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Bond vs stock market's Q: Testing for stability across frequencies and over time[☆]

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ABSTRACT

In this paper we revisit the evidence recently provided by Philippon (2009) about the relationship among bond market's Q, stock market's Q and aggregate investments for the US. Specifically, we analyze the stability of the relationship between aggregate investment and the two measures of Q across frequencies and over time. We find that the relationship between aggregate investment and stock market's Q, in contrast to that with bond market's Q, is both frequency-dependent and time-varying. Both the successfulness of bond market's Q and the poor performance of the usual Tobin's Q can be explained by taking into account stability across frequencies of the first and instability over time of the latter.

1. Introduction

Empirical work testing Q investment models generally adopt the stock market value of corporate equity as a proxy of the shadow value of capital. Consistent estimation of the Q model requires that the observable stock market valuation of a firm provides an accurate (true or, at least, error-free) measure of the present value of its expected future profitability, i.e. firm's fundamental value. Persistent divergences of stock market prices from their fundamental values are not unlikely given the nature and objectives of the different types of traders operating in the stock market and the forward looking nature of share prices which provide information on a firm's expected future value. Indeed, fluctuations of stock market valuations are mostly influenced by chartists or speculative investors: when investors with a short-term horizon predominate over long-term investors existing market valuations may be subject to divergence from firm's fundamentals for a very long time.

The empirical failure of Tobin's Q investment equation based on the market value of equity has stimulated a number of different approaches (managers' and analysts' Q)[1] and measures[2] in order to overcome the difficulty of obtaining results consistent with the

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[1] See Fischer and Merton (1985) and Blanchard et al. (1993) for the first and Cummins et al. (1997). and Bond and Cummins (2000, 2001) for the latter approach.
[2] E.g. Gilchrist and Himmelberg (1995), Cummins et al. (2006), and Erickson and Whited (2000, 2006).

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underlying theory (Tobin, 1969). The literature on aggregate investment has recently shifted attention away from the stock market in favor of the bond market as a consequence of the disappointing empirical results of stock market's Q and the ability of credit spreads to forecast investment and output growth (e.g. Philippon, 2009; Shen, 2010). In particular, Philippon (2009), starting from a yield-theory of investment where Tobin's Q is approximated by a linear function of the spread of corporate bonds over government bonds, shows that a bond market's Q measure performs much better than the usual Q measure in standard investment equations with post-war aggregate US data. Specifically, once bond market's Q is included as an additional regressor to the usual measure of Q the standard measure is no more significant.[3] Similar conclusions are obtained by Shen (2010) which, instead of getting a credit market Q from bond prices as Philippon (2009) does, tests the Q theory using the credit spreads directly. Indeed, his main findings are that the Q model is a good approximation and that the credit market may suffer less from mis-pricing than the equity market so that it may be possible to infer over/under-priced equity market valuation from credit spreads.

The aim of this paper is to analyze the striking results obtained by Philippon (2009) through the time-frequency "lens" of wavelet analysis. Wavelet techniques can be used to gain information and insight about the characteristic features of the data, for example detecting the dominant scales of variation in the data, and to disentangle the individual effects of different variables at different time horizons. These properties of wavelets make them an attractive and powerful tool for the analysis of markets exhibiting multiscale features like financial markets, and stock markets in particular.[4] Financial market prices are the outcome of the actions of different groups of agents, such as intraday, daily, short term and long term traders, each operating over a different time frame which ranges from seconds to years. These market participants are heterogeneous with respect to trading rules, beliefs, expectations, risk profiles, informational sets, and so on, and the interaction of these different types of traders and investors can generate very complex patterns in observed security prices (Hommes, 2006).[5]

Wavelets multi-resolution decomposition analysis, given its ability to separate out different time scales of variation in the data, can provide an effective solution to the analysis of processes with multiscale features. The key insight behind wavelet analysis is to analyze data at different scales or resolution levels. Indeed, wavelets provide a unique decomposition of time series observations that enables researchers to decompose the data in ways that are potentially revealing of relationships that are at best problematical using standard methods and aggregated data. In particular, wavelets' good frequency and time localization properties[6] accord well with our needs, as most of the signals of practical interest in economics and finance have high frequency components for very short periods and low frequency components for long durations.

We exploit the benefits of wavelet analysis as a complementary approach to classical analysis based on standard regression methods using continuous and discrete wavelet transform tools. Hence, we first explore the usefulness for exploratory data analysis of the tools associated with the continuous wavelet transform (CWT), that is the wavelet power spectrum and wavelet coherency. The first offers a powerful tool for detecting the dominant scales of variation in the data, and the latter a measure of the local correlation of two series in time-frequency space. The comparison between the time-frequency representations of the two measures of Q shows that while bond market's Q displays a very high coherency with aggregate investment throughout the sample at almost any scale (the only exception being the very short term scales), stock market's Q is closely related to investment rate only at scales corresponding to the long-run. Then, we perform a scale-by-scale regression analysis of the Q-relationship by applying the discrete wavelet transform, since regression analysis over timescale decompositions can provide important insights into the properties of economic relationships (see Ramsey, 1999). The results confirm the striking differences between the two measures of Q across scales previously evidenced by "wavelet-based" exploratory data analysis. The bond market's Q drives out traditional Q at any scale level, both jointly and in isolation. Moreover, when we test for equality of regression coefficients at different scale levels we are not able to reject the null hypothesis of coefficient's equality for bond market's Q at scales corresponding to frequencies larger than 2 years, the opposite being true for Tobin's Q.

Finally, we consider an important assumption underlying the classical linear regression model, i.e. stability of regression coefficients which is rarely considered, but unlikely to hold when a given relationship is estimated over a long time span. Our results confirm previous findings in Holmes (2010) and Gallegati and Ramsey (2013) which suggest that variations in the Q-relationship over time are responsible for the poor performance of Tobin's Q investment equation. In addition, after taking into account for structural breaks in the Q-relationship the results indicate that in the long run stock market's Q is not only significant for aggregate investment, but has also an explanatory power marginally better than that of bond market's Q.

The paper is organized as follows: in Section 2 we perform exploratory "wavelet-based" analysis of Philippon's dataset using the tools associated with the CWT. In Section 3 we perform a scale-by-scale regression analysis of the Q-relationship, while in Section 4 we examine the hypothesis of stability over time of the estimated relationship. Section 5 concludes the paper.

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[3] Further results are that "the explanatory power is good (both in level and in differences), cash flows are no longer significant, and the inferred adjustment costs are almost twenty times smaller" (Philippon, 2009, p. 1049).

[4] Following the first applications by Ramsey and his co-authors, e.g. Ramsey and Zhang (1995, 1996), and Ramsey and Lampart (1998a, 1998b), the literature on wavelets literally exploded. Recent applications of wavelets in economics and finance are Kim and In (2003), Gençay et al. (2003, 2005, 2010), Gallegati et al. (2006, 2011, 2013), Fan and Gençay (2010), Ramsey et al. (2010), Gençay and Gradojevic (2011) and In et al. (2011).

[5] For instance, long term fundamentalist traders, especially fund managers and institutional investors like pension funds, basing their trades on the fundamental value determined by the dividend discount model, represent the low frequency component of the market. On the opposite side, we find speculative traders, such as the noise traders or chartists, whose trading rule is based on technical analysis and consists on extrapolating recent trend of asset prices. Hence, since the smallest time scales are likely to be linked to speculative activity and the coarsest scales to investment activity of institutional investors with long term horizons, we can expect the relationship between stock prices and investment to be stronger at intermediate and coarsest scales than at the finest ones.

[6] The wavelet transform displays good time resolution and poor frequency resolution at high frequencies, and good frequency resolution but poor time resolution at low frequencies.