

# Blowing against the Wind? A Narrative Approach to Central Bank Foreign Exchange Intervention

Alain Naef<sup>1</sup>

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## Abstract

Few studies on foreign exchange intervention convincingly address the causal effect of intervention on exchange rates. By using a narrative approach, I address a major issue in the literature: the influence of intraday news which affect the exchange rate alongside central bank operations. Some studies find that interventions work in up to 80% of cases. Yet, by accounting for intraday market moving news, I find that in adverse conditions, the Bank of England managed to influence the exchange rate only in 8% of cases. I use both machine learning and human assessment to confirm the validity of the narrative approach.

Keywords: intervention, foreign exchange, natural language processing, central bank, Bank of England.

JEL: F31, E5, N14, N24

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<sup>1</sup> Research Economist, Bank of France, alain-naef@banque-france.fr, 31 rue Croix des Petits-Champs, 75049 Paris. This research was undertaken while a postdoctoral fellow at the Department of Economics of the University of California, Berkeley.

Intervention on the foreign exchange market is important. Most central banks still follow exchange rate objectives and over 80% of countries are on fixed exchange regimes (Taylor 2010; Ilzetzi, Reinhart, and Rogoff 2019). According to recent theoretical findings, intervention could even be welfare-enhancing (Gabaix and Maggiori 2015; Hassan, Mertens, and Zhang 2016) and interventions should lean against the wind (Fanelli and Straub 2020). Central bankers generally believe that intervention has an impact on exchange rates (Neely 2008). Academics, on the other hand, have generated contradictory findings. Most studies trying to assess intervention use daily data and struggle to deal with the endogeneity caused by intraday changes in market conditions, making it difficult to assess the effectiveness of intervention.

Our understanding of central bank intervention is limited by a lack of data, as central banks keep their intervention records secret. In this paper, I unveil hand-collected intervention data from the UK, spanning over 40 years from 1952 to 1992. The data is original as it is mainly composed of secret interventions, which were not communicated to the public (this is still how many central banks operate today). The database I created is the longest for any advanced economy and is open for replication unlike other studies on central bank intervention, which are often bound to data confidentiality. All interventions in the data set are sterilized interventions, a British institutional feature. As operations were run through the Exchange Equalisation Account and not the Bank of England directly, all operations had a counterparty transaction in government bonds.

I find that, after accounting for some of the intraday measurement problems of previous studies, foreign exchange interventions that go *against* market trends (“against the wind”, as central bankers put it) only influence exchange rates in around 8% of cases. This is in stark contrast to recent literature showing foreign exchange intervention success rates of up to 80% (Fratzscher et al. 2019). Half of the interventions considered successful using the previous standard methodologies no longer count as successful, when measuring whether good or bad news (independent from

central bank interventions) were circulating on a given day. Intervention is particularly ineffective when attempting to reverse the direction of the exchange rate after negative news affecting the currency. Bank of England intervention was more effective when trying to tame the appreciation of sterling (“restraining intervention”) than when trying to avoid a depreciation of sterling (“defending intervention”).

An intuitive example allows us to understand the shortcomings of most intervention studies to date. Imagine that today, the People’s Bank of China (PBOC) was trying to make the renminbi appreciate through foreign exchange intervention. At 10am, they buy renminbi with their dollar reserves, hoping this will bolster the renminbi’s price. Now imagine that an hour later, President Trump tweets something signalling an end to the trade war with China, sparking a stark appreciation of the renminbi. Most studies on intervention would simply assume that any interventions during that day were going against the wind, and count this intervention as successful. My narrative approach accounts for other news during the day to assess whether the intervention was really going against the wind, or if it merely happened to go in the same direction as the market.

I use an event study methodology to test the effectiveness of British foreign exchange intervention between 1952 and 1992. From 1952 to 1986, I rely only on an event study and a placebo test to measure the effectiveness of intervention. From 1986 to 1992, I also use the narrative approach, which is at the heart of this paper’s key finding on the impact of intraday news.

Central bank intervention is hard to assess as it is often measured without intraday data, and therefore not accounting for any changes in market conditions. My paper deals with these endogeneity problems by relying on narrative evidence about market conditions written by Bank of England officials. I use a narrative approach as pioneered by Romer and Romer (1989). I clearly identify days when the currency is hit by negative news that is not related to the intervention of the central bank. I get this measure by

analyzing the text from the daily reports written by Bank of England employees. To test the robustness of my analysis, I rely on both an external assessment and machine learning in the form of Natural Language Processing (NLP).

In brief, the main contribution of this paper is to demonstrate how intervention success is much lower when intraday market news is accounted for. Using a narrative approach to deal with endogeneity issues of central bank intervention success is another contribution of the paper. It also offers a new database for research on central bank intervention, spanning over 40 years and available for replication.

## 1. Literature review

Central bank intervention can either be sterilized (with simultaneous bill purchases that leave the monetary conditions unaffected) or unsterilized (with no asset purchases, thus affecting the monetary conditions). Unsterilized intervention affects the exchange rate through changes in interest rates, making the currency more or less attractive to investors. The effectiveness of sterilized intervention has long been questioned and the debate is still ongoing.<sup>2</sup>

The literature identifies three channels through which sterilized intervention works: portfolio-balance, signaling and coordination. The portfolio-balance channel has received the most attention in the literature (Cavallino 2019; Gabaix and Maggiori 2015; Fatum 2015; Dominguez and Frankel 1993). The channel works through investors portfolio shocks, which affect the amount of bonds in circulation and their risk premia and by doing so affect the exchange rate. Signaling works through central banks giving hints of future monetary policy stances to which the market reacts (Fatum and Hutchison 1999). The coordination channel works when

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<sup>2</sup> For an overview of the literature on central bank intervention, see Sarno and Taylor (2001) and Neely (2005), more recent papers by Adler, Lisack, and Mano (2019); Adler and Mano (2018); Echavarría, Melo-Velandia, and Villamizar-Villegas (2018) and Hu et al. (2016).

the market is thin and traders have lost confidence in the ability of macroeconomic fundamentals to inform the price, the central bank can step in and provide direction (Reitz and Taylor 2008). In this paper, I do not choose a channel through which intervention could work, but focus on methodological issues in current papers on the topic.

Looking at the empirical literature on intervention, most papers published fail to identify the causal relationship between intervention and exchange rates as the two variables are too endogenous. In a cross-country study analyzing 35 countries, Blanchard, Adler, and Filho (2015) demonstrate that sterilized intervention can hinder unwanted currency appreciation due to capital inflows. Fratzscher et al. (2019) argue that intervention is effective in over 80% of cases when managing volatility. Presenting evidence from 33 countries, they argue that central bank intervention was effective in attaining the goals set by policymakers from 1995 to 2011. The paper does an excellent job at analyzing new data but does not offer a convincing identification strategy.

Interestingly, independently of what macroeconomists may think, central bankers themselves, when surveyed, generally think that intervention is an effective way to influence exchange rates (Neely 2008).

A key contention in the literature on foreign exchange intervention is that intervention is not random but happens as a reaction to market conditions. Market conditions often shift during the day and intervention success is not exogenous to market conditions. Most articles offer solutions to tackle this endogeneity issue, but few do so convincingly. Fatum and Hutchison (2006, 392) note that the main issue of endogeneity “arises in our study (and every intervention study) since the central bank usually takes its cue to intervene on the basis of observed exchange rate movements”.

To try to mitigate endogeneity, Fatum and Hutchison (2006) group interventions into clusters and assess the effectiveness not of the total daily interventions but of a cluster. In their approach, if a central bank sells dollars for three consecutive days, their measure counts the intervention as successful if after the third day the exchange rate goes in the expected direction. They admit, however, that their clustering might make interventions appear more successful than they are. Fratzscher et al. (2019) use a similar method of grouping interventions in clusters.

This clustering methodology is problematic, especially if the exchange rate is considered as a random walk in the medium term. For example, exogenous factors - such as the publication of better than expected GDP figures when the central bank is trying to make the currency appreciate - can make intervention seem successful, when success has little to do with the intervention itself. Following this logic, the central bank will eventually be successful if it intervenes for long enough and stops when the exchange rate goes in the desired direction. Success will then be due to pure luck or exogenous factors. To avoid this issue, I instead assess the impact of intervention after one day; in addition, my narrative approach factors in exogenous news (on narrative approaches see Romer and Romer 1989; 1994; 2014; Monnet 2014). Using a one-day horizon is also in line with findings showing that most of the impact of intervention lasts one day.<sup>3</sup>

Kearns and Rigobon (2005) use shifts by both the Bank of Japan and the Australian Central Bank from small, frequent interventions to large, infrequent interventions - which they interpret as exogenous shocks - to better understand the effectiveness of central bank intervention. The authors admit that while useful, their contribution does not completely deal with the endogeneity problem.

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<sup>3</sup> Kearns and Rigobon (2005, 31) show that “almost all of the impact of an intervention occurs during the day it is conducted”.

Most studies on intervention effectiveness fail to account for intraday news changes<sup>4</sup>. Most studies also assume that all interventions go against the wind putting them in one homogenous group. My paper shows that this is not the case and that the “wind” (or news about the currency) can change during the day. Authors themselves acknowledge that their studies rarely convincingly address endogeneity. The main contribution of this paper is to show that by not accounting for intraday news, most papers on intervention effectiveness provide biased estimates.

## 2. New confidential data

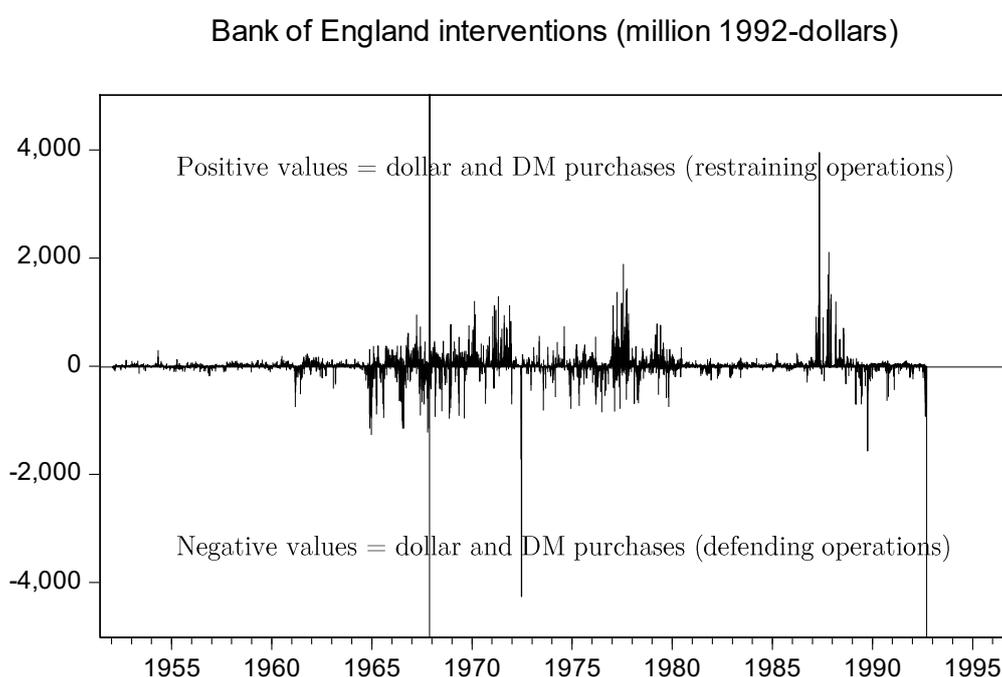
The issue with studies on central bank intervention is the lack of available data. And when data are available, it is often data on public intervention, though it has been shown that most central banks intervene in secret (Mohanty and Berger 2013).<sup>5</sup> Various empirical studies therefore use the same datasets and focus only on countries with public intervention records such as Turkey, Colombia or Japan. Looking at secret intervention, my findings have implications for all central banks intervening in secret, which is under-researched. Almost all interventions in my sample were secret - less than 1% of the operations were publicized (66 out of 8,429). Note that secret intervention does not mean that the market is unaware of the intervention; it means that the central bank does not officially announce it. Dominguez (2003) suggests that traders in the 1990s usually knew that the Fed was intervening at least one hour before any news outlets would report it.

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<sup>4</sup> Note that there papers taking into account intraday foreign exchange rate news such as Andersen et al. (2003), Dominguez and Panthaki (2006), Evans and Lyons (2008) and Ehrmann and Fratzscher (2005) but these papers do not directly deal with intervention effectiveness.

<sup>5</sup> Note that other scholars have looked into secret interventions before, see Klein (1993), Fischer (2006) and Dominguez and Panthaki (2007). The contribution here is to analyse secret intervention data that over a long time period.

This paper presents a long run daily database of intervention by an advanced economy, presenting data for over 40 years. Figure 1 presents the data in 1992-US dollars. The data offers an aggregate amount of all Bank of England intervention operations during a given day. This includes intervention in any currency. In practice interventions were mainly in dollars until 1987 and in deutschmark thereafter (see the historical section for more details).



**Figure 1** – Intervention by the Bank of England in million of 1992-dollars. **Source:** The data have been copied from reports written with typewriters kept at the archives of the Bank of England (archive reference C8).

**NOTE:** The data are cropped at \$1bn to improve readability but the figures go up to -22\$bn for Black Wednesday on 16 September 1992.

The data are negative for sales and positive for purchases of foreign currency. Intervention data come from the Bank of England dealers' reports, which offer daily records.<sup>6</sup> The reports were written by the dealers of the Bank of England, foreign exchange operators who managed sterling on behalf of the government. The archive of

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<sup>6</sup> Bank of England Archives, Cashier's Department: Foreign Exchange and Gold Markets – Dealers' Reports, C8.

the Bank of England kept printed copies of the reports, which I copied individually to put together my database.

Another benefit of this data is that it comes directly from policymakers, without any filter or control. Published data by central banks are likely to be processed before publication and might not include all operations. It is well known to foreign exchange traders today that, for example, South Africa and Brazil, publish some of their operations while keeping a large unpublished derivatives' book. The dataset presented here is much more precise than those of other studies in the field, which rely on proxies, such as changes in reserve levels or press reports.

### 3. Historical background 1952-1992

The postwar history of the pound can be separated into three clear phases when it comes to Bank of England operations on the foreign exchange market. From 1945 to 1987, British policymakers mainly managed the pound against the dollar; from 1987 to 1992, the deutschmark was the reference currency and from 1992 to today, the pound was left to float freely.

#### **Dollar focus 1952-1987**

1939-52	The foreign exchange market is mainly under the control of the state during the war and after.
January 1952	Reopening of the foreign exchange market under the Bretton Woods Fixed regime. Sterling fixed at \$2.80 per pound, then \$2.40 after the 1967 devaluation.
15 August 1971	Nixon shock: the US closes the gold window, in effect leaving the Bretton Woods agreement. Sterling floats.
18 December 1971	Smithsonian Agreement: 2.25% bands and new parities.
23 June 1972	The United Kingdom withdraws from the Smithsonian Agreement and starts floating (effectively a sterling devaluation).
22 September 1985	Plaza Accord: coordinated interventions to appreciate the dollar.

### **Deutschmark focus 1987-1992**

22 February 1987	Louvre Accord depreciates the dollar; the UK starts shadowing the deutschmark.
Early 1988	End of official deutschmark shadowing, but the deutschmark remains the main focus.
1 October 1990	Britain joins the European Exchange Rate Mechanism (ERM) with a band of +/- 6% with the ECU (and <i>de facto</i> with the deutschmark).
16 September 1992	Black Wednesday: the UK leaves the ERM, floating the pound.

The short timeline above outlines the history of these exchange rate systems from 1952 to the present day. Most of the time, the pound was either in a fixed exchange rate system or in a managed float. Only in 1992 was the currency left to float freely.

### **Characteristics of Bank of England intervention**

How did the Bank of England intervene? In the sample presented, interventions by the Bank of England were frequent and secret. Only 66 of the 8,429 interventions were publicly communicated, less than 1% of the sample. Secret intervention makes study of the Bank of England extremely relevant as most central banks today still intervene in secret as well. Surveying central bankers, Mohanty and Berger (2013) found that only 18% of central banks frequently communicated their intervention practices. This means that most central banks intervene in secret, despite the literature arguing that communicating intervention is more effective (Burkhard and Fischer 2009). Overall, the Bank was in the market 79.5% of the trading days from 1952 (when the foreign exchange market reopened after the war) to 1992, when it stopped trying to influence the exchange rate.

## **Sterilized intervention by design**

An institutional feature of the Bank of England ensured that all interventions were automatically sterilized. The Bank of England operations were all done through the EEA (Exchange Equalisation Account), which was independent from the Bank of England and belonged to the Treasury. Howson (1980) showed that the institutional structure of the EEA meant that all intervention operations had a counterparty in Treasury bills. When the Bank of England was selling dollars against pounds, it would reinvest the newly acquired pounds into British Treasury bills and doing so, sterilizing the operation. Conversely, when the Bank wanted to buy US dollars, it first had to sell Treasuries at the EEA to obtain sterling to purchase dollars. This meant that any operation was automatically sterilized as a feature of the EEA.

## **Goals of Bank of England interventions**

When assessing intervention, it is essential to understand what the central bank was trying to achieve. Today, as during the 2009 crisis, central banks mainly want to reduce exchange rate volatility (Fratzscher et al. 2019; Mohanty and Berger 2013; Blanchard, Adler, and Filho 2015). However, during the period observed, the goal of the Bank of England was different. Interviews with policymakers of the time and archival records show that policymakers wanted to influence the exchange rate in one direction or the other.

Although objectives change and are not set in stone, historical analysis shows clear patterns in the goals of the Bank of England. The Bank intervened either to make the exchange rate appreciate or depreciate. Below, I present several reports written by the very people intervening: Bank of England dealers. By analyzing their own assessment of interventions, the underlying goals of intervention become clear.

On April 7, 1988, as sterling was appreciating against the Deutschmark, the dealers' reports read: "Sterling was mostly steady, but dipped this afternoon following a well-publicised round of co-ordinated sales by ourselves and the Bundesbank". Here the goal

was to make the appreciating currency depreciate. The operation, according to the Bank, seemed successful.

On June 23, 1989, Bank of England dealers commented that “Sterling’s early weakness was met by a round of well-publicised official intervention, after which the pound drifted quietly into the weekend”. The goal of the intervention was to counter sterling’s weakness and the impact (as assessed by the Bank itself) was visible over the weekend.

On September 16, 1992 (a day before Black Wednesday), the reports read (emphasis added): “Several rounds of overt intervention only had momentary **success**: selling pressure at the margin increased as the Bank’s early morning money market round passed without a move on interest rates.” Here success is defined as increasing the sterling-deutschmark exchange rate, which was falling against the backdrop of a growing crisis in the ERM.

These examples show the Bank trying to move the exchange rate, up or down. The goal was not simply, as it is today, to reduce volatility, but to *push* the rate in a given direction. This is an important point to bear in mind when assessing what counts as success.

#### 4. Does central bank intervention work? Evidence from new data and methodologies

This section assesses the intervention performance of the Bank of England based on data presented above. Few papers measuring central bank intervention effectiveness deal with the direction of the wind effectively. To better tackle intervention success, I use a narrative approach, detailed below. The advantage of looking into history is that the reasoning behind the intervention decisions of policymakers is available. The Bank of England recently changed its information access policy and now opens most of its archival documents to researchers after a 20-year period. As the last intervention

occurred in 1992, we have recently gained access to the reasoning of central bankers as they were intervening. As a narrative approach can contain some subjective assessment, the robustness section uses both human- and machine-based techniques to control for potential subjectivity in my assessment.

### **Assessing intervention success – An event study on over 10,000 trading days**

Most studies on central bank intervention effectiveness either use GARCH and other similar models to assess the effect of central bank interventions on market volatility, or they rely on event study methodologies to assess the effect of the policy on the exchange rate. GARCH models mainly deal with volatility, when the question here is to understand whether intervention can influence the direction of the exchange rate. Event studies are more appropriate than traditional regression approaches because of the stochastic properties of intervention and exchange rate data: intervention occurs in bursts and the exchange rate changes frequently in a martingale-like fashion. This makes regression analysis unfit to properly assess the effectiveness of the policy.

For interested readers however, the appendix presents regressions as an alternative to the approach taken here. Table 6 in the appendix offers a simple parametric approach and shows that using a naïve regression, intervention can be understood as having the opposite effect to the intended one. When accounting for intraday factors as outlined in the narrative approach below, the regression in Table 9 yields similar results to the event study approach. But as most studies on intervention effectiveness use event studies, the analysis presented here will offer results that easily can be compared to other findings.

This methodology relies on three intervention success criteria (SC) and is inspired by a methodology by Bordo, Humpage, and Schwartz (2015). SC<sub>1</sub> measures whether intervention leads to an appreciation/depreciation of sterling against the dollar (later deutschmark) between the previous day's market close and the current day's market close. SC<sub>2</sub> measures whether the exchange rate depreciates/appreciates less after

intervention between the day's market close and the previous day's market close than it did over the immediately preceding period (also called smoothing). The final criterion,  $SC_3$ , combines the first two. The three criteria take the form of a binary variable and are formalized in the equations on the next page.

$$SC_1 = \begin{cases} 1 & \left\{ \begin{array}{l} \text{if } I_t > 0, \text{ and } \Delta S_t < 0, \\ \text{or} \\ \text{if } I_t < 0, \text{ and } \Delta S_t > 0 \end{array} \right. \\ 0 & \text{otherwise} \end{cases}$$

$$SC_2 = \begin{cases} 1 & \left\{ \begin{array}{l} \text{if } I_t > 0, \text{ and } \Delta S_{t-1} > 0 \text{ and } \Delta S_t \geq 0, \text{ and } \Delta S_t < \Delta S_{t-1} \\ \text{or} \\ \text{if } I_t < 0, \text{ and } \Delta S_{t-1} < 0 \text{ and } \Delta S_t \leq 0, \text{ and } \Delta S_t > \Delta S_{t-1} \end{array} \right. \\ 0 & \text{otherwise} \end{cases}$$

$$SC_3 = \begin{cases} 1 & SC_1 = 1 \text{ or } SC_2 = 1 \\ 0 & \text{otherwise} \end{cases}$$

where  $I_t$  designates foreign exchange intervention on day  $t$ . Positive values are purchase of foreign exchange (called restraining interventions) and negative values are sales of foreign exchange (defending interventions). A purchase is expressed as  $I_t > 0$  and a sale as  $I_t < 0$ .  $\Delta S_t$  is the difference between the spot closing rate on the day of the intervention and the spot closing rate the day before the intervention. It shows the effect of the intervention on the exchange rate during the day.

The focus is on the daily effect. This is justified by the type of intervention by the Bank of England, which was on the market most days as explained above. As we have seen, Kearns and Rigobon (2005, 31) show that most of the impact of an intervention occurs during the day it is conducted. This underpins the choice of focusing on the day of the intervention itself.

As shown in the historical section above, the Bank of England focused on the dollar until February 1987 and the deutschmark thereafter. To account for this clear difference in policy, the sample is divided into two subsamples: a dollar sample from the opening of the foreign exchange market from February 1952 to February 1987. After the Louvre Accord of February 1987, the British foreign exchange policy focuses mainly on the deutschmark and this is the second sample. After the Black Wednesday crisis in September 1992, intervention by the Bank of England stopped. Table 1 below is separated into the three success criteria presented above as well as into defending (to make the exchange rate appreciate) and restraining interventions (to make the exchange rate depreciate).

	Day count	Reversing exchange rate (SC1)		Smoothing appreciation or depreciation (SC2)		Total success (SC3, sum of SC1 and SC2)	
		Success count	Percentage of successful intervention	Success count	Percentage of successful intervention	Success count	Percentage of successful intervention
<b>Dollar intervention (1952-1987)</b>							
Defending interventions	2298	434	19%	465	20%	899	39%
Restraining interventions	4817	1211	25%	794	16%	2005	42%
<b>Deutschmark intervention (1987-1992)</b>							
Defending interventions	357	102	29%	61	17%	163	46%
Restraining interventions	957	327	34%	179	19%	506	53%

**Table 1** – Intervention success according to the three criteria presented above.

Note that these “success” rates do not imply causality; it could be that some of these “successes” are due to other factors (as we will see in the narrative approach). The Bank could be trying to make the exchange appreciate on the same day that improved GDP figures are published. In this case, the intervention would be counted

as successful, but the success would not only be due to intervention but also potentially due to the GDP figures. The next section deals with this endogeneity problem. But as stressed in the literature review, most published studies on the topic rely on these success rates and simply run robustness checks to see if they lie within a realistic frame.

Naïve results in Table 1 show the Bank was more “successful” in restraining than defending interventions, that is, it was more successful when it tried to tame sterling than bolster it. This holds true for all three success criteria in both the deutschmark and dollar periods. The intuition is that markets take a central bank more seriously when it is intervening with its own currency, which is available in unlimited amounts, than when intervening with scarce dollar or deutschmark reserves.

These results compare with other findings in the literature. For example, using the same methodology, Bordo, Humpage, and Schwartz (2015) found that the Federal Reserve was successful in reversing the deutschmark/dollar exchange rate 29% of the time, which happens to be the same number as the results of my study for deutschmark/sterling. However, they found higher success rates on the yen/dollar exchange rate, going up to 70%. Fratzscher et al. (2019), using a different but somewhat similar methodology, found that from 1995 to 2011, countries in free floating regimes could manage to reverse exchange rates (the equivalent of SC1) in 61% of the episodes. This is higher than the 24% reversal rates in this paper, which is likely due to the fact that the Bank of England intervened more frequently, leading to less success. Their paper also uses a different sample and a somewhat different methodology.<sup>7</sup> As these results here are purely descriptive, they do not offer any way to deal with endogeneity and are not causal. The appendix offers a placebo test to show how these results hold

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<sup>7</sup> The sample in Fratzscher et al. (2019) is over 76% of restraining interventions where my sample contains 69% of restraining interventions. Regarding methodological differences, Fratzscher et al. (2019) use several days events, which has certain advantages but can lead to endogeneity problems as it becomes hard to see if intervention was successful because of central bank operations or because of normal changes in the exchange rate. The next section tackles this endogeneity issue in more detail.

up when compared with another sample. This placebo measure, like many other placebos in the literature, has many shortcomings. Therefore, the next section offers a narrative approach to deal with these shortcomings.

### **Narrative approach – Reading the policymakers’ mind**

When trying to assess the performance of foreign exchange intervention, economists are faced with a challenge. Intervention occurs within a specific context where policymakers react to adverse market conditions (what central bankers call “leaning against the wind”). If the exchange rate is depreciating because of poor trade figures, for example, it is likely that intervention will be less effective than if the central bank intervenes on a day with more positive news associated with the currency. Similarly, if traders are bullish about the currency, because of a positive GDP forecast for example, it will be more difficult for the central bank to tame an increase in the currency. This paper deals with this issue by using a narrative approach and providing clear counterfactuals.<sup>8</sup> Using daily records of policymakers over a period of almost 10 years, I compare intervention in favorable (with the wind) and unfavorable conditions (against the wind). Note that the terminology can be slightly misleading as “good news” for the currency, is favorable to the central bank if it is trying to make the currency appreciate (as good news makes the currency appreciate), and unfavorable if it is trying to make it depreciate. I therefore use the terminology intervening “against the wind” (or against the market trend) and “with the wind” (with the market trend).

Starting in April 1986, the foreign exchange dealers of the Bank of England changed the way they reported market activity. They started to provide a small paragraph assessing the situation of the pound for every trading day. These memos were sent to the Treasury (remember that at the time the Treasury was in charge of monetary and exchange rate policy in the UK, not the Bank of England). They concisely list whether

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<sup>8</sup> Narrative approaches have been used for other questions but this paper is the first to use the methodology in the context of foreign exchange intervention. For more on narrative approaches, see Romer and Romer (1989, 1994, 2014) or Monnet (2014).

any exogenous factors were putting pressure on the sterling exchange rate during the day. Table 2 below provides some examples and Table 5 in the appendix presents a broader sample.

These data are invaluable as they not only list exogenous factors influencing the exchange rate (say, the publication of a large trade deficit) but also how the market perceived this in comparison to expectations. This is essential information as bad market news for a currency, such as a large trade deficit, could actually lead to the currency's appreciation if the market was expecting worse figures. Being at the center of the foreign exchange market and in daily contact with all the main foreign exchange dealers, Bank of England employees had a good overview of what the market was expecting. They not only noted any market-moving news but also detailed how it compared to market expectations. The data are accurate as they were directly recorded at the end of the trading day. The information is also superior to any information that can be found in newspapers as the dealers spoke to investment banks daily and had access to insider information, and they usually knew before other dealers if there would be changes in the Bank Rate. The reports are consistent and constant which makes them ideal for our purposes.

I classify the dealers' assessment of market conditions into three categories depending on the news regarding the value of sterling. Each day either displays good news for the currency (for example better trade figures than the market expected), neutral news (no significant news or change in conditions), or bad news (for example worse than expected unemployment figures).<sup>9</sup>

Table 2 below shows examples of the three types of news as expressed by dealers. The Bank of England dealers are also aware of aspects that technical traders observe,

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<sup>9</sup> Note that these news reports include an assessment by the policymakers of whether the news goes with or against expectations. For example, an increase in unemployment of one percentage point can be good news if the market expected an increase of two percentage points. Similarly, a decrease in the trade deficit can be bad news if the market expected a bigger decrease.

for example a psychological threshold of 3DM per sterling. Other technical traders known as chartists would also look at momentum and sell after a certain number of days of currency increase, or other such rules familiar to Bank of England dealers. These subtleties were also noted by the Bank of England dealers in their records and might not be found in news reports.

	Examples of key sentences
GOOD NEWS for sterling	<p>“Sterling benefited from the weekend opinion polls and press comment”</p> <p>“The dollar and sterling both gained on German interest rate rumours”</p> <p>“After an uncertain start, sterling came into strong demand from Europe during the morning, helped by the trade figures.”</p> <p>“Sterling was pulled higher by the strong dollar”</p> <p>“[...] moved steadily higher after the better than expected trade figures”</p> <p>“Sterling was in good demand, helped by the reassuring PPI data and a perception that the recovery is 'on track'.”</p>
NEUTRAL or NO NEWS	<p>“The markets were again quiet”</p> <p>“Sterling was on the sidelines for most of the day”</p>
BAD NEWS for sterling	<p>“New York continues to take a more bearish view of sterling, where more weight is given to devaluation rumours.”</p> <p>“There was also some short covering in front of tomorrow's Mansion House speech by the Chancellor”</p> <p>“Dealers were unimpressed by the CBI survey and sterling tended to move lower with the dollar”</p> <p>“{sterling} tended to soften along with the dollar, and failed to benefit from better than expected output data (industrial production +0.8%, manufacturing +0.6%)”</p> <p>“Sterling ignored better than expected Q2 GDP figures and struggled {...}”</p>

**Table 2** – Examples of good, neutral and bad news for the pound. The assessment is done by the author and the robustness section shows assessment by different methods. Table 5 in the appendix shows twenty randomly selected full quotes from reports with their coding. Source: Bank of England archives, Dealers’ reports, reference C8.

These reports are valuable as they show how better than expected news does not always influence the exchange rate as expected in statements such as “Sterling ignored better than expected Q2 GDP figures” (Dealers’ Report, July 22, 1994). The dealers report not only general market expectations, which they gather from their daily market

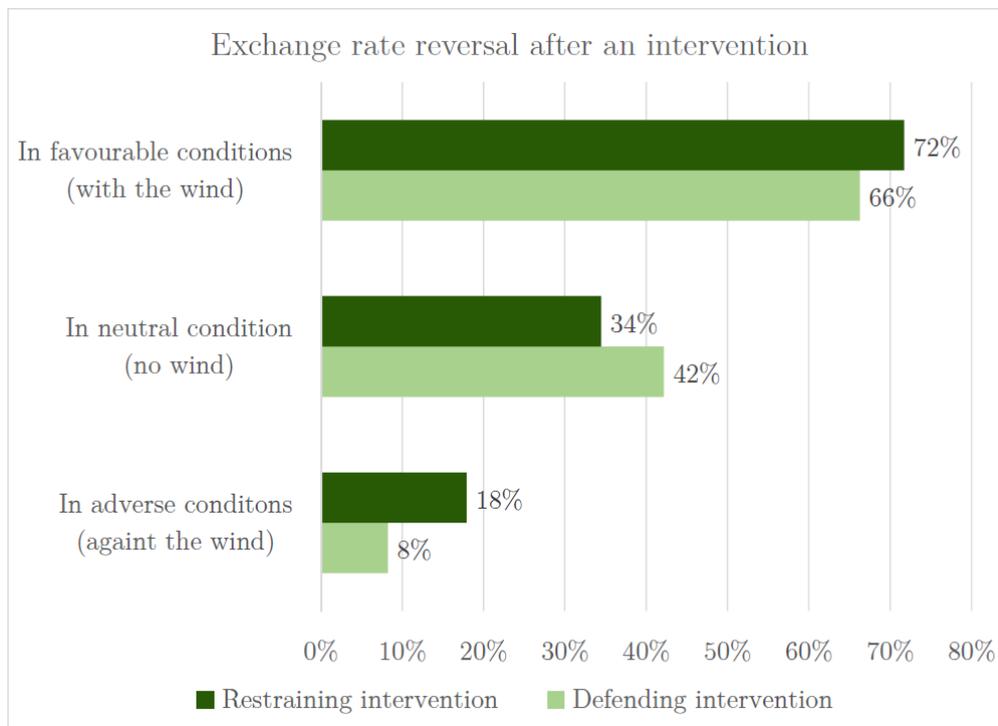
interactions, but also how the different news items are reflected in intraday price changes.

To see exactly how I classified these statements into good, neutral and bad, Table 5 in the appendix shows the choices I made on a random sample from the reports. I use content analysis to assess the dealers' reports on market conditions. Content analysis includes a wide series of tool to extract meaning from text (Krippendorff 2018; Neuendorf 2016). I read each paragraph on market conditions and I assessed whether the general conditions indicated good conditions for the currency of intervention. Data were then coded into a dummy variable: value 1 for positive news (meant to lead to an appreciation of the currency); 0 for days with unclear trends or little market activity; and -1 for days with adverse news (leading to depreciation). I then classified interventions by whether they went *with* the market trend, were done *without* clear market trend or were done *against* the market trend. Note that good news about a currency makes it easier to intervene to bolster its value, but makes it harder to intervene to restrain its rise.

As content analysis entails a portion of subjective judgment, the robustness section below offers several ways of controlling for potential subjectivity. The first was by replacing my personal judgement with a machine learning algorithm; the second, using Amazon Mechanical Turk (MTurk) to make third parties assess the same paragraphs I assessed.

Figure 2 shows the reversal success rate (SC1) according to whether interventions were going with the market, without any significant market direction, or against the market as explained above. The figure shows how interventions are almost 10 times less successful when they go against intraday market conditions. This is expected. However, most studies on intervention effectiveness miss this distinction and measure the effect of intervention ignoring intraday market information. This sample shows that this assumption is wrong: almost half of the Bank of England's interventions during

1986-92 were not going against market forces. Table 11 in the appendix give more detailed result than presented here.



**Figure 2** – SC1 or reversal success count taking into account market conditions.

The success rate of 8% for defending interventions going against market trends can be compared to the benchmark rate of 19%, obtained in the previous section when not discriminating for market conditions (see Table 1). Put differently, around 50% of the interventions that were judged successful using the previous standard methodology now no longer count as successful when accounting for market conditions.

What are concrete examples of the Bank intervening with the wind that we do not want to count? It can be two things, either the Bank is trying to reinforce a market trend. Or it can be that the “wind” turned during the day. Below is an example for each case.

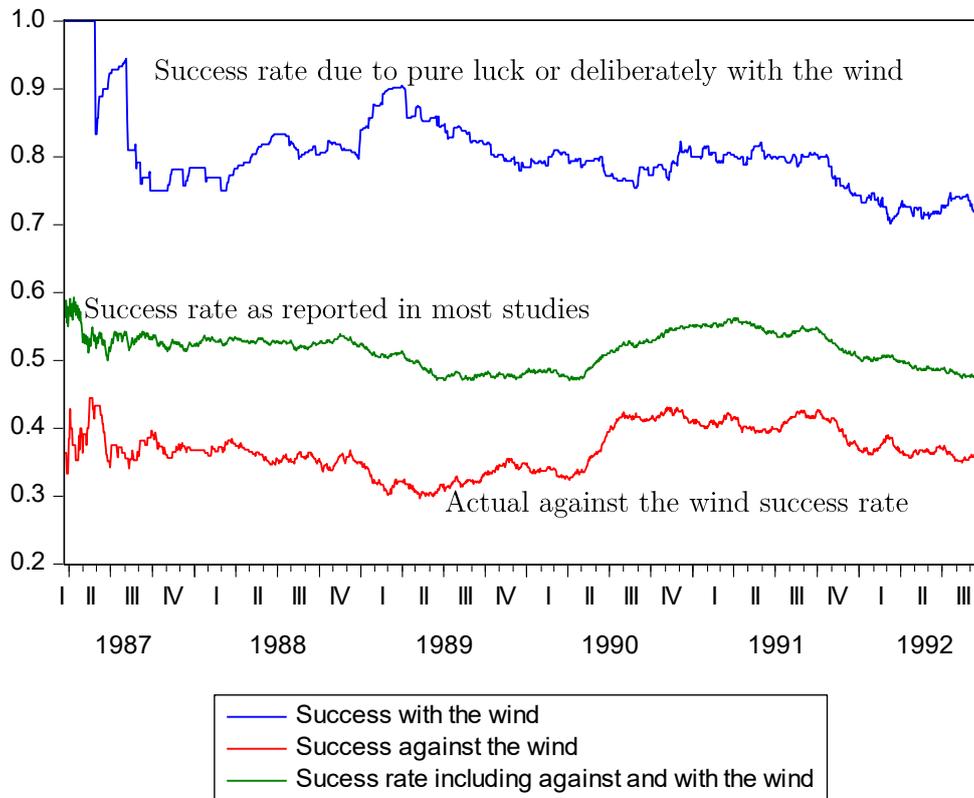
On July 16, 1992 the Bank of England sold deutschemark for 19 million dollars’ worth to strengthen the pound. This intervention was counted as “successful” by the traditional criteria as the exchange rate reversed from the day before. Dealers reported:

“Sterling opened softer on precautionary selling ahead of today’s trade figures. The announcement of a smaller-than-expected deficit caused sterling to rally quickly to its highs.” In this case, the dealers probably intervened in the morning to support the pound and the intervention was only “successful” because of the announcement of the positive trade figures in the afternoon.

On June 27, 1989, the Bank of England explicitly went with the wind after some positive market move. The bank followed the direction of the exchange rate and this intervention should not be counted as successful. The dealers report explain that the “unexpectedly modest May deficit” figures “sparked of a strong rally in sterling” which they followed with “aggressive support” in the same direction as the market. In this case, the Bank explicitly followed the market trend. With my methodology this would not be counted as a successful against the wind intervention when in other studies it would. The cause of the reversal of exchange rate from the previous day is clearly due to the trade figures and not the Bank which simply followed an existing market trend.

In other words, daily studies on intervention success report many “false positive”. Either because the market conditions change during the day or because the central bank explicitly intervenes with the wind as seen in the example above. Figure 3 summarizes this main finding by separating with and against the wind intervention success, in comparison an overall success measure. It shows how against-the-wind success is much lower than what most studies on the topic have been reporting. The top line show successes only due to chance or deliberately against the wind. Removing these success from the middle line (or the one reported in other studies), we obtain the lower line, which is closer to the actual against-the-wind success. Once the direction of the wind is accounted for, success rates drop drastically.

1-year rolling average of success rate in percent according to wind



**Figure 3** – success according to criteria SC3 depending on whether the Bank of England goes with the wind or against the wind, compared with the baseline in the middle. Success when conditions are neutral are not reported here to ease readability. 1-year rolling window helps the data being readable.

### Testing the robustness of the narrative approach – Humans and machines

A frequent criticism to narrative approaches is their subjectivity. What one researcher might classify a certain way, another might do differently. To mitigate the issue, I use two forms of robustness check. First I use Amazon Mechanical Turk (MTurk) to have third party subjects replicate my assessment. Second, I use a machine learning algorithm to see whether my results are consistent. Neither of these methodologies offer the same richness of data analysis as the narrative approach, but they do enable confirmation that the results are unbiased. These two checks do not measure temporality. When I assessed the direction of the wind by reading the dealers’

reports, I specifically made sure that news affecting the currency occurred at the end of the day. For example, if the day started with positive news but ended with negative news, I would record it as a negative day, as this had the most impact on the closing exchange rate. The machine learning algorithm on the other hand does only look at the overall sentiment in the extracts. Equally, as I did brief assessors on Amazon Mechanical Turk to look for news at the end of the day, it is unclear whether all assessors understood this instruction well. However, despite the shortcomings of these tests, they both confirm that the choices made in my assessment are not arbitrary.

### **Amazon Mechanical Turk**

Amazon Mechanical Turk (MTurk) is frequently used in research in psychology, marketing and experimental economics. For example, Ambuehl, Niederle, and Roth (2015) use MTurk to question participants' willingness to take part in a medical trial depending on the size of compensation. The quality of the results obtained is variable, but the advantage is that the workers are unbiased as they are only presented with the text from the dealers' reports to analyze and have no stake in the study.

I randomly selected 100 excerpts from the dealers' reports out of the 1,679 trading days I coded as good, neutral or bad. I then copied the text of these 100 dealer's reports into a document so that they are available in digital form. The respondents on Amazon Mechanical Turk are asked to perform what can be referred to as sentiment analysis. They are asked to assess whether the Bank of England dealer perceived market conditions as good, bad, or neutral for sterling. Detailed instructions can be found in the appendix. Each statement is reviewed by 10 different workers on Amazon Mechanical Turk. The answers take the form of a dummy variable taking value 1 for good news, 0 for no news and -1 for bad news, just as for my assessment. I then take the mode (most frequent answer) of these 10 observations and compare it with my answer. Using the mode controls for the variability in the answers of different

respondents and weeds out lower quality responses while using the consensus.<sup>10</sup> On average, each respondent spent 50 seconds per abstract and was given up to 2 minutes to respond. Extracts in Table 5 compares my assessment with that of the 10 reviewers for the 20 first statements.

Table 3 below measures the agreement on the randomly selected sample. Just by chance, agreeing with one of the three choices (1, 0 or -1) should be 33%. Agreement rates of 77% for positive assessments and 57% for negative assessment are unlikely to be random, whereas the agreement rates for neutral situation are not clearly better than random. While these results do not categorically attest to the objectivity of the analysis, they still show significant overlap for both my positive and negative assessments and those of both MTurk.

	Positive assessment	Neutral assessment	Negative assessment	Total
My assessment	31	41	28	100
Most common answer by 10 MTurk reviewers (mode)	51	26	23	100
Agreement rate	77%	37%	57%	
N = 100 text samples				

**Table 3** – comparing answers by MTurk and the author.

### Natural Language Processing algorithm

As a second form of robustness check, I use sentiment analysis done by an algorithm. Natural Language Processing (NLP) is a set of techniques that use computational power to analyze large datasets of natural language. The field recently

<sup>10</sup> Taking the average and rounding it up leads to similar answers but is less precise as it includes responses from respondents who might not have read the question.

blossomed with advances in machine learning, allowing for a much better understanding of human language. I use a Python script named natural language toolkit (or nltk in short) set up by Bird, Klein, and Loper (2009). This algorithm is widely used. For example Yu, Duan, and Cao (2013) use it to show how social media influence stock returns more than traditional news outlets. Each of the 100 digitized statements presented above are analyzed with the algorithm. Unlike my assessment or the one done by MTurk assessors, the algorithm does not provide a dummy, but a continuous score from -1 (negative sentiment) to 1 (positive sentiment).

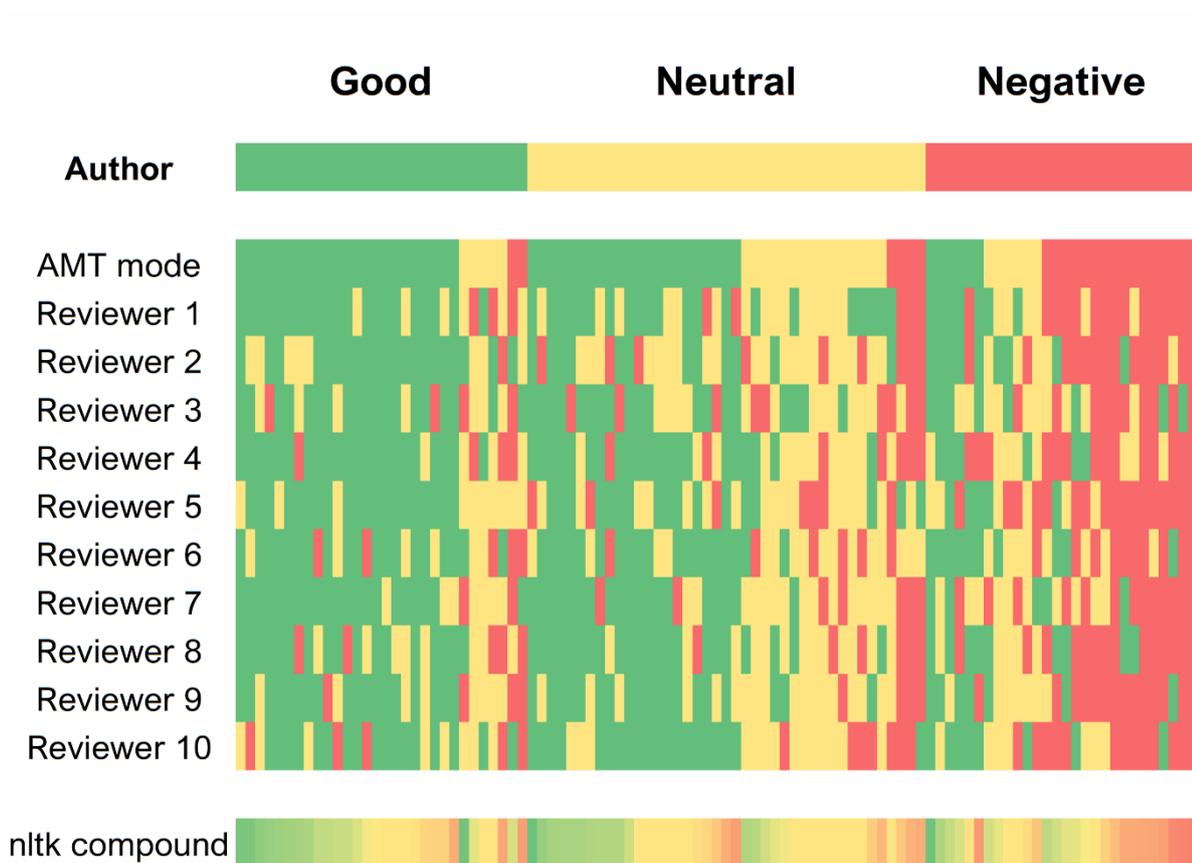


Figure 4 – Heat map of answers by the author, MTurk reviewers and the nltk algorithm. The scale has three colors using green for positive, yellow for neutral and red for negative. See text for how the answers were collected.

Figure 4 above shows a heatmap of the different answers and Table 5 below compares my assessment with the one made by both nltk and MTurk. All the reports

I assessed as negative are also assessed as negative by both nltk and MTurk on average (as the negative coefficient shows). The positive assessments by both other techniques also yield qualitatively similar results. When it comes to neutral assessment, it seems that my assessment was more negative than both other assessment methods (as all my neutral assessments were more often assessed as positive by the two other methodologies). Note that the fact that there is disagreement between manual analysis and NLP measures is not a surprise and has been documented in the literature (Jongeling et al. 2017).

	Average score – nltk algorithm	Average score – Amazon Mechanical Turk mode	Average author score
Assessed as bad by the author	-0.08	-0.36	-1
Assessed as neutral by the author	0.12	0.44	0
Assessed as good by the author	0.23	0.70	1

**Table 4** – correlation matrix of answers of the author, MTurk and the nltk algorithm. The color coding is from green (good news) to red (bad news).

What accounts for differences in assessment? In few cases, it was a clear mistake on my side, where I either misjudged or mistyped the assessment. But the large disagreement over neutral days is justified as the following examples show. “Sterling was quiet and sluggish after some light, technical selling at the opening”. I rated the statement neutrally; the modal MTurk response was -1; and the nltk algorithm scored it -0.40. I gave this statement a neutral score because there seemed to have been little market activity - as suggested by the word “quiet” (word often used by the dealers). The nltk algorithm, however, saw the statement as negative, potentially picking up on negative keywords like “sluggish”. MTurk responses were surprisingly homogenous, with 8 of 10 saying that the statement was negative, and only 2 labelling it as neutral.

A statement I deemed to be neutral but the other systems deemed positive reads: “Sterling remained quietly on the sidelines and gained ground in effective terms despite a further erosion in oil prices.” Here the MTurk consensus was 1 and the nltk algorithm granted a 0.69 score. Here again my justification for the 0 rating was that the market was mainly quiet, meaning that any news or action by the central bank would be likely to move the exchange rate, unlike if there was clear market activity due to specific news moving the price. These examples show that the assessment retains a certain amount of subjective judgement. However, unlike other narrative approaches that rely on the reader trusting the assessor, here I have endeavored to benchmark and cross-check my own judgement against assessments gleaned from two very different approaches. Table 5 shows that on average my assessment was confirmed by both the algorithm and the external assessors.

## 5. Conclusion

Most studies assessing central bank intervention fail to account for exogenous shocks occurring during the day of central bank intervention. Therefore, they overstate the impact of central bank intervention, mistaking it for markets simply picking up on news. Not controlling for the intraday conditions of the currency is problematic when assessing intervention success. Placebo tests often used in the literature only partially address the issue. Good market news (or even bad news that is better than expected) can lead a test to show intervention success when it is only changes in market conditions.

Presenting a novel dataset spanning over 40 years, this paper uses a narrative approach to tackle this issue. By reading the daily reports of policymakers at the time, I show how news affecting the exchange rate during the day can influence intervention outcomes. Far from the intervention success rates of 80% in certain studies, I show that when controlling for market conditions, success rates drop as low as 8%. In particular,

I show that the Bank of England performs particularly poorly when trying to make sterling appreciate in negative market conditions.

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## 8. Appendix (For Online Publication)

### Extract of Amazon Mechanical Turk assessment

Randomly selected date	Text	Most common answer by 10 reviewers (mode)	My assessment
18/11/1986	Sterling was steady and market quiet.	1	0
10/12/1986	Sterling was very quiet but was helped by the stronger dollar this afternoon.	1	0
18/12/1986	Sterling was steady against the dollar but therefore lost a little ground in cross-rate terms.	-1	0
22/01/1987	Sterling remained on the sidelines	0	0
12/2/1987	Sterling remained quietly on the sidelines and gained ground in effective terms despite a further erosion in oil prices.	1	0
26/02/1987	Sterling steadied as the oil price climbed back above \$16 per barrel.	1	1
18/03/1987	Sterling encountered steady demand throughout the day reflecting the favourable response to the budget and the hope that the 1/2% cut in Base rates might leave scope for another reduction soon.	1	1
16/04/1987	Sterling was helped by the stronger dollar and opened firmer in effective and cross rate terms, but was little changed during the day.	0	0
13/05/1987	Sterling was on the sidelines, but was pulled up against third currencies by the stronger dollar.	1	0
29/05/1987	Sterling was on the sidelines but encountered some data commercial demand and touched DM2.97 1/8 at 5 o'clock.	0	0
16/06/1987	Sterling rallied on the better than expected PSBR data (negative borrowing of £374 mn against an expected requirement of £800 mn), but eased against the firmer dollar this afternoon.	1	1
9/7/1987	Sterling was steady in quiet conditions.	1	0
28/07/1987	Sterling was also quiet, but benefited from the encouraging CBI survey.	1	1
25/08/1987	Sterling weakened generally today as the market focused on the recent falls in oil prices and concerns grew about next week's trade figures. Outward investment flows also contributed to the fall but the market was throughout very orderly.	-1	-1

23/09/1987	Sterling firmed against the easier dollar but met no significant upward pressure despite the publication of a bullish CBI survey.	0	0
25/09/1987	Sterling was mostly on the sidelines but enjoyed underlying support as a result of the wider interest differentials against European currencies.	1	1
24/02/1988	Sterling remained quiet but with a firm undertone.	0	0
17/03/1988	Sterling opened on a firm note in the absence of expected official sales at DM3.10 but fell following the Bank's signal of a 1/2% cut in Base Rates. However, good underlying demand led to a partial recovery, and this afternoon the pound regained further ground helped by the firmer dollar.	1	1
26/04/1988	Sterling opened softer after easing in New York last night, but recovered on Middle East demand this morning.	1	0
10/5/1988	Sterling was actively traded in a good two-way market with profit-taking after Yesterday's rise balanced by renewed demand above DM3.15 3/4.	1	0

**Table 5** – First 20 extract randomly selected from the dealers' reports. The two columns on the left show first the mode of the Amazon Mechanical Turk assessment (-1 being negative, 0 neutral and 1 positive) and then my assessment of the extract.

### **Alternative OLS approach**

Most research on central bank intervention relies on event studies with directional dummies to assess the impact of intervention on the exchange rate as I have done in this paper. This section presents the same result as in the paper relying on regression analysis highlighting some of the shortcomings of this approach and offers ways to mitigate them.

When running the regression analysis in its naive form, using intervention as an explanatory variable and interest rate differential as a control, results show that the bigger the intervention, the less it affects the exchange rate. The positive coefficient in Table 6 means that when the Bank of England is buying dollars (also known as restraining intervention), the exchange rate tends to appreciate (instead of the goal of the policy which would be depreciation). And when the Bank sells dollars to try to improve the exchange rate, the opposite happens and the exchange rate depreciates.

This shows the issue with regression analysis. When looking for an overall effect on the whole sample, larger interventions in times of crisis tend to drive the results. For example on Black Wednesday, the Bank of England spent \$22bn in one day but the exchange rate still kept on depreciating. Even when removing the larger outliers, the fact remains that regression analysis shows that on average, the bigger the intervention, the greater the opposite of the wanted effect is to occur. The event study proposed mitigates this challenge by giving a success measure for each intervention episode as opposed to an average result driven by larger values.

Dependent variable – change in exchange rate		
	Dollar period (1952-1987)	Deutschmark period (1987-1992)
Intercept	-0.00056 (0.000101)	-0.001126 (0.000828)
Intervention in billion \$	0.029 (0.00150)	0.0125 (0.00168)
Interest rate differential	0.000163 (0.000034)	0.000122 (0.000119)
<i>Adjusted R<sup>2</sup></i>	0.05	0.04
<i>Observations</i>	8131	1452

Table 6

Even if the intervention variable is replaced with a dummy variable comparing restraining and defending intervention to the days with no intervention, the results still show that intervention to increase the value of the currency has the opposite effect (result in Table 7 below). In other words, on average, interventions usually have the opposite effect on the exchange rate. But this does not take into account that intervention can actually have an effect on some occasions and not on others, which the event study analysis allows for.

Dependent variable – change in exchange rate		
	Dollar period (1952-1987)	Deutschmark period (1987-1992)
Intercept	-0.000586 (0.000178)	-0.001826 (0.001167)
Restraining intervention (1/0)	0.001524 (0.000199)	0.002487 (0.000961)
Defending intervention (1/0)	-0.002794 (0.000227)	-0.005275 (0.001059)
Interest rate differential	0.0002 (0.000003)	0.000211 (0.000116)
<i>Adjusted R<sup>2</sup></i>	0.07	
<i>Observations</i>	8131	1452

**Table 7**

If a simple OLS approaches yields contradicting results, using variables from the narrative approach gives a more convincing picture. Table 9 below is echoing Table 11 in the paper. They both break down intervention success depending on the direction of the wind during the day. Table 9 uses a regression whereas Table 11 uses the event study with directional dummies.

The results in Table 9 show that when going with the wind, the central bank achieved the wanted effect of intervention. However, when going against the wind, the average effect of intervention goes against what the central bank wanted.

Dependent variable – change in exchange rate	
	1987-1992
Intercept	0.0006 (0.0008)
<b>Defending intervention in billion dollar:</b>	
Against the wind (Intervention x dummy for bad news)	0.041 (0.003)
With no wind (Intervention x dummy for neutral news)	0.007 (0.016)
With the wind (Intervention x dummy for good news)	-0.017 (0.008)
<b>Restraining intervention in billion dollar:</b>	
Against the wind (Intervention x dummy for good news)	0.007 (0.002)
With no wind (Intervention x dummy for neutral news)	-0.0001 (0.010)
With the wind (Intervention x dummy for bad news)	-0.205 (0.029)
<i>Adjusted R<sup>2</sup></i>	0.12
<i>Observations</i>	1452

Table 8

## Comparison with post 1992 placebo

To test if the interventions are better than random at affecting the exchange rate, I compared them with placebo interventions. Because over the sample analyzed the Bank was on the market 79.5% of the trading days, days with no intervention might not offer a good comparison as they would present specific characteristics. I therefore compare interventions from 1986 to 1992 (when the Bank is intervening) to a placebo from 1992-1999 (when the Bank is not intervening). These two periods are similar. In the sample period from 1986-92 the Bank was targeting the Deutschmark exchange rate and from 1992-99 the Deutschmark was also the reference currency for the pound (before the introduction of the euro in 1999).

I run two placebo tests. The first is comparing the actual intervention with the period from 1992-1999 where there are no more interventions (remember the Bank of England stopped intervening after Black Wednesday in September 1992). The second placebo does a similar comparison but takes into account the intraday direction or wind of the market. The first test finds that overall the Bank of England was not better than random at moving the direction of the exchange rate.

Both test use the same success criteria presented in the methodology. Since there are no actual interventions occurring during this period, the test mimics what the Bank would have done. For example, if the exchange rate is dropping from day  $t-2$  to day  $t-1$ , the placebo assumes that the Bank of England would have intervened at this time to make the exchange rate appreciate again. In this sense, this methodology counts how often reversal of the exchange rate occurred absent Bank of England operations. This is then compared to the success of the actual operations of the Bank of England. To analyze if the placebo is different from the actual interventions, I calculate if the placebo lies two standard deviations above or below the observed value. The standard deviation is calculated using a hypergeometric distribution presented below (this is common in the literature, see for example Bordo, Humpage, and Schwartz 2015). The three

equations below give the formalization of success criteria and match the success criteria presented on page 13.

$$SC_{1\ placebo} = \begin{cases} 1 & \left\{ \begin{array}{l} \text{if } S_t > S_{t-1} \text{ and } S_{t-1} < S_{t-2}, \\ \text{or} \\ \text{if } S_t < S_{t-1} \text{ and } S_{t-1} > S_{t-2} \end{array} \right. \\ 0 & \text{otherwise} \end{cases}$$

$$SC_{2\ placebo} = \begin{cases} 1 & \left\{ \begin{array}{l} \text{if } S_{t-1} > S_{t-2} \text{ and } \Delta S_t < \Delta S_{t-1} \text{ and } \Delta S_t > 0 \\ \text{or} \\ \text{if } S_{t-1} < S_{t-2} \text{ and } \Delta S_t > \Delta S_{t-1} \text{ and } \Delta S_t < 0 \end{array} \right. \\ 0 & \text{otherwise} \end{cases}$$

$$SC_{3\ placebo} = \begin{cases} 1 & SC_1 = 1 \text{ or } SC_2 = 1 \\ 0 & \text{otherwise} \end{cases}$$

$SC_{1\ placebo}$  covers cases when the exchange rate was going down (from day t-2 to day t-1) and where it reversed on day t.  $SC_{2\ placebo}$  covers cases when the exchange rate depreciated from day t-2 to day d-1 and then depreciated less from day t-1 to day t. These values are then compared to the total number of days the exchange depreciated from day t-2 to day d-1, giving a success rate in percentage (see 6<sup>th</sup> column Table 9 and Table 10).  $SC_{3\ placebo}$  is a combination of the first two criteria. And the same logic applies when the exchange rate was appreciating from day t-2 to day d-1. Below is the formulation of these three criteria.

	Intervention episodes	Intervention success		Placebo episodes	Placebo success		Expected success	Standard deviation	Random range	Is the central bank better than random?
		#	%		#	%				
<b>DEFENDING OPERATIONS</b>										
Success Criteria 1	427	102	24%	848	455	54%	229	3	222 - 236	NO
Success Criteria 2	427	61	14%	848	162	19%	82	3	76 - 87	NO
Success Criteria 3	427	163	38%	848	617	73%	311	4	302 - 319	NO
<b>RESTRAINING OPERATIONS</b>										
Success Criteria 1	1196	327	27%	1000	451	45%	539	8	523 - 556	NO
Success Criteria 2	1196	179	15%	1000	239	24%	286	6	273 - 298	NO
Success Criteria 3	1196	506	42%	1000	690	69%	825	10	805 - 845	NO
<i>Observations sample:</i>	1453									
<i>Observations placebo:</i>	1902									
<i>Exchange rate days in both samples</i>	3355									

**Table 9**

The first test shows that overall, the interventions of the Bank of England did not influence the exchange rate differently from the placebo (Table 9). When distinguishing interventions with and against the wind, I find that interventions against the wind trying to avoid the pound from depreciating (the main mission of the Bank of England during this period), did not affect the market more than the placebo. Restraining interventions and intervention going with the wind or with the absence of wind show an effect significantly different from the placebo. This mirrors the overall findings of

the paper which shows that the Bank of England performed particularly poorly when trying to avoid the exchange rate from falling when intervening against the wind (this is briefly understood by looking at Table 11 and Table 8).

	Intervention episodes	Intervention success		Placebo			Expected success	Standard deviation	Random range	Is the central bank better than random?
		#	%	episodes	#	%				
<b>DEFENDING OPERATIONS</b>										
<i>Against the wind</i>										
Success Criteria 1	206	17	8%	101	10	10%	20	1	18 - 23	NO
Success Criteria 2	206	39	19%	101	21	21%	43	2	40 - 46	NO
Success Criteria 3	206	56	27%	101	31	31%	63	2	59 - 67	NO
<i>No wind</i>										
Success Criteria 1	64	27	42%	91	25	27%	18	1	16 - 19	YES
Success Criteria 2	64	10	16%	91	3	3%	2	0	2 - 3	YES
Success Criteria 3	64	37	58%	91	28	31%	20	1	18 - 21	YES
<i>With the wind</i>										
Success Criteria 1	86	57	66%	124	37	30%	26	1	24 - 27	YES
Success Criteria 2	86	12	14%	124	0	0%	0	0	0 - 0	YES
Success Criteria 3	86	69	80%	124	37	30%	26	1	24 - 27	YES
<b>RESTRAINING OPERATIONS</b>										
<i>Against the wind</i>										
Success Criteria 1	441	79	18%	124	16	13%	57	3	52 - 62	YES
Success Criteria 2	441	103	23%	124	28	23%	100	3	93 - 106	Random
Success Criteria 3	441	182	41%	124	44	35%	156	4	148 - 165	YES
<i>No wind</i>										
Success Criteria 1	322	111	34%	91	23	25%	81	3	76 - 87	YES
Success Criteria 2	322	65	20%	91	6	7%	21	1	19 - 24	YES
Success Criteria 3	322	176	55%	91	29	32%	103	3	97 - 108	YES
<i>With the wind</i>										
Success Criteria 1	191	137	72%	101	26	26%	49	2	46 - 52	YES
Success Criteria 2	191	10	5%	101	0	0%	0	0	0 - 0	YES
Success Criteria 3	191	147	77%	101	26	26%	49	2	46 - 52	YES
Observations sample:	1453									
Observations placebo:	1902									
Exchange rate days in both samples	3355									

Table 10

### Different outcomes by type of intervention, wind and success criteria

Table 11 looks at the results in more detail and breaks them down according to the different success criteria presented in the previous section, and separates restraining from defending interventions. One particularly striking number is the 8% success rate when the Bank of England was supporting the pound in adverse market conditions (the most common case).

		Against the wind	No Wind	With the wind
Defending intervention	Reversing (SC1)	8%	42%	66%
	Smoothing (SC2)	19%	16%	14%
	Either reversing or smoothing (SC3)	27%	58%	80%
Restraining intervention	Reversing (SC1)	18%	34%	72%
	Smoothing (SC2)	23%	20%	5%
	Either reversing or smoothing (SC3)	41%	55%	77%

**Table 11** – Intervention success by success criteria (see previous section for details).

## Distribution of the different assessment methods

The next three charts show the distribution of the classifications of the dealers' reports into negative (-1), neutral (0) or good (1) news. The first chart displays my classification, the second Amazon Mechanical Turk and the third the nltk natural language processing algorithm.

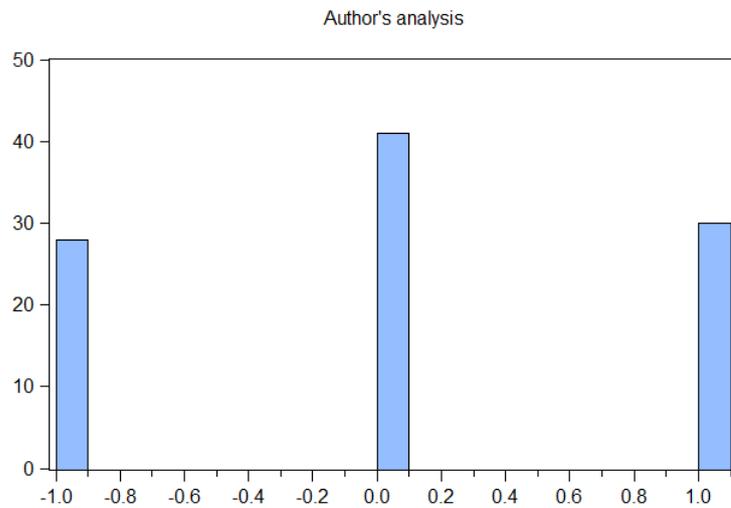


Figure 5

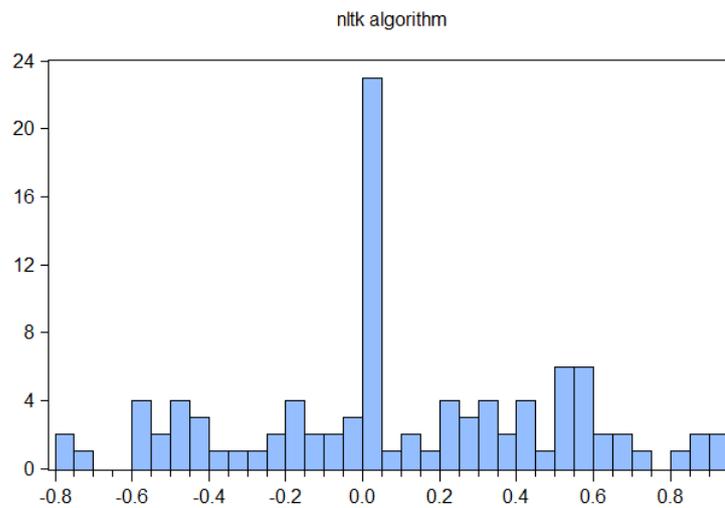


Figure 6

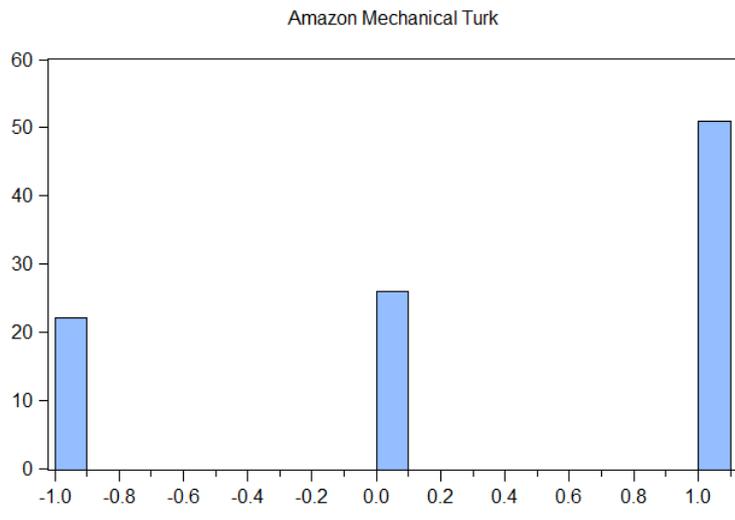


Figure 7