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Pre-Brexit: the EU referendum as an illustration of the effects of uncertainty on the Sterling exchange rate

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Abstract

Exchange rates are determined by many factors. However, the UK referendum on EU membership June 2016 provides an unusual circumstance in which one can reasonably assume that one factor is overwhelmingly influential for a reasonably well-defined period. This concise study explores the period of uncertainty created by the referendum. The focus is the UK real effective exchange rate. The study applies a reduced form exchange rate model, first introduced by Edwards (1994), and makes use of Bank of England daily data, from the period November 2015 to July 2016. The results indicate a sharp depreciation of Sterling with reference to its long-term trend. We set out some of the possible contexts which may account for fluctuations during the referendum campaigning period. This can be distinguished from other longer-term factors likely to be previously responsible for trend depreciation, and also from the further sharp depreciation effects triggered by the referendum outcome.

Key Words: Exchange Rate Tendencies, European Union, Sterling Exchange Rate Market, Uncertainty

JEL Codes: D81, F36, O24

1. Introduction

Changes to exchange rates are a perennial cause for concern. Exchange rates sit as one among many problems for the contemporary UK economy. Brexit has resulted in a significant subsequent depreciation of Sterling. *Inter alia*, though the immediate effect of Brexit on growth was muted due to unexpected sustained consumer spending, throughout the latter half of 2016 and the first two quarters of 2017 business investment slowed, the rate of deficit reduction slowed (but without any concomitant meaningfully rise in government investment in infrastructure etc), and both main measures of inflation began to rise. Given the policy framework in the UK all these trends are adverse. Clearly, Brexit means that the future structure of the UK economy is liable to change in some basic ways, and major policy challenges now arise. The current environment is one of uncertainty and this will continue to be the case, at least until the UK formally leaves the European Union (EU).¹ However, the uncertainty began prior to the result of the June 23rd referendum in 2016, and the period surrounding the referendum provides an interesting case to consider how uncertainty may have real effects on the exchange rate.

Exchange rates are determined by many factors, and so the referendum is just one factor among others that may affect the rate. However, the referendum provides an unusual circumstance in which one can reasonably assume that one factor is overwhelmingly influential for a reasonably well-defined period. That is, the basic uncertainty regarding the outcome of the referendum, creating scope for expectations to shift as different narratives and information come to the fore over the period from the announcement of the referendum 20th February 2016 to the declaration of the results 24th of June 2016, one day after the vote. Market expectations are a significant contributor to exchange rate dynamics, and are often more important than macroeconomic ‘fundamentals’ when accounting for exchange rate movements (see Pilbeam, 2001). Moreover, this has implications for the real economy, since exchange rates affect economic activity. The significance of the exchange rate for globally integrated market economies has been widely acknowledged. It influences trade flows (Bahmani-Oskooee and Satawatananon (2011); Bahmani-Oskooee and Xu (2012), the trade balance (Yusoff 2007; Soleymani and Chua; 2013), and economic growth (Frenkel and Rapetti, 2008; Rapetti et al, 2012).²

Exchange rate dynamics have many implications for the domestic and international economy, and there is a wide ranging literature that explores various aspects of this. There is, for example, extensive research exploring the effect of uncertainty on the exchange rate, and conversely the effect of exchange

¹ Uncertainty can be defined in different ways, and has degrees (see Runde, 1995; 1998). In Keynesian terms it extends to the inability to apply a numeric probability to a situation or circumstance due to the nature of events and what can be known in their regard, this has some relation to Knightian uncertainty, whilst in standard approaches it refers to agent-centred problems of deciding between appropriate models of economic events and for Bayesian’s it refers to a process of refining a distribution over time.

² Of course, there could be differences in terms of the intensity and heterogeneity or duration of impact of different economies to exchange rate fluctuations (Bahmani-Oskooee and Kara, 2003; Bahmani-Oskooee et al, 2010). However, there is a wide consensus on the importance of exchange rates as both a cause as well as an effect and this extends to the UK economy (Thomas, 1986; Abbot et al, 2001; Pattichis et al 2004; De Vita and Abbot, 2007).

rate dynamics on uncertainty. As regards the former, Krol (2014), Mueller et al (2016) and Beckmann and Czudaj (2017 and 2017b) suggest that macroeconomic (policy) uncertainty can have significant implications for the exchange rate. As regards the latter, Garret and Andreas 2017; Bahmani-Oskooee and Wang 2008; Bahmani-Oskooee and Kovyryalova 2008; Bahmani-Oskooee and Hajilee 2011; Bahmani-Oskooee and Satawatananon, 2011; Bahmani-Oskooee et al, 2012; Bahmani-Oskooee and Bolhassani 2014; Bahmani-Oskooee and Gelan, 2017; explore the many ways in which exchange rate uncertainty can effect various aspects of the economy and international trade. Our paper provides a different focus. The uncertainty that concerns us in the context of Brexit is not a matter of macroeconomic policy choices. It is specifically due to the ambiguity concerning the future outlook of the British economy and its trading relationship with its largest trading partner, i.e. the European Union. It is thus a focus that seeks to distinguish specific underlying causes and sources of uncertainty based on a given time period. This is expressed through the exchange rate dynamics over that period.

It should also be noted that there is an extensive literature exploring the response of the exchange rate to anticipated and unanticipated shocks. However, much of this work, following Dornbusch (1976), is underpinned by assumptions of perfect foresight, perfect capital mobility and consistent expectations. This leads to the position that only unanticipated shocks can have effects. However, this tends to over-stylise the problem of uncertainty as it might occur in any real economic situation in which a “shock” may occur. The events surrounding the Brexit referendum seem to undermine the potential for insight based on a perfect foresight and consistent expectations perspective, since the period manifestly violates these as conditions. As Wilson (1979) establishes, anticipated “shocks” can also effect the exchange rate. More recently, Bluedorn and Bowdler (2005), Maitra (2010), Çebi and Çulha (2014), Forni and Gambetti (2016) report significant impacts from unanticipated and anticipated (monetary and fiscal policy) shocks on the exchange rate. In the case of the Brexit referendum, there was *prima facie* a possibility of a vote to leave, and thus the period seems to indicate an anticipated “shock”. However, this raises many further issues, since an abstract possibility is not the same as an ingrained belief with consequences for intentionality that manifest in a particular and consistent pattern of actions or behaviour. The relative credence given to the possibility that the UK could or would vote to remain or leave manifestly varied during the build-up period to the referendum. However, ultimately the Brexit outcome came as a surprise and led to a sharp depreciation, and this too indicates that foresight was less than perfect.

In so far as the referendum provides an unusual circumstance in which one can reasonably assume that one factor is overwhelmingly influential, one can consider the case in Mary Morgan’s terms as a societal form of experimental conditions. That is:

Many, perhaps most, events in the natural world and social world occur with lots of other events happening around them, but some individual events happen in short time periods in specific places where it is reasonable to suppose that the environmental features are very stable, and the

other causal factors (that might normally vary over space or time) are also rather stable. (Morgan, 2013, p. 345-46)

So, in this brief paper, we set out to measure the *additional* impact of the uncertainty surrounding the referendum.³ We distinguish this from the longer trend value of Sterling. We do so using the weekly average of the indexed daily effective exchange rate, provided by the Bank of England.⁴ This provides a measure of the trade-weighted exchange value of Sterling against multiple currencies, including the US\$, the Chinese RMB and the Euro. This is the broadest data source used by the Bank of England to reflect general exchange rate effects in relation to actual trade with significant countries. We measure the additional impact of the referendum in terms of the deviation from the trend, identified using a reduced form exchange rate model of a kind first introduced by Edwards (1994), and subsequently applied by Gan et al (2013). Sterling depreciated based on most exchange rate measures within 2016 (for example, IMF, 2016) and this was then exacerbated by the result of the referendum, declared 24th June 2016. This then requires further interpretation to distinguish the effects of new information and narratives in the context of uncertainty. We explore this in the following parts of the paper. Our principal finding is that during the week of the referendum, up to the declaration of the result, exchange rate depreciation deviated from the long run trend by approximately 3.5 %, but the actual immediate effect on the exchange rate was an 8% depreciation. Over the period from the announcement of the referendum the exchange rate fluctuated markedly around its trend and one can also identify a larger effect based on the ‘wrong-footing’ of markets at the point when the outcome was announced. One might further infer that this marks a step change in attitudes to Sterling as Brexit became a real issue rather than a notional concern. One can thus consider the exchange rate as both symptom of and indicator for determinations of the underlying economic strength or weakness of the economy.⁵ In essence, it has acted as a litmus test.

The paper proceeds as follows, in § 2 we set out a reduced form exchange rate model, in § 3 we provide description of data, in § 4 we provide analysis and in § 5 we conclude.

2. The reduced form exchange rate model

An estimated reduced-form exchange rate model sets out to explain the behaviour of the real effective exchange rate associated with the constituents of actual trade related activity. According to the work of

³ Note, one must assume here that significant changes in the exchange rate over the relevant period are a product of the referendum as a source of uncertainty and assume that this occurs in a situation of underlying relative stability in terms of how exchange rates are otherwise determined.

⁴ The Bank of England trade weighted average is calculated based on an index and initial primary data from 21 countries and the original dataset is available at: <http://www.bankofengland.co.uk/boeapps/iadb/index.asp?Travel=NIxIRx&levels=2&XNotes=Y&A3951XNode3951.x=5&A3951XNode3951.y=4&Nodes=&SectionRequired=I&HideNums=-1&ExtraInfo=true#BM>

⁵ Exchange rate depreciations are now commonly used as a marker for crisis and so have been internalised in models that themselves have effects on sentiment. This places a different context around Reinhart and Rogoff’s (2009) use of a 15% threshold as an indicator of financial crisis (see Nasir et al, 2014).

Edwards (1994), there are dominant influences on the real effective exchange rate over the long term. Edwards (1994) provides a model of real exchange rate determination that allows for both real and nominal factors to play a role in the short run. However, only real factors or "fundamentals" (for instance, terms of trade, speed of innovation, productivity and composition of Government consumption) influence the long term real exchange rate (see Edwards 1994 for details of this model). This approach is used because it distinguishes between short and long term factors, and thus provides an analytical point of departure for the focus on the Brexit referendum period. Gan et al (2013) provide the following general expression of the long term relationship:

$$\log \tilde{e}_t = \beta F_t + \varepsilon_t \quad (1)$$

Where \tilde{e}_t is the long run real exchange rate, F is a vector denoting the actual constituents (including external terms of trade, ratio of government consumption on non-tradables to GDP, level of import tariffs, technological progress, capital flows and investment/GDP ratio) and ε is random disturbance/white noise (*I.I.D.*).⁶ According to this approach, there are deviations, which can only be temporary.⁷ Concomitantly, a number of studies have suggested that it is important to distinguish between temporary and permanent movements in a series (Harris, 1995). This can be achieved using the Hodrick-Prescott filter (HP) (see, Beveridge and Nelson, 1981; Hodrick & Prescott, 1997). The HP method is widely used to obtain a smooth estimate of the long term components of a series. For example, the Bank of England applies a HP filter to measure deviations from long run trends in output (Carney, 2017). In this application, the components are inferred to be representative of the long run underlying constituents (though these need not be time-invariant in the sense of forever fixed). Technically, the HP method is a two-sided linear filter, which computes the smoothed series μ of Y by minimizing the variance of Y around μ . The following analysis is based on weekly computations from indexed daily

⁶ Following Gan et al (2013), a time series for the long run real exchange rate can be constructed using data for the actual real effective exchange rate. This can be used to estimate the co-integration vector β of long term parameters, choosing a set of permanent values for the fundamentals appropriate to period t . However, this requires one to assume that the underlying effects are consistently caused and related during the period under consideration. An equivalent dynamic error correction model can be given as:

$$\Delta \log \tilde{e}_t = \lambda (\log \tilde{e}_{t-1} - \beta F_{t-1}) + \gamma_1 \Delta F_t + \gamma_2 \Delta \log E_t + v_t$$

Where F_t is the vector of fundamentals and the v_t is a stationary random disturbance. The error correction term $(\log \tilde{e}_{t-1} - \beta F_{t-1})$ incorporates the forward-looking sources of real exchange rate dynamics. The coefficient λ governs the speed of adjustment back towards the long-run trend; we require its sign to be negative – in particular, for $1 < \lambda < 0$, the corresponding long-run trend is relatively stable. Using this method inevitably raises issues regarding the difference between the uncertainty of calculation and the calculation of uncertainty. There is not the space here to consider this matter in detail. The point we would emphasise is the need for careful context based interpretation of results.

⁷ Interpretations of what this means can vary. The longer term need not be considered rational in the strict sense but rather an expression of the interplay of different factors over different timelines. As such, one can then also conceptualise short term processes as ultimately affecting longer term trends, so the language of 'fundamentals' becomes problematic if it implies a sharp analytical distinction.

exchange rate data. Accordingly, and following standard practice, the smoothing parameter λ is set equal to 270400.⁸

The degree to which the Real Effective Exchange Rate (REER) deviates from the Long Term Real Exchange Rate (LRRER) is measured in two steps. First, following the decomposition using the HP filter, the LRRER is obtained, second by subtracting the estimated LRRER from the observed Real Effective Exchange Rate we find the level of misalignment and its proportion in percentage. The Real Effective Exchange Rate (REER) deviation is given as follows:

$$\text{Deviation} = \frac{\text{REER} - \text{LRRER}}{\text{LRRER}} \times 100\% \quad (2)$$

Over the period under consideration the immediate and time limited factor is the uncertainty (essentially postulated future potential economic disruption) associated with the UK “remain or leave” referendum, February to June 2016. This can reasonably be assumed to be *the* dominant short run factor, but not the only factor, during this period.

3. Exchange rate data

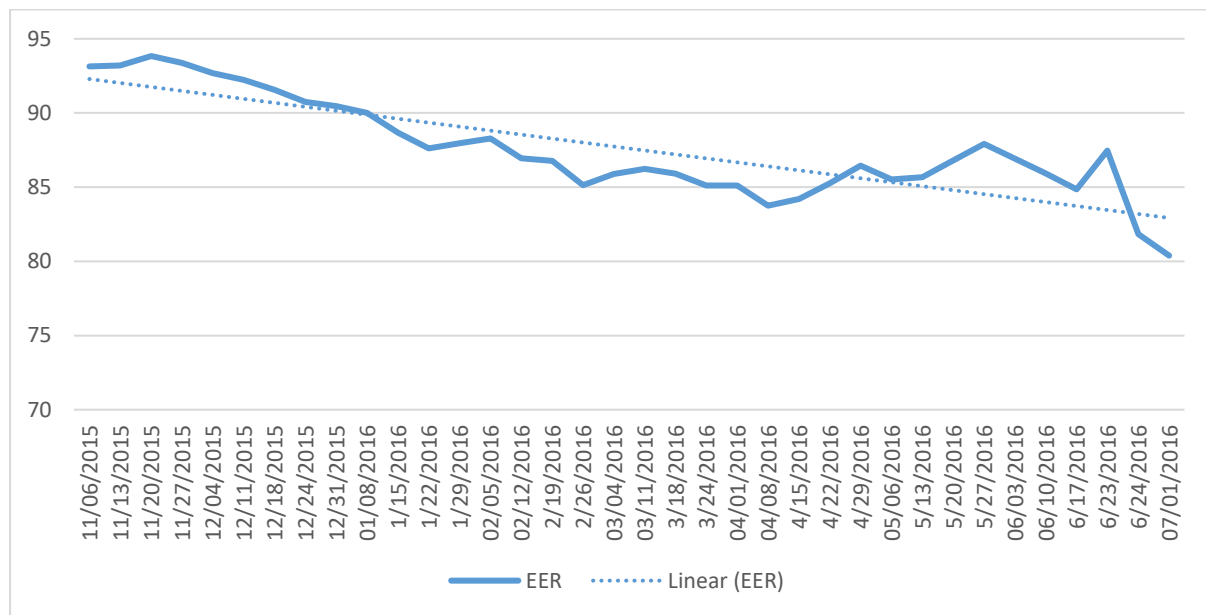
As stated, the model is applied to the Bank of England data of the effective exchange rate. The initial data is for indexed daily averages of the combined trade-weighted exchange value of Sterling against multiple currencies, including the US\$, the Chinese RMB and Euro. The base year for the original effective exchange rate index is January 2005 (and this is 100). In order to render the number of observations more manageable, the daily averages were then converted (using the mean) to weekly figures. This conversion has no significant effect on the subsequent calculation of the deviation from the long term trend, since daily fluctuations are captured in the weekly mean. In order to give some point of comparison but to also capture the shorter duration effects most closely associated with the referendum, data collection was initially restricted to a period beginning approximately 3 months before the announcement of the referendum, and ending just after the result was declared (since declaration is a triggering event and reconciles the initial cause of uncertainty). That is, the period from Monday 2nd November 2015 to 1st July 2016.⁹

⁸ The filter suppresses the growth of the trend component and requires a larger value for shorter period data. Ravn and Uhlig (2002) suggest λ should vary by the fourth power of the frequency observation ratio. Note, a Hodrick-Prescott filter introduces new problems one should be aware of: it can for example, yield inconsistent results based on adjustments between past and present regardless of the λ used, since it is assumed rather than intrinsic to the procedure that the filter adequately represents the data generating process and that non-stationarity is eliminated (which it may not be, and even if it were introduces yet another problem; see Hamilton, 2017). The smoothing, however, provides a point of reference for the analysis that follows and it is the interpretation of variations thereafter that are more interesting.

⁹ Note: the data was converted to weekly averages. However, since the announcement of the Referendum result was on a Friday and the result caused a sudden shift to rapid depreciation on that day, which would distort the prior average for the week, we use only the first 4 working days data (20 - 23 June). The next week was again the full week average. Note also that the intention here is not to assess a long run in which the effects of Brexit become a limited counterfactual-as-contrast; that is, what the exchange rate was and what it could have been without Brexit. This would require a longer data series and different analysis and assumptions. Moreover, the intent is not

As seen in Figure 1, the Effective Exchange Rate for Sterling exhibits a long term depreciation within the period for which data has been collected, and which begins *before* the announcement of the referendum. As such, it is clear that amongst the many factors that may be responsible for determining the exchange rate, the referendum is only one cause of the recent observed depreciation. It is, however, likely the dominant one during the period *after* the Referendum was announced.

Figure 1: Weekly Averages of Daily Effective Exchange Rate (2nd Nov 2015 – 1st Jul 2016)



Source: Bank of England, Bankstats (2016): (January 2005 = 100)

4. Analysis and Findings.

The results for analysis are presented in Figure 2. Overall, we observed a depreciation of about 3.5% from the long term trend during the period of the referendum. More specifically, a downward movement begins in January and this is likely associated with market actors’ focus on the Brussels summit where UK Prime Minister David Cameron sought to negotiate concessions from other EU members, and so avoid triggering his Party’s general election pledge to hold an in/out referendum for EU membership. The arising uncertainty here has prior context (see Morgan & Patomäki, 2017a, 2017b). Before the 2015 general election it was commonly believed that there would be another coalition government, and that a Liberal Democrat Party partner to such a coalition would reject a referendum. Centrist Conservatives felt they could support a referendum pledge in their manifesto, but likely never have to implement it. The intent was to both undercut the growing popularity of the UK Independence Party (UKIP) and placate Conservative Euro-sceptics. European integration had been a source of division within the

to explore what occurs *after* Brexit on the basis that “fundamentals” are transformed from this point, since again this would require a longer series; this time extending forward from Brexit.

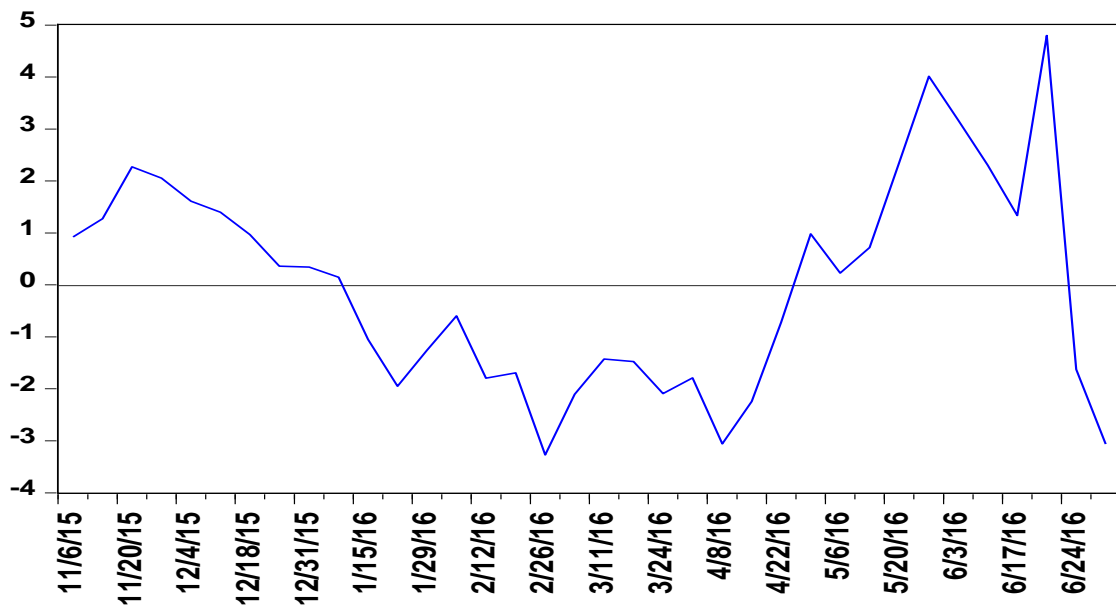
Conservative Party for many years, focused mainly on the ceding of sovereignty to the European Union (EU) via the Maastricht Treaty 1992 [1993] and the Lisbon Treaty 2007 [2009].

It is worth recalling that the immediate effect of the referendum pledge did not follow the logic Cameron seemed to have anticipated. Rather the pledge focused debate on immigration. It actually provided a degree of legitimacy to UKIP and a focal point for Conservative sceptics. UKIP increased their vote from less than 1 million to 3.8 million in the 2015 general election.¹⁰ In attempting to confront the problem of the Euro-sceptic right, Cameron radically miscalculated and this in turn set in motion the chain of events that led to the Brussels summit.

Following the Brussels summit, there was a sharp depreciation in the week commencing 22nd February. One might describe this as an announcement effect, crystallising a new state of uncertainty. Leaving the EU would be a major event resulting in a transformation of the organizations and institutions within which the UK economy operates. As such, if such an event were to occur the likely effect would be structural changes to the UK economy. However, it was immediately clear that the leave campaign had, as yet, no idea what organizational and institutional form exiting the EU would result in (bilateral trade treaties, membership of the European Economic Area etc). Nor was it clear what the impacts on the structure of the UK economy would be. As such, market actors had no definite common background information on which to base long term decision making. In such circumstances, there is a greater tendency for activity to be dominated by multiple rationales and fear effects.

Figure 2. Exchange Rate Deviation (%) 2nd Nov 2015 to 1st Jul 2016

¹⁰ There was general scepticism regarding whether Cameron could negotiate concessions at the Brussels summit of an extent liable to appease the Party's Euro-sceptics and supporters of UKIP in the context of a popular discourse increasingly dominated by migration numbers. In gearing up for the previous general election in 2010, the Conservatives had pledged to reduce net migration to less than 100,000 per year over the next few years. The pledge was entirely unrealistic, based on observable trends and given that the UK government could, as an EU member committed to free movement, do no more than deter migration from the EU. It was also adversely focused, since it has been typical ever since the UK joined the European Economic Community in 1973 for annual net migration to the UK from outside the region to exceed that from within. However, the pledge served to prefigure a focus on migration as a dominant issue and as a numbers issue. Moreover, rather than position the argument around *first* considering any benefits from membership of the EU and then any benefits from migration, as an issue through which the numbers could be disaggregated and considered in parts (purpose, duration etc), it encouraged a popular focus on an aggregate migration figure. It did so based on a widely publicised commitment which would appear as a current particular policy failure (limited or no reduction towards the figure), preventing any sense of positioning *aspects* of migration as primarily a success story.



Through April and May and into June this initial fear effect began to reverse. However, this reversal cannot be considered a reaffirmation of a variety of demonstrable certainty. Rather it seems to be a different inflection to uncertainty. That is, a gradual shift to confidence that the referendum would favour a remain outcome and so Brexit could be avoided. In an objective sense it was impossible to know what the outcome of the referendum would be and so the situation remained one of uncertainty. At the same time, during the campaign expert opinion was mobilised to attempt to influence the vote. The OECD, IMF, UK Treasury, Bank of England, CBI, the Institute for Fiscal Studies, and many others produced reports and analysis indicating that leaving the EU would create adverse short term effects, a shock, and long term adverse structural effects, depending on what form of organizational and institutional arrangement was negotiated (e.g. (BoE 2016, OECD 2016, IMF 2016). All recommended (or implied in the case of the Bank of England), based economic analysis, remaining within the EU was to be preferred. Concomitantly, polling during May and June indicated that remain would likely win, though the result would be close and this seems to have affected market sentiment (e.g. WSJ, 2016). YouGov's final poll forecast a 4% win for remain, and the FTSE 100 and the Sterling exchange rate both rose on June 23rd.

The referendum result is now well publicised. The 23rd June vote was split 51.9% leave and 48.1% remain, with a 72.2% turnout. However, another way of putting the figures is that 17.4 million voted leave and 16.1 million voted remain, constituting a combined 33.5 million voters from an electorate of 46.5 million. Remain lost by less than 1.3 million votes. Clearly, not all voters based their decision on the available expert opinion, nor did they necessarily vote based on purely economic concerns (identity, migration, and ambiguous articulations of 'taking back control' played a role). As such, market actor behaviour over the latter part of the period of the referendum turned out to be ill-founded. Ironically, it

seems to have been based on assumptions that a general electorate would vote based on or in conformity with economic analysis (as the basis of rationality). It failed to take into account both the deep scepticism regarding expert opinion that was cultivated during the referendum campaign and the actual likely participation by different groups of eligible voters. Initial sampling indicated that ages 55-64 and 65 and overs were more likely to vote leave and had a turnout rate of more than 80% (with an aging population where there are more than 11 million over 65s in the UK). 18-24 year olds overwhelmingly supported remain but had a lower turnout -- published figures have ranged from an initial 36% to more than 50%. Approximately 13 million eligible voters did not participate.

The degree to which markets were wrong-footed by the result of the referendum quickly became clear on Friday 24th and Monday 27th June. Extreme equity market fluctuation, and growth forecast and credit rating downgrades quickly followed. By extending data analysis one week into this new period for the exchange rate one observes a sharp decline in the value of Sterling from a point 4.5% above the long-run to a deviation of more than 3.5% below the long-run effective exchange rate. That is, a deviation of 8% in the Effective Exchange Rate of Sterling, based on its long term trend.

5. Conclusion

Clearly, the degree of uncertainty for economic decision-making is itself variable. The UK remain or leave EU Referendum is a particular case. It provides an unusual circumstance in which one can reasonably assume that one factor that may create uncertainty is dominant. We have explored this factor in terms of the exchange rate. In this case one can also make two further points. First, causes of the prior long-term trend depreciation in Sterling remain relevant. Here, one cannot ignore the implications of the UK's current account position. As many have noted this has been adversely constituted for many years, reflecting problems with the balance of trade and the capital account, both of which are indicative of structural problems and dependencies within the UK economy. The current account deficits of Q4 2015 and Q1 2016 were manifestations of enduring basic weaknesses in the British economy (ONS, 2016).¹¹ Second, though June 24th is a single event-as-shock, it is also a trigger or breakpoint liable to reset the long term trend for many significant metrics, including the exchange rate. Depending on how Brexit is implemented the organizational and institutional context of the UK economy is set to change in significant ways. Again, there is basic uncertainty here that will persist for the (un)foreseeable future. This extends, for example, to the status of Sterling as one of several unofficial reserve currencies.¹² It

¹¹ The UK's current account deficit was £32.7 billion in Q4 2015, equated to approximately 7.0% of gross domestic product (GDP) at current market prices, this was then exceeded in Q1 2016 each represented a high point since quarterly records began in 1955. Q4 2015 was a 4.3% increase on Q3 (Office for National Statistics (ONS), 2016). Subsequent potential positive effects of Brexit depreciation for the balance of trade may be overstated. UK exports have two main aspects. First, component production as part of supply chains for final assembly. Clearly, depreciation cannot directly affect demand for these since it is dependent on the whole product spread transnationally. Second, high end manufactured products and services. These tend to be relatively price inelastic.

¹² One also cannot ignore the possibility of renewed financial instability, both for UK banks and European ones.

is truistic to state that the future is not yet written, but some futures are blanker than others. The UK seems to have opted for a particularly empty page.

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