North American Journal of Economics and Finance xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

North American Journal of Economics and Finance

journal homepage: www.elsevier.com/locate/najef

Sluggish private investment in Japan's Lost Decade: Mixed frequency vector autoregression approach☆

Kaiji Motegi[a,*], Akira Sadahiro[b]

[a] Graduate School of Economics, Kobe University, 2-1 Rokkodai-cho, Nada, Kobe, Hyogo 657-8501, Japan
[b] Waseda University, 1-6-1 Nishi-Waseda, Shinjuku, Tokyo 169-8050, Japan

ARTICLE INFO

JEL Classification:
C32
E22
E44

Keywords:
Japan's Lost Decade
Mixed Data Sampling (MIDAS)
Mixed frequency vector autoregression (MF-VAR)
Private investment

ABSTRACT

It is well known that sluggish private investment plagued the Japanese macroeconomy during the Lost Decade. Previous empirical papers have not reached a clear consensus on what caused the investment slowdown. This paper sheds new light on this issue by fitting a mixed frequency vector autoregressive model to monthly stock prices, quarterly bank loans, firm profit, and private investment. Monthly stock prices explain as much as 50.7% of the long-run forecast error variance of investment. We also reveal a spiral of declining stock prices, profit, and investment. Finally, the stagnation of bank loans is a consequence of declined stock prices, and the former is not a cause of declined investment.

1. Introduction

Japan experienced more than a decade of economic stagnation, which is called the *Lost Decade* or sometimes the *Lost Two Decades*, after the stock market bubble burst in 1990. It is well known that the slump of private non-residential investment plagued the Japanese economy in that period. Macroeconomists tried to explain what caused the investment slump, ending up with mixed results. Was the sluggish investment caused by firm-specific factors, bank-specific factors, or some other macroeconomic factors affecting both firms and banks? Firm-specific factors include a decrease in current or expected future profit that discourages firms from investing. Bank-specific factors, also called credit crunch, include a tougher lending attitude of banks due to their worse financial conditions.

Typically, previous researchers test for the relevance of bank-specific factors in two steps. First, they investigate the impact of banks' financial conditions on their attitude to lend money to private firms. Second, researchers estimate the sensitivity of corporate investment functions to the lending attitude of banks.

For the first step, most researchers have found a significant impact of banks' financial conditions on their lending attitude in 1997–1998, when Japanese banks were facing particularly serious situations. Empirical results for other periods are mixed, however. Ito and Sasaki (2002) and Dell'Ariccia (2003) argue that declined bank lending in the early 1990s and early 2000s was indeed caused by banks' financial conditions. Horiuchi and Shimizu (1998) and Woo (2003), in contrast, find that the worse financial conditions of

☆ We are grateful for the managing editor (Hamid Beladi) and an anonymous referee for valuable comments. We thank Shigeyuki Hamori, Stephen Raymond, and Forrest Spence for helpful comments. We also thank participants of the 22nd Kansai Keiryo Keizaigaku Kenkyukai, 6th Seminar on Time Series and Financial Engineering, and the 2015 Spring Meeting of Japanese Economic Association for helpful comments. The first author is grateful for the financial supports of JSPS KAKENHI (Grant Number: 16K17104) and Suntory Foundation.

* Corresponding author.
E-mail addresses: motegi@econ.kobe-u.ac.jp (K. Motegi), sadahiro@waseda.jp (A. Sadahiro).

http://dx.doi.org/10.1016/j.najef.2017.10.009
Received 19 June 2017; Received in revised form 13 October 2017; Accepted 17 October 2017

banks did *not* cause less bank lending in early 1990s.

For the second step, Motonishi and Yoshikawa (1999) find that the investment slump in 1997–1998 was likely attributable to the tougher sentiment of money lenders, a supportive evidence for the bank-specific factor. Ogawa (2003) obtains similar results for each year of 1993–1998. Hayashi and Prescott (2002), in contrast, argue that the declined bank lending did *not* have a significant impact on investment, since firms could have financed investment by liquidating their own land or financial assets.[1,2]

There exists another approach that investigates a dynamic interrelationship between bank-specific factors and firm-specific factors, using vector autoregression (VAR). Sadahiro (2005) finds that the investment slump during the Lost Decade was Granger-caused by a decrease in firm profit and *not* by bank loans. He therefore claims that a firm-specific factor better accounts for the sluggish private investment than a bank-specific factor.[3]

From a methodological point of view, previous papers share a common issue of temporal aggregation. Key variables in this field (e.g. private non-residential investment, firm-specific bank lending for investment, and firm profit) are sampled quarterly or even less frequently. Previous papers were forced to aggregate high frequency variables, such as stock prices and interest rates, since classical models require all variables to have a single frequency. Temporal aggregation is known to have an adverse impact on statistical inference.[4]

The present paper sheds new light on the literature by exploiting mixed frequency data. Analysis of mixed frequency data, called Mixed Data Sampling (MIDAS) regression, was explored by Ghysels, Santa-Clara, and Valkanov (2004), Ghysels et al. (2006), and Andreou, Ghysels, and Kourtellos (2010).[5] In particular, Ghysels et al. (2004) demonstrate that MIDAS regressions lead to more efficient estimation than the classical approach of aggregating all series to the least frequency sampling.

VAR models for mixed frequency data were independently introduced by McCracken, Owyang, and Sekhposyan (2015), Anderson et al. (2016), and Ghysels (2016).[6] Ghysels' (2016) mixed frequency VAR (henceforth MF-VAR) is a user-friendly model that does not require any filtering procedure. A major advantage of MF-VAR relative to single-frequency VAR is that high frequency variables are allowed to have heterogeneous impacts on a low frequency variable within each low frequency time period.[7]

Not many applied papers use MF-VAR so far, since it is a relatively new tool. We are not aware of any applied paper that analyzes the Japanese economy based on MF-VAR. This paper fills that gap by analyzing the interaction of *monthly* stock prices, quarterly bank loans, firm profit, and private investment. Stock prices have a close connection with Tobin's Q, one of the most well-known variables associated with private investment.[8] Computation of Tobin's Q requires corporate net worth data, which are sampled at a quarterly or less frequently level. Stock prices, in contrast, are sampled at much higher frequency than a quarterly level (e.g. monthly, daily, or even intraday). We compare a model with quarterly stock prices and a model with monthly stock prices in order to highlight that changing the sampling frequency can alter empirical results considerably.

Our empirical findings are summarized as follows. First, monthly stock prices explain as much as 50.7% of the forecast error variance of private investment in a long-run (i.e. $h = 12$ quarters).

Second, based on impulse response analysis, we reveal a spiral of declining stock prices, firm profit, and investment. Lower stock prices affected firm profit negatively, which discouraged firms' investment. The investment slowdown put a further downward pressure on the stock prices, creating a loop of negative feedback effects.

Third, the stagnation of bank lending is a consequence of a decrease in stock prices, and the former is not a cause of a decrease in investment. The long-run forecast error variance of bank lending is explained 41.0% by stock prices. Bank lending, by contrast, has only negligible impacts on stock prices, profit, and investment. Thus, the firm-specific factor (i.e. firm profit) better explains the sluggish investment than the bank-specific factor (i.e. bank lending).

We would need to use *quarterly* stock prices if we were forced to work with single-frequency data. Aggregating monthly stock prices into a quarterly level underestimates the influence of stock prices. Quarterly stock prices explain 31.8% of the long-run forecast error variance of investment (as opposed to 50.7% in the mixed frequency case). Also, aggregating stock prices weakens the statistical significance of the spiral of stock prices, firm profit, and investment. The impulse response of stock prices to investment is not significant at the 5% level when aggregating the stock prices. The mixed frequency approach therefore yields richer economic insights than the classical approach.

The remainder of the paper is organized as follows. In Section 2 we describe the MF-VAR methodology. In Section 3 we explain our data and perform some preliminary analysis. In Section 4 we present main empirical results. Section 5 concludes the paper. In Supplementary Appendix, we present supplemental empirical results based on Granger causality tests.

[1] Gibson (1995) shows that the investment of private firms is significantly affected by the financial condition of their main banks in 1991–1992. Gibson (1997), however, finds a weaker evidence for 1994–1995.

[2] See Miyao (2006, Section 8.4) for more detailed literature review on the relationship between bank loans and investment.

[3] Mizobata (2015) fits a panel VAR for investment, hiring, and financial indicators of Japanese firms.

[4] Silvestrini and Veredas (2008) survey the effects of temporal aggregation on time series models.

[5] See Armesto, Engemann, and Owyang (2010) and Andreou, Ghysels, and Kourtellos (2011) for surveys.

[6] Foroni, Ghysels, and Marcellino (2013) survey mixed frequency VAR models and related literature.

[7] Ghysels, Hill, and Motegi (2016) elaborate the statistical properties of MF-VAR, with a particular focus on Granger causality.

[8] See Hayashi (1982),Fazzari, Hubbard, and Petersen (1988), and Abel and Eberly (1994) for early contributions to Tobin's Q-theory. For more recent work, see Mizobata (2014) and references therein.