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Losing sleep at the international market: Daylight Saving Time and exchange rates

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ABSTRACT

This article examines the impact of the move into and out of Daylight Saving Time (DST) on bilateral exchange rates. When a country starts DST, the value of its currency depreciates, which is reversed when the country exits DST.

1. Introduction

Over 1.2 billion people live in the more than 60 countries where Daylight Saving Time (DST) is currently fully or partially observed at different times of the year. The move into and out of DST at different times of year has a considerable physiological and psychological impact on individuals, as well as having a wider economic impact on the countries involved. DST is controversial, with as many as 70 countries that previously observed DST ceasing to do so at different points in the past. At a currently undetermined point in the future this list of countries will include the countries in the EU, as a result of a vote by the European Parliament in March 2019. However, although the choice of whether to observe DST is usually a domestic decision, its impact potentially crosses international borders through interactions between countries. Different countries adjust their clocks on different dates and in different directions depending on whether they are located in the northern or southern hemispheres. As a result, any domestic impacts could potentially spill over internationally through international financial markets, including onto the exchange rates between pairs of countries. If two countries transition into and out of DST on the same date and in the same direction, there is likely to be little impact on their bilateral exchange rate. However, if the transition occurs on different dates, or if only one of the countries involved observes DST, then the transition could feed through to bilateral exchange rates.

Extensive literature has examined the impact of the transition into and out of DST within countries. This transition has been shown to have clear physiological and psychological effects, with Osborne-Christenson (2022) showing that the transition into DST causes rises in suicides and deaths by substance abuse, and Kountouris and Remoundou (2014) showing that this transition is associated with falls in life satisfaction and well being, an effect that Jin and Ziebarth (2020) and Costa-Font et al. (2024) show is reversed during the transition out of DST, and the resultant increases in sleep duration. The damage caused by the transition into DST also extends to vehicular accidents, with Smith (2016), Bunnings and Schiele (2021), Laliotis et al. (2023) and Bejamin-Goodwin et al. (2024) all providing evidence of increased costs and fatalities after the transition into DST, although (James, 2023) shows that this effect is not present in the Australian transitions. Economically, DST, which is partially rationalised by a desire to reduce energy consumption has, if anything, the opposite effect. Kotchen and Grant (2011), Sexton and Beatty (2014) and Shaffer (2019) all find evidence that the observation of DST, rather than reducing energy demand, causes overall energy demand to both shift and increase during the period of its observation.

In financial markets, the results are more uncertain. Kamstra et al. (2000) provided the first evidence of the impact of DST on financial market outcomes, showing that the one day losses on DST transition weekends were between 200% and 500% of the normal weekend effect losses. They attribute such losses to the physiological and psychological impact of disruption to sleeping patterns. Pinegar (2002) and Berument et al. (2010) dispute these results, showing that outlier weekends play a significant role in driving the key findings. Kamstra et al. (2002) and Kamstra et al. (2010) reply to these two papers, refuting some of their conclusions. The original findings of Kamstra et al. (2000) are also disputed by Lamb et al. (2007), whose show that the original results are sensitive to the definitions and empirical specifications used

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in the original papers and by Gregory-Allen et al. (2010), who found no evidence of a significant impact of DST on stock markets, using an expanded sample of countries. Overall, the impact of DST transition on domestic financial markets remains ambiguous.

Relative to this existing literature, our contribution is to extend the domestic focus of the analysis to international interactions between countries, specifically, the nominal exchange rate between them. The remainder of the paper proceeds as follows: Section 2 sets out our empirical specification, as well as the sources of our data. Section 3 sets out our key findings, and presents evidence on the drivers of our results. Section 4 concludes.

2. Empirical specification

This paper examines the impact of the move into and out of Daylight Saving Time on exchange rates. To do so, we estimate the following empirical specification:

$$\begin{aligned} EXR_{b,q,t} =& \alpha + \beta 1 DSTStart_{b,t} + \beta 2 DSTStart_{q,t} + \beta 3 DSTEnd_{b,t} \\ &+ \beta 4 DSTEnd_{q,t} + \theta_{b,q} + \varepsilon_{b,q,t}, \end{aligned} \tag{1}$$

where $EXR_{b,q,t}$ is the (log) mean noon spot exchange rate between base currency b and quoted currency q over week t. $DSTStart_{b,t}$ and $DSTStart_{q,t}$ are indicators that take the value of 1 in weeks after DST starts in the country/ region of the base and quoted currency respectively. Similarly $DSTEnd_{b,t}$ and $DSTEnd_{q,t}$ are indicators that take the value of 1 in weeks after DST ends in the country/ region of the base and quoted currency respectively. $\theta_{b,q}$ are currency specific fixed effects and $\varepsilon_{b,q,t}$ is the error term.

Daily data on exchange rates was obtained from the Federal Reserve Bank of St Louis for all combination of base currency and quoted currency for the following countries/areas that observe DST: Australia, Canada, Denmark, the Eurozone, New Zealand, Norway, Sweden, Switzerland, the United Kingdom and the United States, as well as the following two countries that do not observe DST: Japan and South Africa. Data was obtained for the period 4th January 1971 to 3rd January 2020, which across all combinations of countries gives a total of 305,382 observations. Note that, because we examine all combinations of base and quoted currencies, the estimated values of coefficients $\beta 1$ and $\beta 2$ will be equal and opposite to each other, as will the estimated values of $\beta 3$ and $\beta 4$. For a later robustness check we will use data on equity markets, specifically the MSCI Indexes for Australia, Canada, Denmark, Japan, New Zealand, Norway, Sweden, Switzerland and the United Kingdom, the FT South Africa index, the S&P Euro Plus Index and the Wilshire 5000 Total Market Index for the United States.[1]

3. Results

This section examines the impact of the transition into and out of Daylight Saving Time (DST) on bilateral nominal exchange rates. Table 1 presents the baseline estimation of specification (1):

The results in column (1) in Table 1 show that, relative to the currency average, the transition into DST has no impact on the exchange rate, but the transition out of DST on the part of the base country causes the exchange rate to appreciate. One possible explanation for this is broader patterns of exchange rate movements before and after the initial introduction of DST in each country. If we expand our controls to estimate the impact of DST transition on currencies relative to their average in each year, the impact of the transition out of DST by the base country remains positive and significant, but the transition into DST now becomes negative and significant. This holds even once the impact of DST is examined relative to each month in each year for each currency, but now the impact of the transition into and out of DST has a much smaller impact, albeit with the same direction and without significance in the case of the transition out of DST.

One possible explanation for the smaller impact of the transition into and out of DST on bilateral exchange rates, once the most granular Currency-Month-Year fixed effects are included is the impact of the inclusion of the US dollar in the analysis. Unlike the other currencies in the sample, the US dollar is de facto utilised as the predominant currency, either thorough unofficial utilisation, or explicit exchange rate pegging, by a large number of countries around the world, meaning that the value of the currency is determined not only by activities in the US economy, but also, at least partially, by activities in other countries, that do not observe DST, or observe it at different times. Therefore, in column (4) we exclude the US from our analysis. Once this is excluded, the significance increases and the coefficients increase in size for both the transition into and out of DST, with the same direction as in the original estimation.

Examining the coefficients in more depth, the sign of the effects could be consistent with either the normal physiological/ psychological mechanism impacting on market participants or a different 'market position' mechanism. The existing health literature shows negative impacts on physiology and psychology of the transition into DST and vice versa for the transition out of DST (see Osborne-Christenson (2022), Kountouris and Remoundou (2014), Jin and Ziebarth (2020) and Costa-Font et al. (2024)). If there is a negative physiological or psychological impact on market participants in the base country we would expect this to be reflected in a depreciation of the exchange rate. However, the stock market physiological/psychological impact of DST is shown to be negative for both the transition into and out of DST (see Kamstra et al. (2000)), which could also be the case for exchange rates. Therefore, while the coefficients for the transition into DST are consistent with a physiological/ psychological mechanism, the coefficients for the transition out of DST may not fit this mechanism, depending on if exchange rates follow the same pattern as equity markets.

An alternative mechanism operates via market time-zone positioning, particularly relative to the USA. As a country enters DST, the time difference between them and the USA increases and then decreases upon exit from DST. If time zone synchronicity is important as a market tool through trading with the US market, then the increase of time zone difference associated with the transition into DST reduces market advantage and the opposite for the transition out of DST, which would then feed through to exchange rates in the same direction as our results. This also potentially offers another explanation why the exclusion of the USA from the sample increases the size and significance of the coefficients of the impact of DST transition.

We test these mechanisms in two ways on our sample of non-US country pairs. First, we incorporate the ratio of base and quoted country stock market indexes (which have been shown to be impacted by a physiological/ psychological mechanism) into specification (1). We would expect the physiological/ psychological impact to be reflected in equity prices, and therefore any remaining DST impact to be driven by an alternative mechanism. Secondly, we interact our DST transition variables with the difference between the normal population weighted time zone of the relevant country/region and the normal population weighted time zone of the USA. If there is no market position effect, then we would expect the coefficients on the interaction term to be zero. Table 2 presents these results, reproducing column (4) of the previous analysis in column (1) for ease of comparison:

As expected, once equity markets, and hence the physiological/ psychological impact of DST transition is taken into account (column (2)), the impact of this transition becomes smaller, indicating that there is a physiological/ psychological impact on exchange rates. However, there remains a significant impact of DST transition, indicating the presence of a market-position effect. The results with the interaction terms in columns (3) and (4) (with and without controlling for equity markets), confirm that there is a significant impact of time zone position, with the

[1] Our equity market data is only available from January 1986.

Table 1
Exchange rate mean and daylight saving time results.

	(1) Exchange rate mean	(2) Exchange rate mean	(3) Exchange rate mean	(4) Exchange rate mean
DST Start (Base)	0.0156	−0.00461***	−0.00101***	−0.00134***
	(0.00932)	(0.00116)	(0.000229)	(0.000274)
DST Start (Quoted)	−0.0156	0.00461***	0.00101***	0.00134***
	(0.00932)	(0.00116)	(0.000229)	(0.000274)
DST End (Base)	0.0241*	0.00412**	0.000542	0.00121***
	(0.0106)	(0.00128)	(0.000283)	(0.000290)
DST End (Quoted)	−0.0241*	−0.00412**	−0.000542	−0.00121***
	(0.0106)	(0.00128)	(0.000283)	(0.000290)
Currency FE's	Yes	No	No	No
Currency-Year FE's	No	Yes	No	No
Currency-Month-Year FE's	No	No	Yes	Yes
Dollar ExR Included	Yes	Yes	Yes	No
Observations	305 382	305 382	305 382	252 050
R^2	0.947	1.000	1.000	1.000

Standard Errors, clustered at the currency level, are in parentheses, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table 2
Exchange rate mean and daylight saving time mechanisms.

	(1) Exchange rate mean	(2) Exchange rate mean	(3) Exchange rate mean	(4) Exchange rate mean
DST Start (Base)	−0.00134***	−0.000875**	0.000745	0.00155**
	(0.000274)	(0.000271)	(0.000398)	(0.000477)
DST Start (Quoted)	0.00134***	0.000880***	−0.000745	−0.00143**
	(0.000274)	(0.000260)	(0.000398)	(0.000466)
DST End (Base)	0.00121***	0.00109***	0.00330***	0.00420***
	(0.000290)	(0.000317)	(0.000420)	(0.000422)
DST End (Quoted)	−0.00121***	−0.00108***	−0.00330***	−0.00420***
	(0.000290)	(0.000317)	(0.000420)	(0.000421)
DST Start (Base) ×			−0.000230***	−0.000271***
Time Zone Difference			(0.0000576)	(0.0000499)
DST Start (Quoted) ×			0.000230***	0.000257***
Time Zone Difference			(0.0000576)	(0.0000490)
DST End (Base) ×			−0.000233***	−0.000350***
Time Zone Difference			(0.0000365)	(0.0000431)
DST End (Quoted)×			0.000233***	0.000350***
Time Zone Difference			(0.0000365)	(0.0000434)
Currency-Month-Year FE's	Yes	Yes	Yes	Yes
Equity Market Ratio	No	Yes	No	Yes
Observations	252 050	179 708	252 050	179 708
R^2	1.000	1.000	1.000	1.000

Standard Errors, clustered at the currency level, are in parentheses, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

interaction terms having significant coefficients for both the transition into and out of DST, supporting the presence of a market-position effect. However, given the small coefficients, the aggregate benefits of any market positioning effect on exchange rates are small, but not insignificant, compared to average volatility. Over the weeks in our sample, the (log) average noon spot bilateral exchange rates vary by 0.54% within a week, meaning that the approximately 0.1% impact of the DST transition, once equity market behaviour is taken into account, represents a substantial portion of these within-week volatilities.

4. Conclusion

In this paper we have examined the impact of the transition into and out of Daylight Saving Time (DST) on nominal bilateral exchange rates. We have shown that the transition of the base country into DST causes a depreciation in the exchange rate, which is matched by an appreciation in the exchange rate when the base country transitions out of DST. We explain this result through a combination of a physiological and psychological impact on market participants and a time-difference market position effect.

Data availability

Data will be made available on request.

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