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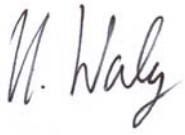

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# New Evidence on the Effectiveness of 'Quantitative Easing' in Japan*

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**Abstract:**
Central banks have recently introduced new policy initiatives, including a policy called 'Quantitative Easing' (QE). Since it has been argued by the Bank of England that "Standard economic models are of limited use in these unusual circumstances, and the empirical evidence is extremely limited" (Bank of England, 2009b), we have taken an entirely empirical approach and have focused on the QE-experience, on which substantial data is available, namely that of Japan (2001-2006). Recent literature on the effectiveness of QE has neglected any reference to final policy goals. In this paper, we adopt the view that ultimately effectiveness will be measured by whether it will be able to "boost spending" (Bank of England, 2009b) and "will ultimately be judged by their impact on the wider macroeconomy" (Bank of England, 2010). In line with a widely held view among leading macroeconomists from various persuasions, while attempting to stay agnostic and open-minded on the distribution of demand changes between real output and inflation, we have thus identified nominal GDP growth as the key final policy goal of monetary policy. The empirical research finds that the policy conducted by the Bank of Japan between 2001 and 2006 makes little empirical difference while an alternative policy targeting credit creation (the original definition of QE) would likely have been more successful.

**JEL Classification:** E41, E52, E58

**Keywords:** Central Banking, General-to-specific Methodology, Monetary Policy, Nominal GDP Growth, Quantitative Easing

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# 1 Introduction

Central banks have recently introduced new policy initiatives, including a policy called 'Quantitative Easing' (QE). This has renewed interest in the question of the effectiveness of different approaches to monetary policy conduct and implementation. Since it can be argued that "Standard economic models are of limited use in these unusual circumstances, and the empirical evidence is extremely limited" (Bank of England, 2009b), more empirical evidence on the effectiveness of QE would seem desirable. In this paper we focus on the QE-experience that has delivered a substantial set of time series data, namely that of Japan (2001-2006), which could also be put into the context of the even longer time period of post-banking crisis economic underperformance (since about 1993).

*Measurement of Central Bank Performance*

The performance of monetary policy can be measured in terms of processes ('process-based performance', which we choose to christen 'input performance') or relevant final economic outcomes ('result performance', 'outcome performance' or, our preferred term, 'output performance'). The literature on central bank performance measurement can accordingly be divided into these two categories.

The first chooses an 'output performance' measure that focuses on whether a final target variable, such as price stability or growth performance (and sometimes also currency stability) has been achieved (Parking and Bade, 1980, Emerson et al., 1992, Cukierman et al., 1992, Alesina and Summers, 1993, Hasan and Mester, 2008). This has a major drawback: By not engaging in an analysis of the details of monetary transmission, we learn little about the suitability of particular monetary policy

instruments, intermediary targets or approaches (i.e. by leaving 'input performance' up to the central bank).

The second branch of literature focuses on the effectiveness of specific operational procedures in affecting operational targets (see, e.g. Hamilton, 1996; Bartolini and Prati, 2006; Nautz and Schmidt, 2009). The literature on the role of the bank lending channel (BLC) in the transmission of monetary policy often also belongs to this category, as it argues that the effectiveness of monetary policy is contingent on its impact on bank behavior (see, for instance, Bernanke and Gertler, 1995; Kishan and Opiela, 2006). Thanks to the Japanese experience beginning in 1991, of low interest rates and low inflation or deflation, a new literature has developed which focuses on the effectiveness of specific monetary policy instruments, tools or intermediate targets under such circumstances of extremely low interest rates.

In principle, the renewed interest in 'input performance' is a welcome development. However, the literature has gone to the other extreme and in recent years virtually ignored 'output performance' measurements.

The literature analysing the effectiveness of Japanese monetary policy since 1991; i.e. monetary policy under conditions of extremely low interest ('zero interest') and/or the specific monetary policy instrument called 'quantitative easing' (QE), has defined the 'effectiveness' of such monetary policy not in terms of a final economic outcome, such as a sustainable economic recovery with steady nominal GDP growth of 2.5%. Instead, the criterion for performance measurement is process-based 'input

performance'; namely, whether such policy had an impact on interest rates, another intermediate target.[2] At the same time, the empirical research fails to present evidence that interest rates are a reliable proxy for any relevant output performance goal.

There is thus a gap in the literature concerning empirical work on the effectiveness of monetary policy tools and instruments (i.e. input performance; engaging with details of the transmission mechanism) that relates performance measurement to a final target variable (output performance). While this is already implemented in studies on the effectiveness of central bank FX intervention, including in Japan (e.g. Kim and Sheen, 2006; Beine et al., 2009), it has not been applied to overall monetary policy. This paper aims to fill this gap by examining the performance of actual and potential monetary policy instruments and intermediate targets in explaining a final policy target variable, and conducting a 'horse race' test between them. The empirical data are from Japan, where extremely low interest rates have existed for the longest time period and where a policy called 'quantitative easing' was first introduced.

In this paper, we concur with the view that ultimately monetary policy effectiveness will be measured by whether it will be able to "boost spending" (Bank of England, 2009b) and "The effectiveness of the MPC's asset purchases will ultimately be judged by their impact on the wider macroeconomy" (Bank of England, 2010). In line with a widely held view among leading macroeconomists from various persuasions, while attempting to stay open-minded concerning the distribution of demand changes

[2] In the context of the earlier literature on central bank independence and inflation performance, this is tantamount to arguing that independent central banks are better able to influence interest rates, while any

between real output and inflation, we are assuming that nominal GDP growth is the key final policy goal of monetary policy.

Thus the effectiveness of Japanese monetary policy is re-examined, using a methodology that differs from other papers and is thought to be more suitable for the task. Based on the results, meaningful conclusions can be made concerning the actual performance of the central bank's policies, as well as for other countries that have since adopted similar policies.

*The Relevance of Japan*

The Japanese experience is relevant for a number of reasons: like the US and the UK, Japan's economy experienced significant asset price rises, followed by a major banking and financial crisis. The central bank adopted dramatic measures, by reducing interest rates from about 8% in 1991, to 0.001% a decade later, and by boosting bank reserves significantly. It is also the first country in which a central bank introduced a policy that was officially termed 'quantitative easing' (henceforth 'QE'). The Bank of England adopted a policy with this name in March 2009.[3]

## 2 The Literature on Quantitative Easing in Japan

The conduct of monetary policy when interest rates approach zero has attracted significant attention by economists. Theoretical work, inspired by the Japanese

potential or actual link with inflation is left for the reader to work out.

[3] Finally, and somewhat ominously, Japan's central bank has not been obviously successful in achieving basic aims of monetary policy, such as price stability (Japan holds the world record for deflation in the

experience, asks whether a shift to the quantity of money as an operational tool could substitute for lacking manoeuvrability of interest rates. Most authors propose a theoretical general equilibrium model with rational expectations, including Krugman (1998), Fujiki et al. (2001), Woodford (2003), Svensson (2003), Eggertsson and Woodford (2003) and Benhabib et al. (2003). This literature tends to share the assumptions of complete and efficient financial markets, whereby no agents face any constraints on their ability to borrow against future income. Instead of featuring a mechanistic monetary transmission mechanism, the models rely on the role of (unobservable) expectations and their impact on interest rates, which are assumed to be the main component of monetary transmission.

As a result, the 'effectiveness' of QE is defined by its effectiveness in moving interest rates (whether only short-term rates, as for instance in Krugman, 1998, or "the entire expected future path of short-term real rates, or very long term real rates" in Eggertsson and Woodford, 2003). The theoretical papers conclude that QE must be ineffective when adopted under conditions of a zero interest rate policy, because it does not affect the general equilibrium level of interest. Since that is the only way to stimulate the economy in such models, the policy will be ineffective. In the words of Eggertsson and Woodford (2003): "'quantitative easing' that implies no change in interest-rate policy should neither stimulate real activity nor halt deflation; and this is equally true regardless of the kind of assets purchased by the central bank." This is also the conclusion of Fujiki et al. (2001), employees of the BoJ, who published their paper denying the effectiveness of QE in February 2001, one month before QE was

era of regular GDP statistics) or stable economic growth (Japan's post-crisis economic underperformance has lasted for the better part of two decades).

reported to have been introduced by their employer. They define QE as an expansion in bank reserves and/or increased open market purchases. BoJ staff, Kimura et al. (2002) and Shirakawa (2002), chose the same definition of QE, which is also in line with the set of policies adopted by the BoJ in March 2001. While the goal of central bank policy is described as including the stimulation of the economy (nominal GDP), with the implied intermediary goal of stimulating bank lending, these authors, like others, measure the effectiveness of this 'QE' policy by the impact it had on interest rates. They conclude that one year after introduction, QE was not effective. Unlike studies on the effectiveness of other aspects of central bank policy (such as studies on the effectiveness of FX intervention policy, see e.g. Beine et al., 2009) they do not define effectiveness in terms of a final policy goal.

A number of other papers argue that the low-interest rate environment constitutes a structural break from earlier periods. Blinder (2000), Bernanke (2000), Clouse et al. (2003), and Bernanke et al. (2004) are sceptical of the above models and discuss the tools and policy options available to central banks as nominal interest rates approach zero. They define QE as an increase of the size of the central bank's balance sheet, and distinguish it from changes in the composition of the latter (by increasing the holdings of long-term government bonds). Their empirical work also measures policy effectiveness by the success in lowering long-term interest rates, and finds negative results in the case of Japan. Okina and Shiratsuka (2004), BoJ employees, define QE as the 'abundant provision of funds' by the central bank. They also assume that monetary policy effectiveness can primarily be measured in its success in influencing (short-term and) long-term interest rates, and that the transmission mechanism is the

formation of expectations due to a commitment to such a policy. Analysing yield curves, and spot and forward rates, they conclude that QE was ineffective. They conjecture that this was due to the policy's inability to dispel deflationary expectations, as long-term yields remained low ('indicating financial-market expectations that deflation will persist'). This is of interest, since it highlights one of the shortcomings of defining the 'effectiveness' of a policy tool in terms of input performance, depending on the central bank's interpretation: The Bank of England has by contrast (and somewhat more convincingly) argued that low bond yields are a reflection of *successful* QE, as the bond purchase operations are said to be the reason for lower long-term interest rates (see, for instance, Miles, 2009).

BoJ staff, Oda and Ueda (2005), also focus on the impact of QE on long-term interest rates. They find that QE has reduced medium- to long-term interest rates, and that there is no significant 'portfolio balancing' effect of asset purchases. Kimura and Small (2006, from the BoJ and the Fed, respectively) find some positive, though mixed results of 'portfolio rebalancing' due to BoJ asset purchases, which reduced risk premiums on assets such as government bonds, although they argue it may have increased risk premiums on equities and low-grade bonds. Ugai (2006, BoJ) surveys empirical studies and concludes that findings are mixed, with the largest effect of QE found in form of their impact on expected future short-term interest rates.

Only Kobayashi et al. (2006) seems to adopt a different methodology. They argue, more in line with your argument, that "one of the primary motivations offered by the BoJ for its quantitative easing program… was to maintain credit extension by the

troubled financial sector". Although actual bank credit growth could be used as a measure of the central bank's performance, they examine bank equity values. They find that excess returns were larger when the BoJ increased its long-term government bond purchases, and that the markets perceived that this policy disproportionately helped weaker banks. In this sense, they find QE to have had some effect – even if not fulfilling its 'primary motivation' (bank credit growth has largely remained negative in the years since 2001).

### 2.1 Gaps in the literature and contribution of this paper

The majority of the papers on the effectiveness of QE in Japan share a number of weaknesses, in addition to their largely inconclusive results:

(a) Excessive focus on input performance, while neglecting the measurement of output performance – the effectiveness in achieving final policy goals, as discussed above.

(b) Assumptions: The literature is based on models of financial markets and the economy that make result-critical assumptions largely at odds with empirical reality (no friction or financial constraints, rational expectations and perfect information). Assuming perfect markets is not likely to be useful when boom/bust cycles and banking crises are observable (as criticised by Bernanke et al., 2004 and Miles, 2009). There is considerable empirical evidence that banks are 'special' (e.g. Fama, 1985, Ashcraft, 2005), yet the literature on QE fails to incorporate banks in models that afford them special

features not offered by non-bank financial intermediaries. The reliance on expectations as the sole transmission mechanism also raises a number of analytical problems.[4] It precludes the possibility of a direct, more mechanical transmission of monetary policy, as is frequently called for (e.g. Bernanke et al., 2004, Miles, 2009, Werner, 1997).[5]

(c) The role of interest rates: The literature does not empirically estimate the actual relationship of monetary policy instruments and interest rates with final policy targets (such as nominal GDP). Were nominal interest rates not in the assumed negative and causal relationship with nominal GDP growth, as Blanchard (1986) and Bernanke and Gertler (1995) indicate,[6] the measurement of the effectiveness of QE by quantification of their impact on interest rates would be invalid.

(d) None of the literature considers the origins of the expression 'quantitative easing', which was coined in the 1990s by critics of the BoJ and referred to an expansion in broad credit creation (as opposed to reserve or high powered money expansion; see Werner, 1995).

4 This strand of literature suffers from and at times concedes the time inconsistency problem identified by Kydland and Prescott (1977), which renders monetary policy ineffective.

5 Bernanke et al. (2004) have pointed out that the assumptions of frictionless financial markets and complete separation of monetary and fiscal policies which characterise this literature "to be sure, are rather strong. If these assumptions do not hold, we may have some basis for believing that quantitative easing will be effective. " (p. 18). While remaining "agnostic about the precise mechanisms by which quantitative easing may have its effect" Bernanke et al. point to "the undeniable fact that, historically, money growth and inflation have tended to be strongly associated. It follows, according to this argument, that money creation will raise prices independent of its effects on the term structure" (p. 18).

6 However, see also Mojon et al. (2002) for contrary evidence from Europe.

(e) The literature on the effectiveness of QE fails to integrate the growing body of literature on the 'credit view' of monetary policy transmission, which indicates that the bank lending channel is important (see, for instance, Bernanke and Gertler, 1995; Kakes and Sturm, 2002; Huang, 2003; but also earlier work such as VanHoose, 1983) or other evidence on aspects of the transmission mechanism (see, e.g. Andries and Billon, 2010).

(f) Assumed structural breaks: the literature often assumes but rarely tests for a structural break in the era of near-zero interest rates. This is, due to the limited data availability, likely also true for the otherwise convincing statement that "Standard economic models are of limited use in these unusual circumstances…" (Bank of England, 2009b). The admission of a structural break suggests that the models employed are not sufficiently robust to allow for diverse circumstances. Should more robust models without structural break be found, they would be preferable.

This paper aims to address the above shortcomings and gaps in the literature by employing a different empirical methodology, which does not require untested assumptions about the functioning of the economy, or the operation of intermediate tools, and which tests for both 'input' and 'output performance'. The question of the efficacy of policy tools is addressed by conducting a 'horse race' between different potential monetary policy tools or intermediary targets. This allows for the operation of different types of monetary policy transmission than assumed in the QE literature, especially via the credit channel.

# 3 Empirical work

Whether the BoJ's actions between 2001 and 2006 were effective, or even whether the central bank actually did "discard the orthodox operating framework" (Kimura, 2002) in 2001 are empirical questions that can be investigated.

## 3.1 Methodology

In order to implement the principle of 'Revealed Preference' (Samuelson, 1938), in this paper we step back from announcements by central banks ('what they say') and instead examine which of a list of potential policy tools and intermediary targets can empirically be shown to have been more relevant ('what they do').

We thus compare a list of potential CB tools and instruments (including different interpretations of what could be meant with 'quantitative easing') with a generally accepted final target variable for monetary policy. No doubts about what this goal should be exist, when it comes to the aims of the central bank's constituents (the government, businesses and the general public): their main interest is nominal GDP growth, as wages, revenues and profits are in nominal terms. The greater relevance of nominal GDP as the final policy target variable, and the measure by which to evaluate central bank performance, is especially obvious in the era of low or declining inflationary pressures. With deflation, real growth may be recorded while nominal growth is negative. Since corporate performance is not symmetric with respect to inflation and deflation (accounting is in nominal terms and firms are not able to

accumulate losses indefinitely), deflation is accompanied by higher bankruptcies and unemployment than inflation.

The above literature on QE in Japan also mentioned nominal GDP growth as one of the aims of central bank policy. So do several of the Bank of England's publications on the "ultimate" objective of QE. There are other reasons why the final target variable should be nominal GDP growth. The literature on central bank performance has identified price stability, maximum economic growth, and stable currencies as the three key outputs of monetary policy.[7] For our purposes, currencies are not of primary interest. Meanwhile, prices and output can be examined in one combined target variable, nominal GDP, without the need of separating the two. Finally, a significant number of macroeconomists from various persuasions agree (unusually in this profession) that a nominal GDP growth target more readily reflects the objectives of governments and economic agents (Tobin, 1980, Bean, 1983, Meade, 1984, Gordon, 1985, Hall, 1985, Taylor, 1985, McCallum, 1997, McCallum and Edward, 1999, Frankel, 1995). Akram and Eitrheim (2008) find that output stabilization also enhances financial stability.

[7] Hasan and Mester (2008, p. 6) state: "…while the tasks assigned to particular central banks have changed over the years, their key focus remains macroeconomic stability, including stable prices (low inflation), stable exchange rates (in some countries), and fostering of maximum sustainable growth (which may or may not be explicitly listed as a goal of the central bank in enabling legislation). See, e.g., Tuladhar (2005), Siebert (2003), Lybek (2002), McNamara (2002), and Healey (2001), Amtenbrink (1999), Maier (2007), and Caprio and Vittas (1995)." Not everyone shares the focus on maximum growth. Cecchetti and Krause (2002) define central bank performance as a weighted average of output and inflation variability, and in the process rating the Japanese central bank's performance highly: it delivered output and inflation outcomes with little variability – unfortunately at unusually low or negative levels. Poloz (2006) also discusses central bank performance in terms of stability, and the lessons for their choice of goal.

We will attempt to establish empirically, based on historical relationships, which policy tools and instruments are more likely to be useful in influencing nominal GDP growth.

An attractive empirical methodology for this purpose is the general-to-specific model selection methodology (the 'London School of Economics methodology', also known as the 'Hendry method'), which allows competing monetary policy tools, intermediary instruments and differing interpretations of 'quantitative easing' to be equally represented in the first general model, whose features and statistical characteristics can also be tested (see Campos et al. 2005). Then, an objective sequential procedure of downward reduction to the parsimonious form is adopted, which amounts to a horse-race between the contenders and enables us to assess the relative performance of the competing policy models.[8] This empirical benchmark can then be compared with particular actions taken by central banks in order to assess their likely relevance or effectiveness.

The following potential central bank policy instruments or intermediary targets have been cited in the literature on the Japanese experience since the 1990s:

(a) Price tool: interest rates. Since the mid-1980s the role of the overnight uncollateralised **call rate** has become the dominant interest rate tool (Fukui, 1986).

(b) Quantity tool I: traditionally, monetarist theory emphasised 'high powered money' (aka monetary base), which consists of two components: notes and

[8] Theoretical discussions about the usefulness of a particular tool may turn out to be futile if this tool is not significant as an explanatory variable of the target variables.

coins in circulation and banks' reserves held in their accounts with the central bank. There are theoretical reasons for considering notes and coins in circulation less as tools of active monetary policy, as the endogenous component is likely to be large or dominant (see Okina, 1993; Goodhart, 1989). The more relevant variable is thus likely to be **bank reserves**, which is consistent with both the literature on QE and the BoJ's announcement of 19 March 2001.

(c) Quantity tool II: it has been argued by the literature that the central bank's balance sheet may be considered a tool of quantitative monetary policy (e.g. Bernanke et al., 2004). Specifically, both literature and the BoJ's announcement of 19 March 2001 emphasise the role of purchases of long-term assets (government bonds) by the central bank. More recently, the Federal Reserve has purchased a wide variety of assets, which has resulted in a dramatic expansion in its balance sheet. This policy tool can be quantified by considering the growth of **central bank assets**, in addition to the:

(d) 'Quality tool': the role of the composition of the central bank's balance sheet (what Buiter calls 'qualitative easing'). Here the basic **ratio of long-term central bank assets to total assets** is tested. These are defined to include both government bonds and direct loans to legal entities.

(e) Intermediate target I: the money supply. In Japan the most widely watched traditional broad money supply aggregate is **M2+CD**.

(f) Intermediate target II: bank credit. There is a substantial body of literature, including the so-called 'credit view' that considers bank lending important and 'special' (Bernanke and Gertler, 1995). A further innovation in this

paper is the use of a more refined credit aggregate, namely **bank credit to the real economy** (excluding the sectors closely associated with non-GDP, financial transactions) which has been shown to be superior theoretically and empirically in accounting for nominal GDP (Werner, 1997).[9]

The *personae dramatis* of the econometric analysis can thus be summarised in Table 1, including their abbreviations in the econometric model.

**Table 1: Variables in the Empirical Model**

| **Policy instrument or intermediary target** | **Relevant variable in Japan** | **Abbreviation in econometric model** |
|---|---|---|
| Interest rates | ODR or o/n u/c call rate | Call |
| Bank reserves | Reserves | Res |
| Asset purchases | BoJ B/S | Total Assets |
| 'Qualitative easing'/balance sheet composition | Ratio of long-term assets of central bank B/S | LTAR |
| Money supply | M2+CD | M2+CD |
| Bank credit to the 'real economy' | Bank credit to all sectors except real estate, financial institutions and construction | Cr |

### 2.2. Empirical Findings

After stationarity tests have confirmed that all variables (except interest rates) are I(1) processes, year-on-year growth rates are calculated (except for interest rates) and the

[9] The distinction between money used for asset transactions and the real economy has in various forms been called for by Fisher (1926), Keynes (1936), Friedman (1956) and reflected in recent empirical work

general model with nominal GDP as dependent variable formulated. The independent variables are call rate (call), bank reserves (Res), the proportion of long-term assets on the CB balance sheet (BoJLTAR), BoJ total assets (BoJTA), money supply M2+CD and the measure of broad credit used for GDP transactions (Cr). The general model is shown below in Table 2 (Eq 1). Tests of the error normality properties of the model found no problems.

**Table 2: The General Model**

EQ (1) Modelling YoYNGDP by OLS
The estimation sample is: 1984 (1) to 2008 (1)

| | Coefficient | Std.Error | t-value | t-prob | Part.R^2 |
|---|---|---|---|---|---|
| YoYNGDP_1 | 0.550700 | 0.1273 | 4.33 | 0.000 | 0.2319 |
| YoYNGDP_2 | 0.0414786 | 0.1431 | 0.290 | 0.773 | 0.0014 |
| YoYNGDP_3 | 0.106657 | 0.1375 | 0.776 | 0.441 | 0.0096 |
| YoYNGDP_4 | -0.212991 | 0.1145 | -1.86 | 0.068 | 0.0528 |
| Constant | 1.25370 | 2.686 | 0.467 | 0.642 | 0.0035 |
| Call | 0.304339 | 0.3581 | 0.850 | 0.399 | 0.0115 |
| Call_1 | 0.0690669 | 0.5046 | 0.137 | 0.892 | 0.0003 |
| Call_2 | 0.0823537 | 0.4865 | 0.169 | 0.866 | 0.0005 |
| Call_3 | -0.457302 | 0.4726 | -0.968 | 0.337 | 0.0149 |
| Call_4 | 0.147538 | 0.3131 | 0.471 | 0.639 | 0.0036 |
| YoYRes | -0.00482798 | 0.00596 | -0.810 | 0.421 | 0.0105 |
| YoYRes_1 | -0.00456327 | 0.007507 | -0.608 | 0.546 | 0.0059 |
| YoYRes_2 | 0.0152022 | 0.007690 | 1.98 | 0.053 | 0.0593 |
| YoYRes_3 | -0.00464491 | 0.007835 | -0.593 | 0.555 | 0.0056 |
| YoYRes_4 | -6.96581e-005 | 0.00559 | -0.0125 | 0.990 | 0.0000 |
| BOJLTAR | 0.292561 | 3.005 | 0.0974 | 0.923 | 0.0002 |
| BOJLTAR_1 | -0.356588 | 2.943 | -0.121 | 0.904 | 0.0002 |
| BOJLTAR_2 | 1.18909 | 2.922 | 0.407 | 0.685 | 0.0027 |
| BOJLTAR_3 | 1.31038 | 2.801 | 0.468 | 0.642 | 0.0035 |
| BOJLTAR_4 | -3.66124 | 2.863 | -1.28 | 0.206 | 0.0257 |
| YoY BoJTA | -0.0149838 | 0.01597 | -0.939 | 0.352 | 0.0140 |
| YoY BoJTA_1 | 0.0146504 | 0.01631 | 0.898 | 0.373 | 0.0128 |
| YoY BoJTA_2 | 0.0147589 | 0.01617 | 0.913 | 0.365 | 0.0133 |
| YoY BoJTA_3 | -0.0305062 | 0.01581 | -1.93 | 0.058 | 0.0567 |
| YoY BoJTA_4 | 0.00829787 | 0.01604 | 0.517 | 0.607 | 0.0043 |
| YoYM2+CD | -0.254060 | 0.2179 | -1.17 | 0.248 | 0.0215 |
| YoYM2+CD_1 | 0.515606 | 0.3743 | 1.38 | 0.173 | 0.0297 |
| YoYM2+CD_2 | -0.376703 | 0.4118 | -0.915 | 0.364 | 0.0133 |
| YoYM2+CD_3 | 0.123713 | 0.3970 | 0.312 | 0.756 | 0.0016 |
| YoYM2+CD_4 | 0.0342873 | 0.2346 | 0.146 | 0.884 | 0.0003 |
| YoYCr | 0.511693 | 0.1646 | 3.11 | 0.003 | 0.1348 |
| YoYCr_1 | -0.239732 | 0.1875 | 1.28 | 0.206 | 0.0257 |
| YoYCr_2 | -0.249947 | 0.1994 | -1.25 | 0.215 | 0.0247 |
| YoYCr_3 | 0.301781 | 0.1743 | 1.73 | 0.088 | 0.0461 |

(e.g. Büyükkarabacak and Krause, 2009; Büyükkarabacak and Valev, 2010; Drake and Fleissig, 2010).

| | | | | | |
|---|---|---|---|---|---|
| YoYCr_4 | -0.0745332 | | 0.1874 | -0.398 | 0.692 0.0025 |
| sigma | 1.20633 | | RSS | | 90.2244824 |
| R^2 | 0.911775 | | F(34,62) = | | 18.85 [0.000]** |
| log-likelihood | -134.125 | | DW | | 2.03 |
| no. of obs. | 97 | | no. of parameters | | 35 |
| mean(YoYNGDP) | 2.53633 | | var(YoYNGDP) | | 10.5429 |
| AR 1-5 test: | F(5,57) | = | 2.0781 | [0.0814] | |
| ARCH 1-4 test: | F(4,54) | = | 0.39342 | [0.8125] | |
| Normality test: | Chi^2(2) | = | 3.6188 | [0.1638] | |
| hetero test: | Chi^2(68) | = | 69.545 | [0.4252] | |
| RESET test: | F(1,61) | = | 0.013157 | [0.9091] | |

Next, the 'gets' methodology is applied and this general model is reduced to its parsimonious form by sequentially dropping the most insignificant coefficient and then re-estimating the new model, until all coefficients are significant at the 5% level. Additionally, the downward reduction is checked for validity using F-tests and linear restriction tests (the progress report in PcGive). As a cut-off for the validity of reduction progress, the 1% level was chosen. The result is the following parsimonious form (Table 3):

**Table 3: The Parsimonious Model**

EQ(32) Modelling YoYNGDP by OLS
The estimation sample is: 1984 (1) to 2008 (1)

| | Coefficient | Std.Error | t-value | t-prob | Part.R^2 |
|---|---|---|---|---|---|
| YoYNGDP_1 | 0.620707 | 0.07803 | 7.95 | 0.000 | 0.4075 |
| YoYNGDP_4 | -0.113130 | 0.06514 | -1.74 | 0.086 | 0.0317 |
| Constant | 0.517173 | 0.1819 | 2.84 | 0.005 | 0.0808 |
| YoYRes_2 | 0.00688439 | 0.002782 | 2.48 | 0.015 | 0.0624 |
| YoYCr | 0.364538 | 0.05785 | 6.30 | 0.000 | 0.3015 |

| | | | |
|---|---|---|---|
| sigma | 1.19896 | RSS | 132.250598 |
| R^2 | 0.870681 | F(4,92) = | 154.9 [0.000]** |
| log-likelihood | -152.671 | DW | 2.16 |
| no. of obs. | 97 | no. of parameters | 5 |
| mean(YoYNGDP) | 2.53633 | var(YoYNGDP) | 10.5429 |

| | | | | |
|---|---|---|---|---|
| AR 1-5 test: | F(5,87) | = | 1.8064 | [0.1199] |
| ARCH 1-4 test: | F(4,84) | = | 0.80851 | [0.5232] |
| Normality test: | Chi^2(2) | = | 5.3159 | [0.0701] |
| hetero test: | F(8,83) | = | 0.71401 | [0.6785] |
| hetero-X test: | F(14,77) | = | 1.3420 | [0.2033] |
| RESET test: | F(1,91) | = | 2.4094 | [0.1241] |

Analysis of lag structure, coefficients:

| | Lag 0 | Lag 1 | Lag 2 | Lag 3 | Lag 4 | Sum | SE(Sum) |
|---|---|---|---|---|---|---|---|
| YoYNGDP | -1 | 0.621 | 0 | 0 | -0.113 | -0.492 | 0.0759 |
| Constant | 0.517 | 0 | 0 | 0 | 0 | 0.517 | 0.182 |
| YoYRes | 0 | 0 | 0.00688 | 0 | 0 | 0.00688 | 0.00278 |
| YoYCr | 0.365 | 0 | 0 | 0 | 0 | 0.365 | 0.0579 |

Tests on the significance of each variable

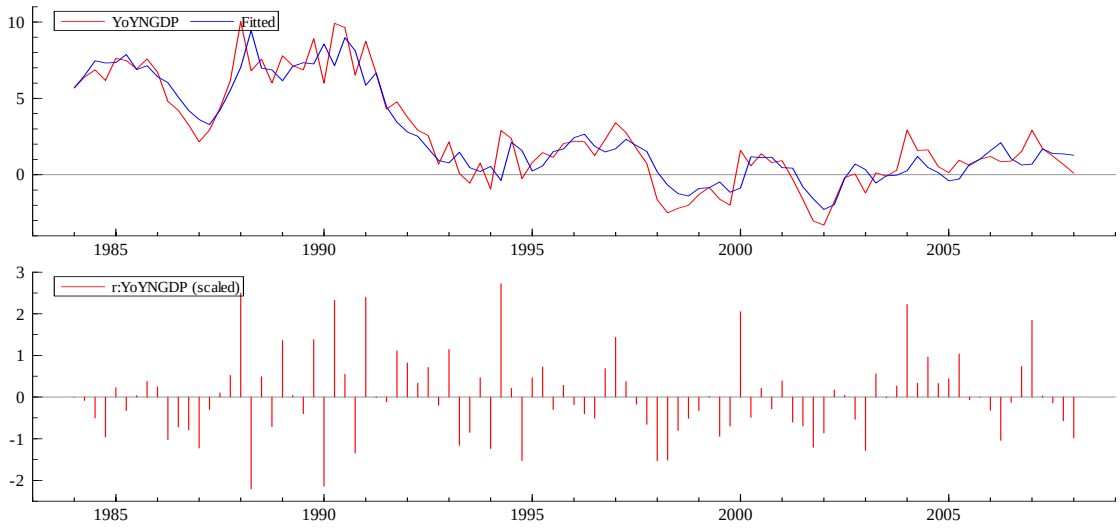
| Variable | F-test | | Value [ Prob] | Unit-root t-test |
|---|---|---|---|---|
| YoYNGDP | F(2,92) | = | 33.764 [0.0000]** | -6.4894** |
| Constant | F(1,92) | = | 8.0862 [0.0055]** | |
| YoYRes | F(1,92) | = | 6.1258 [0.0152]* | 2.475 |
| YoYCr | F(1,92) | = | 39.706 [0.0000]** | 6.3012 |

Tests on the significance of each lag

| | | | |
|---|---|---|---|
| Lag 1 | F(1,92) | = | 63.273 [0.0000]** |
| Lag 2 | F(1,92) | = | 6.1258 [0.0152]* |
| Lag 4 | F(1,92) | = | 3.0167 [0.0858] |

The parsimonious model has no noticeable problems and appears to be a valid empirical model of nominal GDP growth. Figure 1 shows the actual and fitted curves for nominal GDP growth.

**Figure 1: Nominal GDP, Actual and Fitted, Error terms**




Granger-causality tests show that there is evidence for unidirectional 'causality' from credit variable Cr to nominal GDP, and not in the other direction (Table 4).

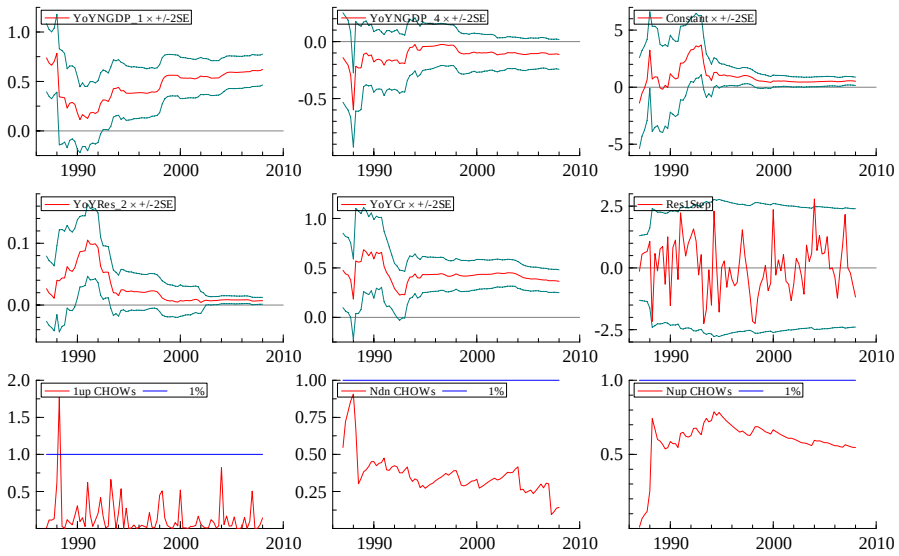
**Table 4: Granger 'causality' tests: Autoregressive Distributed Lag Model**

| **Test on the significance of independent variable** | **nGDP dependent Cr independent** | **nGDP independent Cr dependent** |
|---|---|---|
| Dynamic Analysis: | F(5,86) = 3.6510 [0.0048]** | F(5,86) = 0.23255 [0.9473] |
| Linear Restriction Test | F(1,86) = 10.1243 [0.0020] ** | F(1,86) = 0.00355254 [0.9526] |

Finally, structural break tests are conducted, to examine whether there were any breaks in the relationship between nominal GDP and monetary variables. This was done with the general model, in order to capture any structural breaks within any of the potential explanatory variables.

First, the recursive graphical tests are shown in Figure 1. As can be seen, there is no indication that a structural break occurred in 2001 or 2006, when 'quantitative easing' was said to have been adopted.

**Figure 2: Recursive Structural Break Tests**




The data output shows that 1-step Chow tests found evidence for a structural break only in 1988 Q1 and Q2, 1991 Q1, 1993 Q2, and 2004 Q1 (all at the 5% level, with the sole exception of 1988 Q2), but in no other quarter. The data output of the breakpoint Chow test found evidence of structural break in the 1987 Q2 to 1988 Q2 period (5% level), but in no other period. We proceed to specifically test the hypothesis that a structural break occurred in 2001(1) by dividing the sample into two periods, from 1984 (1) to 2001 (1) and from 2001 (2) to 2008 (1) and test whether it is permissible to pool them into the full length sample. This is done with the Chow Breakpoint test. The F statistic is F(20,57) = 0.9848. The critical value is 1.757. We fail to reject the null hypothesis of parameter stability.

A more precise test of whether the relationship between nominal GDP and its explanatory variables changed in the period of 2001 Q2 and 2006 Q2, when the BoJ is said to have implemented QE, can be conducted by the inclusion of a dummy variable.

We do this firstly by including the dummy in the parsimonious form, and secondly, in the general model followed by the downward reduction. In both cases, the dummy was not significant. The model with dummy showed some normality problem and the F-test for exclusion of the dummy indicated that it can be dropped. The final form, identical with the above, did not have normality problems (see Table 5 for the former case).

**Table 5: Dummy Variable for QE (2001 Q2 to 2006 Q2)**

EQ(33) Modelling YoYNGDP by OLS
The estimation sample is: 1984 (1) to 2008 (1)

| | Coefficient | Std.Error | t-value | t-prob | Part.R^2 |
|---|---|---|---|---|---|
| YoYNGDP_1 | 0.624518 | 0.07845 | 7.96 | 0.000 | 0.4105 |
| YoYNGDP_4 | -0.108985 | 0.06579 | -1.66 | 0.101 | 0.0293 |
| Constant | 0.496360 | 0.2077 | 2.39 | 0.019 | 0.0590 |
| YoYRes_2 | 0.00610657 | 0.003112 | 1.96 | 0.053 | 0.0406 |
| YoYCr | 0.354955 | 0.06039 | 5.88 | 0.000 | 0.2752 |
| **Dummy** | **0.104820** | **0.3991** | **0.263** | **0.793** | **0.0008** |

| | | | |
|---|---|---|---|
| sigma | 1.20884 | RSS | 132.977134 |
| R^2 | 0.869492 | F(5,91) = | 121.3 [0.000]** |
| log-likelihood | -152.937 | DW | 2.18 |
| no. of obs. | 97 | no. of parameters | 6 |
| mean(YoYNGDP) | 2.6171 | var(YoYNGDP) | 10.5043 |

| | | | | |
|---|---|---|---|---|
| AR 1-5 test: | F(5,86) | = | 1.6045 | [0.1675] |
| ARCH 1-4 test: | F(4,83) | = | 0.76419 | [0.5515] |
| Normality test: | Chi^2(2) | = | 6.0946 | [0.0475]* |
| hetero test: | F(9,81) | = | 0.65815 | [0.7439] |
| hetero-X test: | F(19,71) | = | 1.1106 | [0.3599] |
| RESET test: | F(1,90) | = | 2.2435 | [0.1377] |

**Test for excluding: Dummy**
Subset F(1,87) = 0.101898 [0.7503]

We conclude that no statistical evidence of a significant change in the relationship between potential monetary policy tools or intermediary targets and nominal GDP could be found. The announcement of changes in the operating procedure by the BoJ did not make a difference to the implementation of monetary policy.

# 4 Conclusions

The results suggest that the research strategy of measuring the effectiveness of QE by the perceived impact on nominal interest rates or the term structure – as has been dominant in the literature – may not be fruitful. The findings also differ from much of the literature in that there appears to be a stable relationship between nominal GDP growth and a broad money aggregate – albeit its modified credit counterpart, in line with earlier findings (Werner, 1997). This has important implications for monetary policy conduct, as the apparent breakdown of a stable relationship between monetary aggregates and nominal GDP (the 'velocity decline') led to much uncertainty among theorists and practitioners.

Until 2001, the Japanese central bank had stated that "the operating target for money market operations is the uncollateralised overnight call rate" (BoJ, 2001). On 19 March 2001 we were told the CB had decided "to finally discard the orthodox operating framework and adopt a new framework" (Kimura, 2002, p. 4). But there is no evidence that the operating instrument of monetary policy had, in fact, been the call interest rate until 2001: as interest rates are not significant in explaining economic activity, a rational central bank would not target them. For all we know, the BoJ may have always focused on bank credit creation, supported by a suitable provision of bank reserves, as our empirical model suggests.

In summary, findings are:

(a) Until the financial crisis of 2008, the 'new consensus' of monetary policy implementation had been the use of nominal short-term interest rates

(Woodford, 2003; call rates in the Japanese case). However, interest rates dropped out from the model in the sequential downward reduction.

(b) One of the more orthodox intermediary targets, bank credit growth, appears to be in a stable long-term relationship with nominal GDP growth.[10] The innovations made in the definition of the monetary aggregate are the use of the credit counterparts, and the disaggregation, so that only credit for transactions that are part of GDP is used. Lack of such disaggregation has been argued to explain the apparent 'velocity decline' (Werner, 1997). This raises the prospect of a revival of a more traditional, quantity-based approach (monetarism modified by the use of disaggregated credit counterparts).

(c) The BoJ's announcement of 19 March 2001 claimed that a break with prior policy was made and reserves were newly emphasised. However, there is no evidence that monetary policy changed from March 2001 to March 2006. The empirical model derived through the 'gets' methodology found that reserves have been the only other of two successful explanatory variables throughout the 1984 to 2008 observation period; and therefore, if one ignores the PR aspect of the post-March 2001 announcements, the use of reserves would not appear to be a new or unorthodox strategy.

(d) While some studies claimed to have found support for a significant impact of the 'qualitative easing' strategy of changing a central bank's balance sheet composition (by increasing long-term holdings of assets), this particular indicator dropped out from the model.

[10] This finding supports the results reported by Akram and Eitrheim (2008) that stabilization of credit growth enhances stability in both inflation and output.

(e) Total central bank asset growth was not found to be empirically relevant as a potential explanatory variable of nominal GDP growth.

(f) Finally, given the importance of credit for GDP transactions in affecting economic growth, all methods that may influence this particular variable need to be considered. Werner (1995) makes suggestions, including the substitution of bond issuance with government borrowing from banks. This would boost credit creation which, ironically, was the original meaning of the term 'quantitative easing'. Another, more controversial method would be the re-introduction of a regime of credit controls ('window guidance'), or at least a re-appraisal of the techniques of rediscounting (Langohr and Santomero, 1985). Alas, such policies were not adopted and nominal GDP growth remained sub-optimal, as had been warned (Werner, 1995).

(g) Concerning central bank performance, we conclude that it was possible for the Bank of Japan to boost nominal GDP growth during the 1990s and 2000s, via policies that affect bank credit creation. Central bank performance is therefore found to have been unsatisfactory.

(h) The Japanese experience may hold lessons for countries affected by the 2007/8 financial crisis. Policies aimed at stimulating bank credit growth are likely to be crucial in order to achieve an economic recovery.

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