OXFORD JOURNAL
OF STUDENT
SCHOLARSHIP

Speculative Capital and Kondratiev Waves in the Age of Investment

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ABSTRACT

While the exogenous money framework spearheaded by Friedman holds that engineered expansions of the M2 systematically precede and inflate asset valuations, Neo- and Post-Keynesian thought contends that the aforementioned supply is largely demand determined, led by incentives placed upon private banks responding to speculative borrowing. This conflict raises the question of whether overly-risky investment is a symptom or a cause of bubble formation and central governmental interference. This paper extends these concepts to the realm of technological innovation, testing for a Granger-causal relationship between innovation, expansionary monetary policy, and overly risky equity cycles, especially when coinciding with Kondratiev waves (stylized as K-Waves). This paper empirically tests the "double wave" (installation and deployment) framework established by Perez (2002) and Freeman & Louça (2001), examining the boom-bust cycles and expansions in the money supply that cause short-term speculative capital inflows to exceed real productive capacity within a reasonable time horizon.

Using quarterly U.S. data spanning 1959–2020 (n=248), it was found that valuation levels predict weaker three-year forward equity returns during long-wave expansion periods, even across alternate phase dating. However, this paper finds no Granger-causal link running from money supply or private credit growth to equity valuations, undercutting the exogenous-money account of the model. A secondary result provides suggestive but non-robust evidence connecting R&D growth to subsequent P/E growth, implying that speculation may be more directly driven by innovation than changes in the money supply. Following corrections, nonfarm labor productivity also exhibited no statistically significant change across symmetric windows.

INTRODUCTION

The debate at the heart of monetary economics may always be between the opposing frameworks of Post-Keynesian thought and Milton Friedman's monetarism[1]. Friedman's view (Friedman & Schwartz, 1963, chs 11-13) was that the money supply was something imposed upon an economy rather than something arising naturally from it (p. 12), with the implication of this being that the money supply,

[1] Friedman's analysis in *A Monetary History of the United States* is inherently more nuanced than what is described here. However, the overall summary should remain reasonably accurate as to portray a brief overview of a complex belief structure.

principally controlled by the central bank, would fluctuate and create relatively predictable effects on nominal economic output. Under this perspective, engineered expansions allow the government to wield monetary policy with precision and consistency.

In contrast to this view, post-Keynesian theorists such as Kaldor (1970) would argue that the money supply is demand determined, expanding as a second order response to borrowing demand influenced by central authorities[2]. Expanding on this view, Hyman Minsky (1992) would outline how profit-maximizing behaviors from individual financial agents can systematically generate fragility within markets which have been peaceful for long periods, as financial sectors shift from lower-risk investing to "speculative investing," a place in which revenues only cover interest, and eventually Ponzi financing, where asset appreciation alone justifies continued borrowing. These trades are justified by confidence created after prolonged stability, leading lenders to extend credit over aggressively. This precarious balance will, eventually, be toppled. As Minsky observed:

> "...if an economy with a sizeable body of speculative financial units is in an inflationary state, and the authorities attempt to exorcise inflation by monetary constraint, then speculative units will become Ponzi units and the net worth of previously Ponzi units will quickly evaporate" (p.8)

Thus, central banks, having allowed for or created overly-comfortable environments and attempting to correct, can lead to collapse. This is not the only path, however, but is the most common.

Minsky's framework is focused on the short-term business cycles; A complementary framework for understanding this on a longer time horizon are the dynamics that Nikolai Kondratiev investigated (1925/1984, pp. 25-35). Kondratiev identified long-term oscillations in aggregate economic activity, highlighting recurring patterns driven by slow depreciation and cost of creating new infrastructure. Joseph Schumpeter (1939/1989) would synthesize this with innovation, proposing that general purpose technology that creates prolonged investment based on new technology:

> "...practically all new [infrastructure] that is being constructed beyond replacement, and much of what is being constructed by way of replacement, either embodies some innovation or is a response to situations traceable to some innovation." (p. 94)[3]

To make these investments, entrepreneurs take credit. As technological advancements eventually slow after decreasing marginal returns, speculative finance is outpaced, and defaults lead to lost trust and recessions.[4]

Existing literature has developed a connection between these technological advancements and overspeculation, with Perez (2002) focusing on periods of "installation and development," while works

[2] Kaldor rebukes this most directly in p.16 of *The New Monetarism*, responding to Friedman's belief that exogenous factors are the primary drivers of change in the money supply: "This basic relationship between the money supply and GNP is modified… by the behaviour of the income-expenditure relation of those particular sectors whose net dependence on 'outside finance' is both large and liable to large variations, for reasons which are endogenous, not exogenous, to the sector."

[3] This describes creative destruction, which is generally accepted to be the driver behind K-waves.

[4] Schumpeter distinguished between K-waves, Juglar cycles, and Kitchin cycles, arguing that all of these operated simultaneously. The general trend outlined here is affected by other economic externalities.

such as Freeman and Louça (2001) connect long-term dynamics in technological revolutions to effects in production. Building off literature like this, this paper does not attempt to claim to have invented the double wave concept, but instead attempts to operationalize and quantitatively test Perez's framework while also building out the idea of a money supply fueled expansion. In doing so, this paper also connects to previous literature which evaluates valuation-ratio to return predictability (Campbell & Shiller, 1998; Fama & French, 1988)

THEORETICAL FRAMEWORK

Following the logic of Minsky's financial instability model, overexpansion of the money supply leads to an acceleration of investments built on credit, necessitating rapid returns. During the expansion phase of Kondratiev waves, creative destruction[5] allows for rapid growth and an opportunity for wealth creation, something for which investment firms know[6]. When firms are incentivized to accept low to negative margins, especially as valuations become heavily projection based and not current assets, opportunities for new technological clusters can be seen as having greater future returns than is necessarily accurate. Firms are incentivized to invest early, which can lead to over speculation that outpaces real productivity. This may have devastating consequences, with the largest fear being the financial markets overflowing into tangible markets and limiting macroeconomic output (both in the short-term and the long-term). When the K-wave inevitably leads to growth on tangible markets, economic output may be decreased compared to theoretically less-constrained development that would have been powered by innovative clusters fueled through credit[7]. Cartelization is also a concern, as companies with slightly more fundamentally sound balance sheets that could survive the original contraction may dominate the new market, leading to inefficient allocation of resources.

During the initial phase[8] of a K-wave, expectations regarding future productivity cause valuations to diverge from underlying cash flows. This mechanism is consistent with the installation phase described in Perez (2002), in which financial capital supports the expansion of new technological growth whilst simultaneously risking overexpansion due to unrealistic expectations around future opportunities[9]. When declining marginal returns and tightening liquidity eventually expose projects that depend on expanding credit, borrowing conditions deteriorate. This can lead to a correction; however, this correction does not necessarily represent the failure of the underlying technology, but instead represents an overeager market facing economic realities. This is, for the sake of this paper, described as "Wave 1."

[5] As outlined by Schumpeter, see p.94 and the quote attached to footnote 4.
[6] "Investment firm" is defined here very generally, similar to Minsky's use of banker. Any direct investor in equities is considered a "firm" for the sake of this paper.
[7] The implication being that a tight credit market would reduce the ability for companies to participate in creative destruction and generally increase aggregate production.
[8] Stylized as Wave 1 or W1 throughout the rest of this paper.
[9] This is an example of the "temporary components" in stock prices described by Eugene Fama and Kenneth French (1988) which generally lead to a regression of the mean towards a fundamental stock value.

The benefit of this contraction is that surviving firms are generally more fundamentally sound, allowing productive investment to continue despite destruction of speculative capital, though there should be a worry around collusion and the creation of a non-competitive environment. The second wave, in this scenario, would differ fundamentally from the first, being based on increasingly realized improvements in productivity. Price to earnings[10] ratios would be lower than the initial wave, even if still inflated, reflecting a lending market less dominated by speculative and Ponzi units[11]. Infrastructure and companies built during Wave 1 may begin generating tangible economic returns and rapid economic/financial growth would resume under more intrinsically stable financial conditions, as seen in the works of Perez (2002) and Freeman & Louça (2001). The negative impacts of Wave 1 may continue, however, potentially delaying the productivity gains associated with innovation, as lenders become overly risk-averse and constrict credit.

If the double-wave framework reflects the market, several relationships would arise. Periods associated with K-Waves could exhibit expansions in liquidity (shown in rapid growth in the M2) in Wave 1 and, as speculative investment accelerates, one-year forward equity returns gradually decline despite rising inflation-adjusted P/E ratios, implying market expectations outpaced productivity. Financial markets would later contract and credit may become tight while measures of productivity recover or continue unaffected. Should this occur, it would reinforce the theory that overeager firms accelerate capital allocation before productivity can follow in the initial parts of K-Waves. Eventually, the financial markets would recover to match the growth in productivity. If contraction eliminates a plurality of industries, indicators of concentration may rise in industries experiencing creative destruction. This would show how contractions reshape markets while also reallocating capital, although establishing causality between speculative finance and industrial concentration is beyond the scope of this paper.

METHODOLOGY / EMPIRICAL STRATEGY

This analysis uses quarterly United States macroeconomic and financial data spanning from 1959Q1-2020Q4 (n=248), including inflation-adjusted P/E ratios, M2, innovation measures, private credit growth where available, and three-year forward equity returns. Real activity is measured by non-farm labor productivity and innovation is proxied by real private fixed investment in research and development, commonly defined major diffusion periods, and secondarily by granted patents when available.

There are three hypotheses for which this paper is attempting to evaluate:
Hypothesis 1: The null hypothesis is that money supply growth and private credit growth[12] do not Granger-cause higher inflation adjusted equity valuations during an early expansion of K-waves.[13]

[10] Stylized as P/E throughout the rest of this paper.
[11] As defined by Minsky in *The Financial Instability Hypothesis*
[12] All evidence for this work comes from the United States, but the general foundation should be universal.
[13] Represented by unusually high patent and R&D spending, ending with corrections.

Hypothesis 2: The null hypothesis is that higher real equity valuations do not predict lower three-year forward returns during these early expansionary K-waves.
Hypothesis 3: The null hypothesis is that, after corrections, productivity growth does not continue or rises following falling asset prices and credit tightening.

Support for this idea would imply that finance and innovation move on different time scales and that this disconnection (combined with a Minsky-destabilized market[14] and knowledge of potential profits) creates a pattern of "double-waves" within equity values, resulting in negative effects that could, theoretically, delay long-run productivity gains.

DATA

As previously mentioned, this work draws on a quarterly United States time series spanning 1959Q1–2020Q4 (n=248). Money supply is M2[15]; private credit is a private-sector credit-to-GDP ratio; innovation is proxied by real private R&D spending[16] and, secondarily, granted patents[17] (for which the data exist only for 1992–2020 and could not be extended backward) within the U.S. Real activity is measured by non-farm labor productivity[18]. Valuation is represented through the Shiller cyclically-adjusted P/E (P/E10).

As Kondriatiev cycles last 45 to 60 years, the 62 year sample used here largely captures one full cycle. While data like Shiller's price series extends to 1871, the other data sources this author could gather did not. Consequently, this study can only explicitly test whether the double wave framework holds across one single episode and the captured "edges" of other episodes.

[14]Defined here as a market with a vast amount of speculative or Ponzi lenders following periods of relative stability, as theorized by Minsky.
[15] FRED M2SL
[16] FRED Y694RX1Q020SBEA, available the full period
[17] FRED PATENTUSALLTOTAL
[18] OPHNFB

Table 1: K-Wave Phase Dating

Phase Start	Phase End	Quarters (n)	Classification	Historical Event
1959-01-01	1968-10-01	40	Expansion	End of K4 expansion (postwar economic boom)
1969-01-01	1982-04-01	54	Correction	K4 wave-1 correction (oil shocks and stagflation)
1982-07-01	2000-10-01	74	Expansion	K5 initial expansion (web bubble)
2001-01-01	2002-10-01	8	Correction	K5 wave-1 correction (dot-com bust)
2003-01-01	2007-10-01	20	Expansion	K5 wave-2 expansion
2008-01-01	2009-04-01	6	Correction	Great Financial Crisis / K5 wave-2 contraction[19]
2009-07-01	2020-10-01	46	Expansion	Possible K6 Wave 1

K-wave phases were dated using a combination of standard long-wave periodization and empirical confirmation. Correction episodes were identified as drawdowns of 15 percent or more from the running real-price peak, combined with documented monetary or macroeconomic crises.

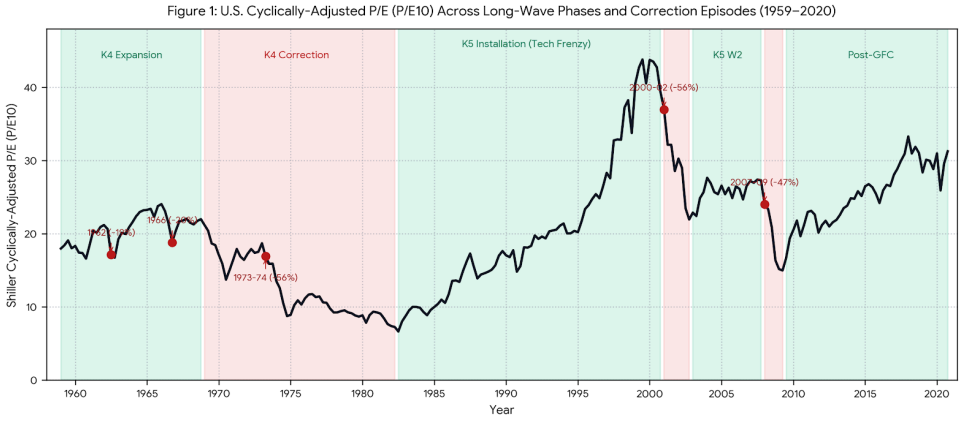
[19] The Great Financial Crisis is difficult to define within this model. It is more connected to boom-bust cycles within a normal economy than a reflection of technological growth. It does, however, reflect the Minsky theory of financial instability. Either way, it is considered a part of a K5 wave-2 contraction, as the ease of lending affected the growth of the tech industry.

Table 2: Empirically Detected Correction Episodes

Peak Date	Correction Start	Trough Date	Recovery Date	Real Drawdown	Duration	Pre R&D Trend	Credit/GDP Δ	Credit Tightening?	Episode Filter & Context
1962-01-01	1962-07-01	1962-10-01	1963-07-01	-19.4 %	2 Qtrs	10.14 %	+0.66 pp	False	1962 Flash Crash; verified by ≧ 15% drawdown (2Q duration)
1966-01-01	1966-10-01	1966-10-01	1967-04-01	-20.4 %	2 Qtrs	9.57 %	-0.17 pp	True	1966 Credit Squeeze; verified by ≧ 15% drawdown (2Q duration)
1973-01-01	1973-04-01	1974-10-01	1980-10-01	-55.7 %	7 Qtrs	3.46 %	+0.24 pp	False	OPEC stagflation bear market; verified by ≧ 15% drawdown (7Q duration)
2000-01-01	2001-01-01	2002-10-01	2006-10-01	-55.7 %	8 Qtrs	4.36 %	+0.38 pp	False	Perez Turning Point; verified by ≧ 15% drawdown (8Q duration)
2007-10-01	2008-01-01	2009-04-01	2013-01-01	-47.3 %	6 Qtrs	2.83 %	-0.35 pp	True	Subprime banking crisis; verified by ≧ 15% drawdown (6Q duration)

Expansion windows were cross-checked against a moving average of R&D growth. Agreement between the two is 53.9 percent of phase-labeled expansion quarters also showing above-median smoothed R&D growth. This is statistically indistinguishable from chance, and proves a very limited empirical connection, and so the periodisation should be understood as more qualitatively defined from quantitative data rather than endogenously confirmed by R&D data.

Fig.1: Shiller P/E Across K-Waves.



Note: Shaded bands represent the long-wave phases, but the dots represent correction episodes, so they don't necessarily align.

Notably, the definition of "Early" expansion within the non-alternate periodizations was very broad. In lieu of threshold tuning to find a preferred correlation which may not exist, this author elected to let it be.[20]

RESULTS

Hypothesis 1 failed to reject the null hypothesis, and the null cannot be rejected. Granger causality tests (nested-model F-tests, lags 1–8 quarters) find no significant relationship running from M2 growth or credit/GDP growth to P/E10 growth in the full sample (best p=0.107 and p=0.134, respectively) or, more importantly, within the K-wave early-expansion subsample specifically, where the hypothesis predicts the relationship should be strongest (p=0.115 and p=0.164).

However, an interesting and more direct pattern was noticed in connecting K-Waves to higher P/E ratios. In connecting R&D YoY growth and P/E YoY growth between 7-9 quarters out found statistical Granger causality,[21] but this is very sensitive to lag selection. The absence of reverse direction relationship is still

[20] Data referenced here can be found at https://doi.org/10.5281/zenodo.22435760, which should be permanently accessible. Should the data be unavailable, please contact the author.
[21] p = .0526, .0988 on a seven and eight quarter lag, full sample. At AIC (k=7) p = .0526, right outside of a 5% threshold but interesting enough for more research to be necessary. AT BIC (k=6), the null hypothesis could not be rejected at either a 10% or 5% threshold.

suggestive of an asymmetric pattern existing, and the evidence is consistent with the possibility that the innovation affects financial expectations. Granger causality here should not be seen as proof of innovation standing as the primary driver of speculative expansions, or necessarily a factor of structural causation, but it is an interesting idea which requires further empirical work.

Table 3: Bidirectional Granger Causality:

Lag (Qtrs)	n	R&D to P/E10 (F)	p-value	P/E10 to R&D (F)	p-value	Selection / Role
1	243	0.0076	0.9308	2.5243	0.1134	Baseline lag
2	242	1.2127	0.2992	0.6898	0.5027	
3	241	1.0758	0.3601	0.4953	0.6859	
4	240	1.5656	0.1843	0.8689	0.4833	Annual frequency
5	239	1.9582	0.0858	0.8589	0.5095	
6	238	1.6956	0.1231	0.5131	0.7981	BIC Selected (k=6)
7	237	2.0289	0.0526	0.7252	0.6508	AIC Selected (k=7)
8	236	1.7033	0.0988	0.6943	0.6964	
9	235	1.9258	0.0497	0.6628	0.7421	Marginal tail lag

Hypothesis 2 rejected the null hypothesis, albeit with caveats. A predictive regression of three-year-forward annualized real returns on log (P/E10), with Newey-West standard errors (16 lags) to account for return-overlap autocorrelation, shows a weak and statistically insignificant relationship in the full sample[22] that becomes large and highly significant within the K-wave early-expansion subsample[23].Valuation predicts subsequent returns specifically during these periods, consistent with the theoretical account of overextended expectations during early K-wave diffusion. This finding stood consistent even within Perez's (2002) installation chronology[24] and Freeman & Louça's K4 and K5 upswings alternate periodization.[25]

[22] slope=-4.66, t=-0.88, p=0.378, R^2=0.028, 236 observations
[23] slope=-16.18, t=-3.47, p=0.0005, R^2=0.256, 168 observations
[24] slope = -16.48, t=-2.76, p=0.0058, R^2=0.432, 74 observations
[25] slope = -17.91, t=-3.84, p=0.0001, R^2=0.381, 114 observations

Table 4: Hypothesis 2 Regressions, 3-Year Forward Returns

Specification	Total n	Non-Overlap	Intercept	Slope	HAC t-stat (16 lags)	HAC p-value	R^2	Methodological Role
Full Sample (1959–2020)	236	~20	16.48	−4.66	−0.88	0.3782	0.028	Full-sample baseline benchmark
Baseline Expansion Dating	168	~14	54.95	−16.18	−3.47	0.0005	0.256	Baseline combined expansion windows
Perez (2002) ICT Installation	74	~6	53.64	−16.48	−2.76	0.0058	0.432	Independent literature dating (Perez, 2002)
Historical K4+K5 Upswings	114	~10	60.18	−17.91	−3.84	0.0001	0.381	Long-wave upswings (Freeman & Louça)

Since the slope survives under external dating, the result is likely not to be an artifact of the way in which the dating was originally created. Three caveats remain however, as sampling quarterly causes observational overlap, the placebo tests had borderline results (with an exact circular block placebo of p=0.0508 and a p=0.0509 for 10,000 draw Monte Carlo evaluation), and, because the regression is highly persistent and small sample bias inflates predictive slopes away from zeroes, the slope may be less than what it initially may seem to be.

Hypothesis 3 failed to reject the null hypothesis. The original asymmetric comparison produced results opposite to the prediction, however symmetric windows produced no statistically significant results[26]. These adjustments imply that the original negative estimate was not due to systematic post-correction declines in productivity.

[26] -0.49 pp change in four quarter windows (t=-0.44, p=0.681), +0.12 pp change in six quarter windows (t=+0.18,p=0.869), +.05pp change in eight quarter windows (t = +0.11, p=0.917), and -0.39pp change in twelve quarter windows (t = -1.09, p = 0.337). Background secular productivity drift (which slowed by -0.0019 pp per quarter across the sample, t = -1.22, p = 0.223) accounts for the slight negative tilt at longer horizons.

The tertiary hypothesis regarding post-correction industry concentration could not be evaluated. No concentration or market-share data exists in the underlying dataset, consistent with the difficulty in sourcing this data noted at the outset.

DISCUSSION

Hypothesis two, of the three hypotheses, has seen the most empirical support. Through its relatively strong confirmation, it can be assumed that K-Waves and innovation connect heavily to financial bubbles and overinflated valuations. The low correlation outside of the K-Waves implies that speculative overextension is specific within the Kondratiev cycles rather than a generality within equity markets. The lack of a detectable Granger-causal link from money supply/credit growth into valuations (Hypothesis one) hurts the credibility of the exogenous money driven theory for the double-wave model. Financial instability is either difficult to empirically define or unnecessary for the double-wave pattern to emerge.

The relationship between R&D growth and shifts in equity valuations would provide an interesting explanation for these observed cycles, however it is limited in its empirical support. The strongest R&D growth occurs at nine quarters, but it is found in a way which would lend itself to lag selection and should not be taken as certain to any extent. That connection suggests that financial markets respond to innovative activity on a delay, and may serve as preliminary evidence that technological investment heavily affects speculative valuation expansions, rather than changes in the money supply fully causing speculative valuation expansions. Investments into innovation could, instead, attract optimistic expectations and encourage speculative capital inflows, reshaping the double-wave model by having innovation be the main driver of the speculative cycle. It is worth mentioning, however, that Granger causality is not necessarily proof of causation, and that reverse causality may also exist.

The lack of evidence for Hypothesis three does not necessarily imply that there is not a change in real production after the first wave completes, but it does place more doubt on that possibility. It may be that the contractions within financial markets aren't able to reach the real markets. Credit contractions could still affect long-term investment, but this remains a theoretical possibility rather than anything empirically proved.

Taken together, this showcases how the interaction between finance and innovation may be more nuanced than this paper initially assumed. Innovation appears capable of generating speculative behavior, implying the double-wave model's causal ordering may require revision.

CONCLUSION

This paper has found partial empirical support for the double-wave framework. Money supply and credit growth show no Granger-causal link to valuations, undercutting a monetarist reading, but valuation does predict weaker three-year returns during early K-wave expansions to a certain extent, supporting the core claim of overextension tied to these windows. The relationship remains stable across alternate phase dating, implying that the result is relatively robust.

The R&D finding provides tentative evidence of a relationship between innovation and valuation, but it is not robust enough and does not establish innovation as a causal replacement for the money-supply mechanism. While it connects well within theory, it would require significant evidence to be reinforced, especially since it may be work to signal how central banks aren't the only source of Minskian instability, but rather that instability is formed from general optimism. This would align with Minsky's original work and slightly generalize its conclusion.

Avenues for future research remain clear, as numerous questions still exist: Concentration data wasn't available to test post-correction market consolidation; the patent series only starts in 1992; and the R&D connection needs to be empirically studied more deeply.

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