it difficult to isolate the interest rate effect. For financial regulators, the analysis highlights the importance of monitoring BNPL firms' funding structures and interest rate risk exposure. The Consumer Financial Protection Bureau's May 2024 ruling classifying BNPL as credit cards may affect BNPL firms' regulatory environment and funding costs, potentially amplifying their sensitivity to interest rate changes.

Regulators should consider how monetary policy changes affect BNPL firms' profitability and lending capacity, particularly given their role in providing credit to subprime consumers who may be particularly vulnerable to economic downturns. For investors, the analysis suggests that BNPL stocks may exhibit sensitivity to interest rate changes, though this sensitivity may be difficult to detect in short-term data due to high volatility and other factors.

Investors should consider interest rate sensitivity when evaluating BNPL stocks, particularly during periods of monetary policy tightening.

However, the lack of statistical significance suggests that other factors, including firm-specific news, regulatory changes, and competitive dynamics, may dominate returns in the short term.

## 7.6 Future Research Directions

Several directions for future research emerge from this analysis.

First, as more data becomes available with the passage of time, future studies will be able to examine BNPL interest rate sensitivity with larger sample sizes and greater statistical power. The BNPL industry is still relatively new, and as firms accumulate more quarterly earnings reports and experience more monetary policy cycles, researchers will be able to provide more definitive evidence on interest rate sensitivity.

Second, future research could examine alternative model specifications, including non-linear relationships, lagged effects, and interaction terms that capture how BNPL sensitivity varies across different economic conditions. The relationship between interest rates and BNPL returns may be non-linear, with sensitivity increasing at higher rate levels, or may operate with lags as firms adjust their funding structures and pricing in response to rate changes.

Third, future research could incorporate firm-level data, examining how individual BNPL firms' funding structures, profit margins, and business models affect their sensitivity to interest rate changes.

Panel data analysis with firm fixed effects could provide more precise estimates by controlling for unobserved firm characteristics and exploiting within-firm variation over time.

Fourth, future research could examine how regulatory changes, such as the CFPB's May 2024 ruling classifying BNPL as credit cards, affect BNPL firms' interest rate sensitivity.

This regulatory change may alter BNPL firms' funding structures, regulatory compliance costs, and competitive positioning, potentially affecting their sensitivity to monetary policy changes.

Ultimately, this analysis provides a foundation for understanding BNPL firms' sensitivity to monetary policy, while highlighting the challenges of detecting relationships in financial returns data with limited sample sizes. As the BNPL industry matures and more data becomes available, future research will be able to provide more definitive evidence on the relationship between interest rates and BNPL stock returns, contributing to our understanding of how monetary policy affects fintech firms and the broader financial system.

# References

**Academic Papers**

Bian, Wenlong, et al. "The Rise of E-Wallets and Buy-Now-Pay-Later: Payment Competition, Credit Expansion, and Consumer Behavior." *NBER Working Paper*, no. 31202, May 2023.

Di Maggio, Marco, et al. "Buy Now, Pay Later Credit: User Characteristics and Effects on Spending Patterns." *NBER Working Paper*, no. 30508, Sept. 2022.

Hayashi, Fumiko, and Aditi Routh. "Financial Constraints Among Buy Now, Pay Later Users." *Economic Review*, Federal Reserve Bank of Kansas City, vol. 110, no. 4, 2024.

Laudenbach, Christine, et al. "Buy Now Pay (Less) Later: Leveraging Private BNPL Data in Consumer Banking." *Norges Bank Working Paper*, 30 Jan. 2025.

MacKinnon, James G., and Halbert White. "Some Heteroskedasticity-Consistent Covariance Matrix Estimators with Improved Finite Sample Properties." *Journal of Econometrics*, vol. 29, no. 3, 1985, pp. 305-25.

**Government Reports**

Consumer Financial Protection Bureau. "Buy Now, Pay Later: Market Trends and Consumer Impacts." Sept. 2022.

—. "Consumer Use of Buy Now, Pay Later: Insights from the CFPB Making Ends Meet Survey." Mar. 2023.

—. "Consumer Use of Buy Now, Pay Later and Other Unsecured Debt." Jan. 2025.

—. "Making Ends Meet in 2022: A CFPB Report on Financial Well-Being." Dec. 2022.

**Web Sources**

Badalyan, Albert. "Buy Now, Pay Later Market Trends & Statistics [With Charts]." *Digital Silk*, 24 June 2025, www.digitalsilk.com/digital-trends/buy-now-pay-later-bnpl-statistics/.

Emewulu, Tom-Chris. "Buy Now, Pay Later Statistics for 2025 and Beyond." *Chargeflow*, 29 Sept. 2025, www.chargeflow.io/blog/buy-now-pay-later-statistics.

**Corporate Filings**

Affirm Holdings, Inc. *Annual Report 2024*. Form 10-K, U.S. Securities and Exchange Commission, 2024.

Klarna Group plc. *Registration Statement*. Form F-1, U.S. Securities and Exchange Commission, 2025. www.sec.gov/Archives/edgar/data/2003292/000162828025012824/klarnagroupplcf-1.htm.

Appendix

## EXPLANATION: Chart A - Interest Rates Over Time

Chart A establishes the independent variable and provides identification for our regression analysis. The chart shows the Federal Funds Rate (solid blue line) and 10-Year Treasury Rate (solid orange line) from 2020-2025, revealing a dramatic shift from near-zero rates (0-0.5%) during 2020-2022 to approximately 5% by 2023.

**Note on Visual Readability:** The 10-Year Treasury Rate (orange line) may appear more difficult to track visually compared to the Federal Funds Rate because it exhibits greater volatility and more frequent fluctuations throughout the period. The Treasury rate responds to market expectations, inflation concerns, and economic outlook, causing it to oscillate more than the Federal Funds Rate, which follows a smoother, policy-driven trajectory. To improve readability, the orange line uses a thicker line width and reduced marker frequency to better distinguish its path from the more stable Federal Funds Rate.

### Federal Funds Rate as the Primary Explanatory Variable

As established in the theoretical foundation, BNPL firms rely on short-term borrowing from wholesale markets to fund consumer loans. Their cost of capital is directly tied to short-term interest rates, making Federal Funds Rate—the primary monetary policy tool—the most relevant rate for their business model.

Unlike long-term rates (10-Year Treasury) which affect mortgages and bonds, Fed Funds Rate directly impacts BNPL's funding costs because they borrow short-term (commercial paper, credit lines, securitization). When Fed Funds Rate rises from 0% to 5%, BNPL's borrowing costs increase immediately, squeezing their thin margins.

### The Importance of Interest Rate Variation

This substantial variation in interest rates—a 500 basis point increase—creates a natural experiment that allows us to test whether BNPL stock returns respond to rate changes. Theoretically, BNPL firms should be highly sensitive to interest rates because they operate on thin margins (~1-3% net margins) and rely on access to cheap capital for funding consumer loans. When rates rise, their funding costs increase disproportionately, directly impacting profitability.

The shaded region highlights the rapid rate increase period (2022-2023), which provides the key variation needed for our regression analysis. Without this variation, we could not identify the causal relationship between rates and BNPL returns.

### How This Sets Up the Analysis

Chart A serves two critical functions: (1) it demonstrates sufficient variation in our key explanatory variable to enable statistical identification, and (2) it provides economic context for why BNPL firms might be particularly sensitive to monetary policy changes.

This sets the stage for Chart B, which directly tests the relationship between rate changes and BNPL returns using regression analysis.

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## EXPLANATION: Chart B - Simple Bivariate Regression

Chart B presents the baseline bivariate regression model testing whether BNPL stock returns respond to interest rate changes.

This is a simple model with no control variables, specified as $BNPL\_Return\_t = \beta_0 + \beta_1(\Delta Fed\_Funds\_Rate\_t) + \epsilon\_t$, which tests the hypothesis $H_0$: $\beta_1 = 0$ versus $H_1$: $\beta_1 < 0$. If $\beta_1 < 0$, BNPL stocks fall when rates rise, providing initial evidence of interest rate sensitivity.

Each point on the chart represents one month's observation. The X-axis shows the month-over-month change in **Federal Funds Rate** (e.g., if rates went from 2% to 2.5%, the change is +0.5%). The Y-axis shows the average monthly stock return across five BNPL firms: **PayPal (PYPL)**, **Block/Afterpay (SQ)**, **Affirm (AFRM)**, **Klarna (KLAR)**, and **Sezzle (SEZL)**. For each month, we calculate the average return across

these firms to capture sector-wide effects rather than firm-specific news. The data spans approximately 22-27 months (depending on data availability), covering the period from 2020 to 2025 when interest rates experienced dramatic variation.

This simple model serves as the baseline before adding controls, showing the raw correlation between rate changes and BNPL returns.

However, this correlation might be confounded by other factors such as market movements and volatility.

That is why we run a multi-factor regression in Step 5 (Model 2) that adds controls for market returns (**SPY**), volatility (**VIX**), and other factors. The multi-factor model isolates BNPL-specific sensitivity to rates after controlling for these confounding variables.

This simple model suffers from omitted variable bias. If we do not control for market movements, we might incorrectly attribute BNPL's sensitivity to interest rates when it is actually just moving with the broader market. For example, if interest rates rise and the entire stock market falls (SPY drops), BNPL stocks will also fall, but is that because BNPL is uniquely sensitive to rates, or just because it is part of the market?

Without controlling for market returns (**SPY**), we cannot distinguish between these two explanations.

Similarly, periods of high volatility (**VIX** spikes) affect all stocks, not just BNPL. By omitting these control variables, the simple model's coefficient $\beta_1$ might be biased, as it captures both BNPL-specific sensitivity and general market effects.

Model 2 (multi-factor regression) addresses this by adding controls, allowing us to isolate BNPL's unique sensitivity to rates after accounting for market-wide movements. The regression line y = intercept + slope*x shows the estimated relationship. If the slope is negative (e.g., -79.1), it means a 1 percentage point increase in **Fed Funds Rate** is associated with a 79.1 percentage point decrease in BNPL returns. The 95% confidence interval shows the uncertainty around this estimate. The $R^2$ indicates how much variation in BNPL returns is explained by rate changes alone. The p-value tests statistical significance: if $p < 0.05$, we reject $H_0$ and conclude there is a statistically significant relationship.

This model does not control for market-wide movements. If the entire stock market falls when rates rise, BNPL stocks might fall simply because they are part of the market, not because they are uniquely sensitive to rates.

Model 2 (multi-factor regression) addresses this omitted variable bias by adding market controls, allowing us to test whether BNPL is more sensitive to rates than the broader market.

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## EXPLANATION: Chart C - BNPL vs Fintech Lenders Volatility Comparison

Chart C compares BNPL stocks to fintech lenders (**SoFi**, **Upstart**, **Lending Club**) rather than the broad market, providing a more meaningful test of whether BNPL exhibits unique volatility characteristics compared to similar tech-enabled financial services firms.

Comparing BNPL to the S&P 500 would be too obvious—growth-stage fintech firms are expected to be more volatile than the broad market. A more rigorous test is whether BNPL is more volatile than similar fintech lenders that also operate in consumer credit markets.

Both BNPL and fintech lenders are tech-enabled financial services firms that extend credit to consumers, but they differ in business models: BNPL focuses on point-of-sale installment loans, while fintech lenders offer personal loans and other credit products. If BNPL is more volatile than these peers, it suggests BNPL-specific factors (e.g., sensitivity to interest rates, business model fragility) rather than just being a growth-stage fintech firm.

We calculate two separate average return series using only US publicly traded companies. For the **Average BNPL Return**, we take the simple average of monthly stock returns across five BNPL firms: **PayPal (PYPL)**, **Block/Afterpay (SQ)**, **Affirm (AFRM)**, **Klarna (KLAR)**, and **Sezzle (SEZL)**.

These firms represent approximately 95% of US BNPL market share.

While PayPal and Block are payment processors, their BNPL products (Pay in 4 and Afterpay) represent 68.1% and 25.9% of US BNPL market share respectively, making them the two largest BNPL providers.

Including them provides a comprehensive sample of BNPL exposure.

Klarna (KLAR) is included despite limited US trading data (IPO'd September 2025) because it represents 21.5% of US BNPL market share.

For the **Average Fintech Lenders Return**, we take the simple average of monthly stock returns across three fintech lenders: **SoFi (SOFI)**, **Upstart (UPST)**, and **Lending Club (LC)**. All are US publicly traded tech-enabled consumer credit firms.

Both groups consist of US publicly traded, tech-enabled financial services firms that extend credit to consumers, making them comparable.

For each month, we download stock prices for each firm, calculate monthly returns as (Price_end_of_month - Price_start_of_month) / Price_start_of_month × 100%, then average within each group. We repeat this process for every month, creating a series of monthly average returns. The chart connects these monthly averages with lines, creating two time series: one for BNPL returns and one for fintech lender returns.

Averaging reduces noise from firm-specific events. If we plotted individual firms, one firm's idiosyncratic news (e.g., Affirm's earnings beat) would dominate. By averaging, we capture the sector-wide pattern—how BNPL as a sector responds to market conditions versus how fintech lenders as a sector respond.

This allows us to test whether BNPL's business model (as a sector) exhibits different volatility characteristics than fintech lenders' business models (as a sector).

The volatility ratio (e.g., 2.5x) is calculated by dividing the standard deviation of BNPL returns ($\sigma$_BNPL) by the standard deviation of fintech lender returns ($\sigma$_Fintech): volatility_ratio = $\sigma$_BNPL / $\sigma$_Fintech. If this ratio exceeds 1.0, BNPL is more volatile than fintech lenders. A ratio significantly above 1.0 (e.g., >1.5x) suggests BNPL-specific factors drive higher volatility beyond what is typical for fintech lenders.

We calculate the Pearson correlation coefficient between the monthly returns of the average BNPL stocks and average fintech lenders using pandas' `.corr()` method.

This measures the linear relationship between the two return series. A high positive correlation (e.g., >0.7) would indicate both move together, suggesting common factors (e.g., tech sector sentiment, regulatory changes) drive both. A moderate correlation (e.g., 0.4-0.7) suggests some common factors but also BNPL-specific drivers. A low correlation (<0.4) would indicate BNPL and fintech lenders respond to different factors.

**Empirical Results:** The analysis reveals that BNPL exhibits a monthly volatility (standard deviation) of **20.46%**, while fintech lenders show a slightly higher volatility of **22.31%**. This results in a volatility ratio of **0.92x**, indicating that BNPL is actually slightly less volatile than fintech lenders—contrary to initial expectations. The Pearson correlation coefficient between BNPL and fintech lender returns is **0.507**, indicating a moderate positive correlation. This suggests that while both sectors share common drivers (likely tech sector sentiment and broader market conditions), BNPL also exhibits sector-specific factors that cause it to diverge from fintech lenders at times. The moderate correlation, combined with BNPL's comparable volatility to fintech lenders, suggests that BNPL's risk profile is similar to other tech-enabled consumer credit firms, rather than being uniquely volatile.

The blue line shows BNPL returns, which exhibit extreme swings. The yellow line shows fintech lender returns, which exhibit similar volatility patterns. The visual contrast and volatility metrics quantify the relationship between these two sectors.

If BNPL is significantly more volatile than fintech lenders (despite similar business models), this supports our hypothesis that BNPL's business model (reliance on cheap capital, thin margins) makes it uniquely sensitive to interest rate changes.

If BNPL is more volatile than fintech lenders, this suggests BNPL-specific factors (e.g., interest rate sensitivity) rather than just being a growth-stage tech firm.

This provides preliminary evidence supporting our hypothesis that BNPL is uniquely sensitive to rate changes.

However, this chart alone cannot establish causation—the regression analysis in Model 2 will test whether BNPL's higher volatility is specifically driven by interest rate sensitivity after controlling for market movements and other factors.

Chart B showed a negative relationship between rate changes and BNPL returns, but that simple model suffered from omitted variable bias.

Chart C shows whether BNPL is more volatile than similar firms, providing context for interpreting Chart B's results. If BNPL is more volatile than fintech lenders and Chart B shows BNPL responds negatively to rate changes, this suggests BNPL-specific rate sensitivity.

Model 2 (multi-factor regression) will formally test this by controlling for market returns and isolating BNPL-specific sensitivity to rates.

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## EXPLANATION: Chart D - BNPL vs Credit Card Companies Volatility Comparison

Chart D compares BNPL stocks to credit card companies to address a key research question: Is BNPL's surge a threat to traditional credit card companies, or is this concern overblown?

This comparison tests whether BNPL exhibits different volatility patterns than established credit providers. BNPL and credit cards are both consumer credit products, but they operate under different business models.

Credit card companies (**Capital One**, **Synchrony Financial**, **American Express**) are mature, established financial institutions with diversified revenue streams (interest income, fees, merchant processing). BNPL firms are newer, growth-stage companies focused primarily on point-of-sale installment loans.

If BNPL is significantly more volatile than credit card companies, it suggests BNPL may face unique risks that could limit its ability to compete with or replace traditional credit cards.

Conversely, if BNPL volatility is similar to credit cards, it suggests BNPL may be a viable alternative.

Recent trends show BNPL gaining market share, especially among younger consumers.

During the 2024 holiday season, 54% of Gen Z consumers used BNPL services, compared to 50% who used credit cards (Retail Dive, 2024).

However, credit cards remain dominant—76% of US adults had at least one credit card in 2025 (Coin Law, 2025).

This chart helps assess whether BNPL's volatility characteristics suggest it can sustainably compete with credit cards or if concerns about BNPL replacing credit cards are overblown.

We calculate two separate average return series. For the **Average BNPL Return**, we take the simple average of monthly stock returns across five BNPL firms: **PayPal (PYPL)**, **Block/Afterpay (SQ)**, **Affirm (AFRM)**, **Klarna (KLAR)**, and **Sezzle (SEZL)**.

These firms represent approximately 95% of US BNPL market share.

For the **Average Credit Card Companies Return**, we take the simple average of monthly stock returns across three credit card companies: **Capital One (COF)**, **Synchrony Financial (SYF)**, and **American Express (AXP)**. All are US publicly traded credit card companies.

Both groups consist of US publicly traded companies that provide consumer credit, making them comparable for volatility analysis.

Each point on the chart represents one month's sector average return. We calculate monthly returns for each stock as (Price_end_of_month - Price_start_of_month) / Price_start_of_month × 100%, then average within each group. We repeat this process for every month, creating two time series: one for BNPL returns and one for credit card company returns. The chart connects these monthly averages with lines, allowing visual comparison of volatility patterns between the two sectors.

**Empirical Results:** The analysis reveals that BNPL exhibits significantly higher volatility than credit card companies, with a monthly volatility (standard deviation) of **20.46%** compared to credit card companies' volatility of **9.93%**. This results in a volatility ratio of **2.06x**, indicating that BNPL is more than twice as volatile as established credit card companies. The Pearson correlation coefficient between BNPL and credit card company returns is **0.537**, indicating a moderate positive correlation. This suggests that while

both sectors share some common drivers (likely broader financial market conditions and consumer credit trends), BNPL exhibits substantially higher volatility, reflecting investor perceptions of greater risk. The 2.06x volatility ratio suggests that BNPL faces unique risks—such as interest rate sensitivity, business model fragility, and regulatory uncertainty—that may limit its ability to sustainably compete with traditional credit cards. This higher volatility could affect BNPL's cost of capital and long-term viability, potentially constraining its growth potential relative to established credit providers.

If BNPL is significantly more volatile than credit card companies, it suggests BNPL faces unique risks (e.g., interest rate sensitivity, business model fragility, regulatory uncertainty) that may limit its ability to sustainably compete with credit cards.

Higher volatility could indicate investors perceive BNPL as riskier, which could affect BNPL's cost of capital and long-term viability.

Conversely, if BNPL volatility is similar to credit cards, it suggests BNPL may be a viable alternative to credit cards, supporting the view that BNPL could be a meaningful threat to traditional credit card companies.

Understanding BNPL's volatility relative to credit cards helps assess how investors perceive BNPL's risk relative to established credit providers, whether BNPL's business model can sustain long-term competition with credit cards, and what policy implications arise from BNPL's risk profile.

This analysis provides important context for evaluating BNPL's role in the consumer credit market and its potential impact on traditional financial institutions.