Time Variation of Regression Coefficients related to Macroeconomic News affecting Currency Prices

Victor Mitchell

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abstract here when I'm done with the writing and have all results

1 Introduction

There exists a number of macroeconomic figures that are released on a predetermined schedule for certain countries. These include for example the Non-Farm Employment change that is released on the first friday of every month informing economists and investors alike of the status of employment in the United States.
Classic economic theory helps us understand that an increase of interest rates is warranted when economies are performing well and prices are generally increasing. Those who decide to increase national interest rates, the central banks, typically refer to measures of inflation in order to make their decisions. Because of this, investors and traders alike pay close attention to news releases (such as inflation, and also the Non-Farm-Payrolls in the case of the United States) and react according to the results. These news releases are not made public until specific times on specific days and since investors and traders react to the same news the moment it is released, the result is often a violent reaction of price in one direction or another. The common discourse is that the direction and the magnitude of the change of price depends on the difference between the expectation of the market (combined expecation of worldwide investors) and the result of the

Table 1: Summary of the news figures considered in the study

Country	News.Event	Pair.used	GMT.Time	Frequency	Observations	Dates
Single News					**NA**	
Canada	Consumer Price Index	USD/CAD	13:30	Monthly	135	Jan 2008 to Dec 2019
Canada	Core Retail Sales	USD/CAD	12:30	Monthly	144	Oct 2008 to Dec 2019
United States	Consumer Price Index	USD/CHF	13:30	Monthly	135	Oct 2008 to Dec 2019
New Zealand	Consumer Price Index	NZD/USD	21:45	Quarterly	43	Jan 2009 to Oct 2019
Australia	Consumer Price Index	AUD/USD	00:30	Quarterly	48	Jan 2008 to Oct 2019
Australia	Retail Sales	AUD/USD	00:30	Monthly	135	Oct 2008 to Dec 2019
United Kingdom	Consumer Price Index	GBP/USD	09:30	Monthly	135	Oct 2008 to Dec 2019
United Kingdom	Retail Sales	GBP/USD	09:30	Monthly	135	Oct 2008 to Dec 2019
Grouped News					**NA**	
United States	Average Hourly Earnings Change	USD/CHF	13:30	Monthly	135	Oct 2008 to Dec 2019
United States	NonFarm Employment Change	USD/CHF	13:30	Monthly	135	Oct 2008 to Dec 2019
United States	Unemployment Rate	USD/CHF	13:30	Monthly	135	Oct 2008 to Dec 2019
Canada	Employment Change	USD/CAD	13:30	Monthly	135	Oct 2008 to Dec 2019
Canada	Unemployment Rate	USD/CAD	13:30	Monthly	135	Oct 2008 to Dec 2019
Australia	Employment Change	AUD/USD	00:30	Monthly	135	Oct 2008 to Dec 2019
Australia	Unemployment Rate	AUD/USD	00:30	Monthly	135	Oct 2008 to Dec 2019

news release.

In this paper, we decide to use currency pairs to measure the price shocks. As certain news pertaining to a particular country affects its respective currency more than other ones, it makes sense to observe the currency most relevant to the news announcement. As currency prices are typically measured in pairs, the second chosen currency will be another major currency that is known for its high liquidity (EUR, USD or CHF) and does not have any other news announcements at the same time[1]. As an example, we would use the USD/CAD currency pair to measure the effect of the Canadian Consumer Price Index (CPI).

The paper of (Andersen et al. 2003) reveals that over the time period between 1987 and 2002 there has been little time-variation in the reaction to news. Some more recently published literature of (Ben Omrane et al. 2019) involving an analysis on euro-dollar contracts has determined that unlike the the decade(s) encompassing the "Great Moderation" where there was lower relative volatility in the financial markets, the time period between 2004 and 2014 is characterized by evolving reactions to macroeconomic news.

This paper aims to _____________

2 Data

The minute-by-minute OHLC Data of 7 currency pairs were collected from the Metatrader5 platform. This represents over 4 million data points for each pair. Only a small fraction of this data is actually used since we consider only the 5 time frame from when each piece of monthly or quarterly news is released until 5 minutSes afterwards.

3 Construction of the model

Being consistent with previous literature on the subject, the first step involves estimating the impact that each piece of news has on its respective currency assuming 1.) That the news effects are constant over time. 2.) The surprise element S_t of the regression is evaluated as:

$$S_t = \frac{A_t - E_t}{\sigma_d} \tag{1}$$

A_t is the actual result of the news at time t, E_t is the expected result aggregated from experts and σ_d is the

[1] When simultaneous news cannot be avoided, a sequence of stability tests will be applied to ensure time variation is identified on a specific news release

Table 2: Results of regressions tests - HAC standard errors

News.Event	M5.Coefficient	std.error	HAC.std.error
Single News		**NA**	**NA**
UK CPI	12.681***	1.729	2.601
CA CPI	-12.896***	2.254	2.673
CA CRS	-13.773***	2.112	2.871
US CPI	3.968**	1.207	1.230
NZ CPI	24.109***	2.910	4.727
AU CPI	22.293***	4.145	4.226
AU RET	9.647***	1.215	2.656
UK RET	16.574***	1.968	2.572
Grouped News		**NA**	**NA**
US AHE	10.295***	2.577	2.665
US NFP	17.938***	2.572	4.143
US URÂ°	1.975	2.579	2.198
CA EMC	-25.588***	3.940	4.211
CA UR	1.053	3.940	4.262
AU EMC	21.59571***	1.842	2.780
AU UR	-11.93102***	1.842	1.828

empirical standard deviation of this difference over the entire sample. We use the expectation numbers from the ForexFactory website[2] Thereafter, we use this surprise element in a first simple OLS model.

$$R_t = \beta_0 + \beta_1 S_t + \varepsilon_t \tag{2}$$

Moreover, because we are working with a dataset where subsequent observations are suspected to be related to one another, one could expect that the errors of the basic model above be autocorrelated. Specifically, adjacent R_t would be more similar to one another than reactions that are separated in time to a greater extent. In this case, the inference on the β_1 would be flawed. Previous researchers have used what is called Heteroskedasticity and Autocorrelation-Consistent (HAC) estimators for the variance of the OLS estimator β_1. Using the Newey-West estimator for this variance from Newey and West (1987), we use modified standard errors of the β_1 in our results. If we are wrong in our assumption in some of the news instances, and there is no underlying autocorrelation of the R_t observations, our estimation of β_1 is less efficient than the original estimator in those cases. Nonetheless, it remains consistent and ensures we avoid type 1 error of rejecting a true null hypothesis suggesting $\beta_1 = 0$.

Table 2 shows the result of the different β_1 coefficients for separate news reports. The construction of the truncation parameter in the Newey-West estimator is such that our monthly news reports consider 2 autocorrelation coefficients whereas the quarterly ones only contain 1. This is due to the difference in the number of observations in our data. A higher estimated autocorrelation between the errors of the regression will result in a stronger correction of the variance of β_1. In all of the news in Table 2, the higher standard error does not affect the significance of the term. While it is not formal evidence, we suspect that the news for which the HAC standard error is vastly different than its unedited counterpart contains many unknown regressors that come from any of the findings that are summarized in Goldberg and Grisse (2013) (mentioned in the introduction).

$$R_t = \beta_0 + \beta_{1,t} S_t + \varepsilon_t \tag{3}$$

[2] The expectations of most online sources such as "Investing.com" or "DailyFX" are very similar. The aggregation methods are not disclosed to the public.

3.1 Two Directions Considered

4 Testing for instability of the news impact parameter

4.1 The quasi-Local-Level Test

There exists many ways to test whether β_t is time dependent or not. We first choose the methodology of the authors of (Elliott and Müller 2006) and briefly replicate their method. The advantage of their test is that it identifies instability no matter whether it comes in the form of a single break, many breaks, or a continuous change (all of which are feasible in our context).

The quasi-Local-Level (qLL) test enables one to test for many different types of persistent processes of the β_t. It is explained that many of these breaking processes can have a "temporary memory" (strictly speaking are strongly mixing) but will be well approximated by a Wiener process.[3]. This is extremely practical in our scenario as there are many possiblities for the possible variation of the β_t. The Null Hypothesis implies there is a stable parameter as in a familiar OLS regression. We obtain the likelihood under the Null assuming that the R_t observations are independently and identically distributed (and therefore so are their first differences):

$$L_{H0}(\beta_0, \beta_1, \sigma^2) = log \prod_{t=1}^{T} p(\Delta R_t | S_t; \beta_0, \beta_1, \sigma^2) \tag{4}$$

$$= -\frac{T}{2} log(2\pi) - T log(\sigma) - \frac{1}{2\sigma^2} \sum_{t=1}^{T} (\Delta R_t - (\Delta\beta_0 + \Delta\beta_1 S_t))^2 \tag{5}$$

Only the last term of (5) is kept as the first constants will cancel out. $\Delta\beta_0 + \Delta\beta_1 S_t$ becomes 0 as the terms do not change with time.

$$L_{H0} = \frac{1}{2\sigma^2} \sum_{t=1}^{T} (\Delta R_t)^2 \tag{6}$$

This contrasts with the alternative where instability is implied. We assume $\beta_t - \beta_0$ is approximated by the Gaussian random walk and ΔR_t is therefore a Gaussian moving average of order 1 MA(1) with the specification: $\Delta R_t \sim \eta_t + \psi_\eta \eta_{t-1}$, $\eta_t \sim iidN(0, \sigma_\eta^2)$, constant $\psi_\eta < 1$. Using the same *iid* assumption we obtain the likelihood of this alternative process:

$$L_{HA} = \frac{1}{2\sigma^2} \sum_{t=1}^{T} (\Delta\eta)^2 \tag{7}$$

The qLL statistic is obtained by subtracting L_{HA} from L_{H0}. The qLL test is therefore a monotone transformation of the Likelihood Ratio Test (LR_T), so while it does not follow a chi-square distribution exactly, it does follow a certain related distribution that has its percentiles defined by Elliott and Müller (2006) and reported in their table, reproduced here as Table 3. The general extension to the LR_T can be made where we can reject the model related to the Null Hypothesis (the stable model) if the critical value is sufficiently negative.

4.2 CUSUM and CUSUM-squared tests

Separate tests to the one explained previously are considered. We explore the ones elaborated in Brown, Durbin, and Evans (1975) named the CUSUM and CUSUM-squared. These tests use the successive error terms of predictions of a standard Recursive-Least-Squares (RLS) model that assumes stability of the β parameter. This model is described in _____________. In this specific application, we use the result of the

[3] Theorem 7.30 of (White 2001) can be applied since certain assumptions are made about the process

Table 3: Asymptotic Critical Values of the qLL Statistic

k	1	2	3	4	5
1%	-11.05	-17.57	-23.42	-29.18	-35.09
5%	-8.36	-14.32	-19.84	-25.28	-30.60
10%	-7.14	-12.80	-18.07	-23.37	-28.55

standard OLS as a baseline *prior* or initial value for the algorithm (ie. β_0) and we use an empirical $\hat{\sigma}_\varepsilon$ residual error that is based on the entire sample. By examining the prediction errors, one can observe whether or not they violate the $N(0, \sigma^2)$ assumptions. Namely that they are a 1.) zero mean sequence $E(\varepsilon_t) = 0$ and 2.) that they are serially uncorrelated $E(\varepsilon_t \varepsilon_j) = 0$ when $t \neq j$. The first step consists in running a standard RLS algorithm and obtaining one-step-ahead errors from it. These errors are obtained as follows:

$$u_t = R_t - \hat{R}_t | R_{t-1} \tag{8}$$

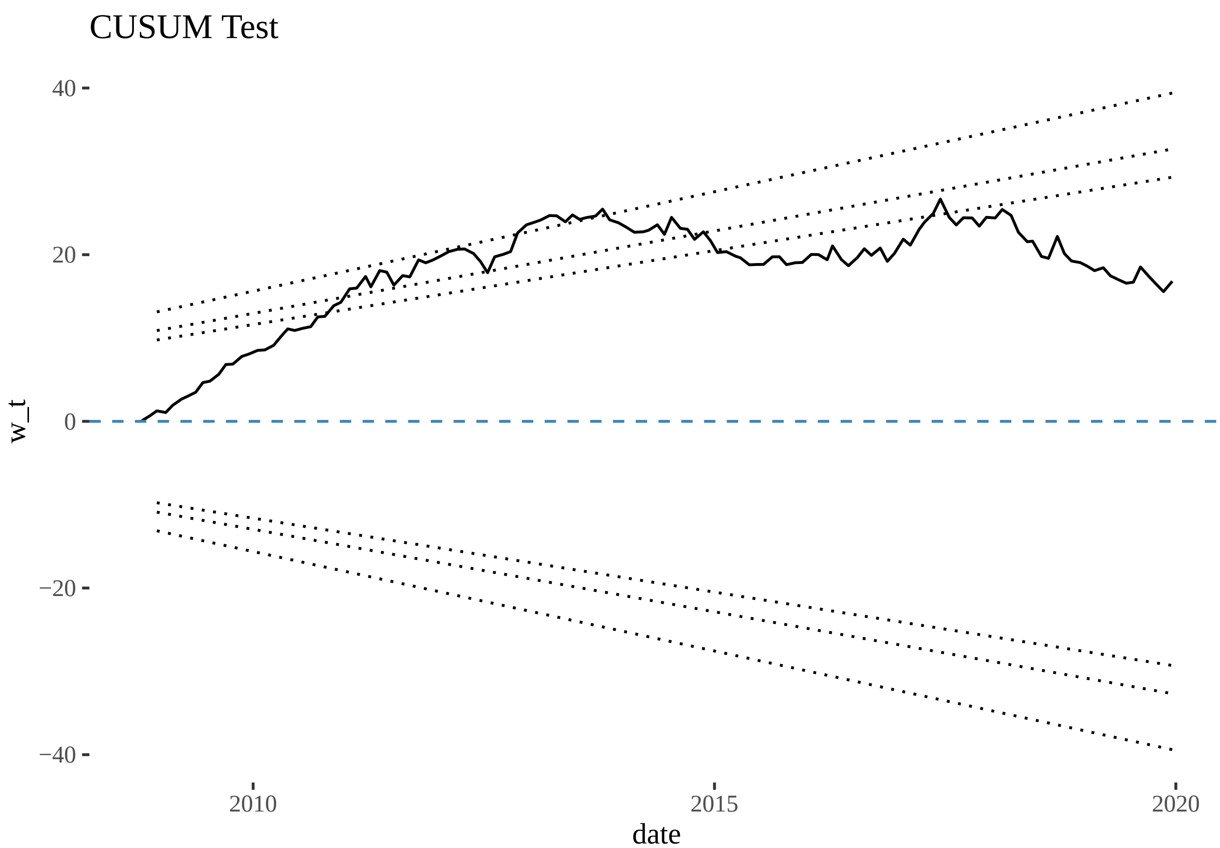
Effectively the realized price shock minus the predicted price shock at each observation. A transformation of these errors enables us to obtain a homoscedastic series.

$$u_{n,t} = \frac{u_t}{(1 + S_t^T P_t S_t)^{0.5}} \tag{9}$$

Where P_t is the covariance (or variance if there is only one news element at a time) of the β_t. A new series of summed up and standardized for use in the CUSUM test.

$$W_t = \frac{1}{\hat{\sigma}_{cs}} \sum_{i=k+1}^{t} u_{n,i} \tag{10}$$

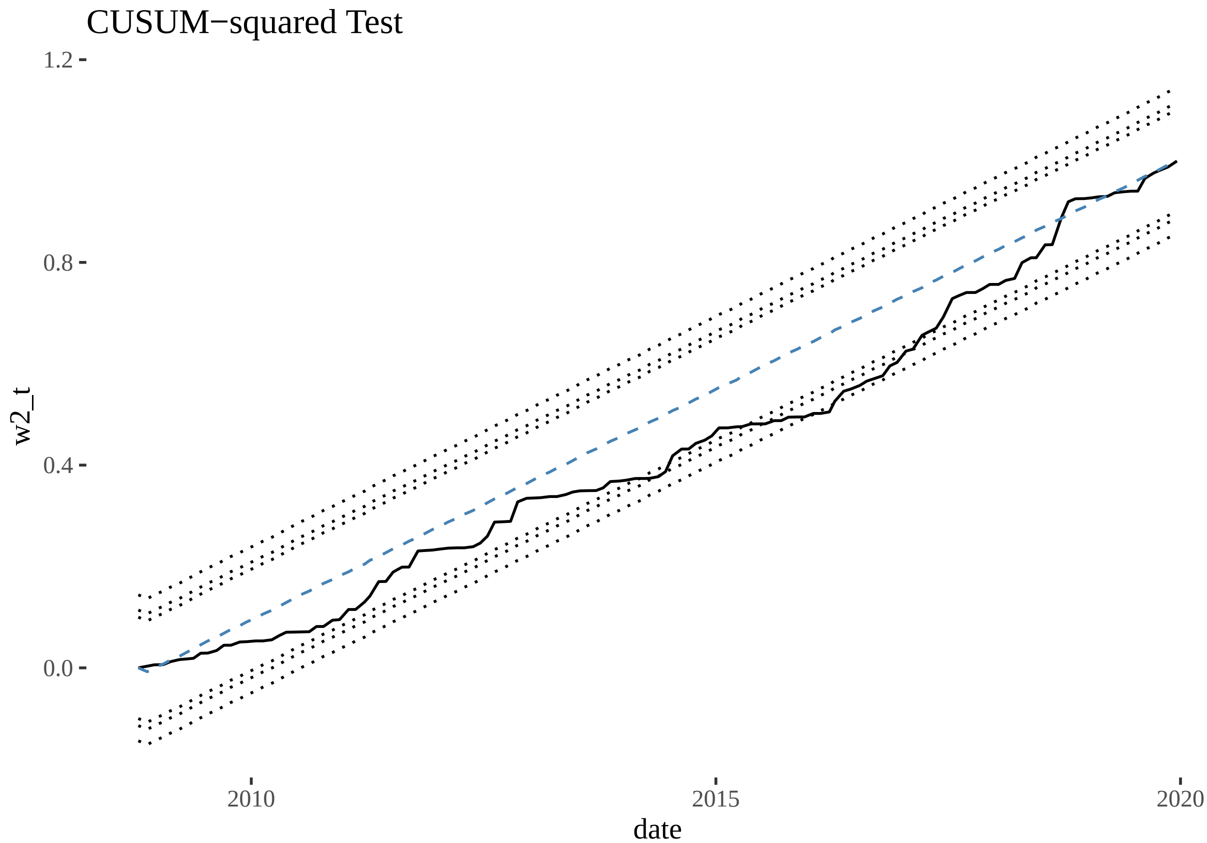
In theory, these successively compounded errors should not stray too far from the zero-line if the true $beta_t$ is constant. We also use the confidence bands suggested by Brown, Durbin, and Evans (1975). They are constructed by constructing pairs of lines starting at time k: $\pm a(T-k)^{0.5}$ and ending at time T: $\pm 3a(T-k)^{0.5}$



The second test, the CUSUM-squared can be run by once more by creating a new series, similar to the W_t from earlier. Here we consider:

$$V_t = \frac{\sum_{i=k+1}^{t} u_{n,i}}{\sum_{i=k+1}^{T} u_{n,i}} \tag{11}$$

With a Null-Hypothesis of a constant parameter(s), these cumulative sum of squares should follow a beta distribution and its mean should be $(k-h)/(N-h)$. As significance levels, we use the bounds set as: $\pm c_o + (k-h)/(N-h)$. The values of c_0 depend on the sample size. Our sample sizes are typically larger than the maximum value given in Brown, Durbin, and Evans (1975). For those cases where



- Assumptions of the test - appropriate in our case???

5 Parameter Path Estimations

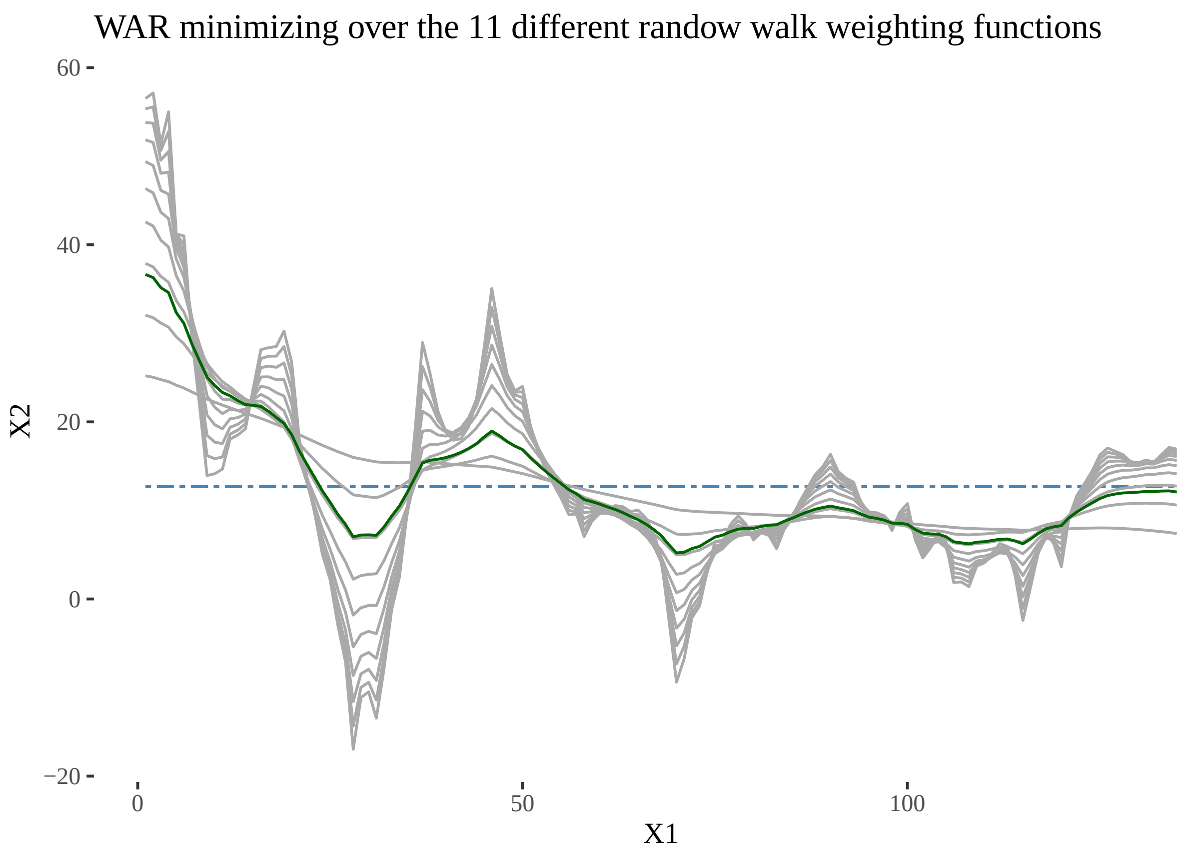
Having established that there is instability over time in the market reactions to the news, we take on the task of obtaining the parameter paths.

5.1 Weighted Average Risk Minimization

The paper

Table 4: Instability Test Results

News.Event	qLL	CUSUM	CUSUM.sq
Single News			
UK CPI	-12.964***	***	**
CA CPI	-18.387***		***
CA CRS	-14.445***	***	***
US CPI	-21.582***	***	***
NZ CPI	-7.267*	**	**
AU CPI	-9.022**		***
AU RET	-17.623***	***	
UK RET	-4.503		***
Grouped News			
US Batch			
Test 1 All News	-28.14***	***	***
Test 2 AHE&NFP	-24.015***		
Test 3 NFP&UR	-20.326***		
Test 4 AHE&UR	-7.078		
Test 5 NFP	-17.643***		
CA Batch			
Test 1 All News	-9.30	**	***
AUD Batch			
Test 1 All News	-22.912***	***	**
Test 2 EMC	-6.85		
Test 3 UR	-5.66		


WAR minimizing over the 11 different randow walk weighting functions
60
40
20
0
−20
X2
0
50
100
X1

6 Stochastic Recursive Linear Least Squares Algorithm

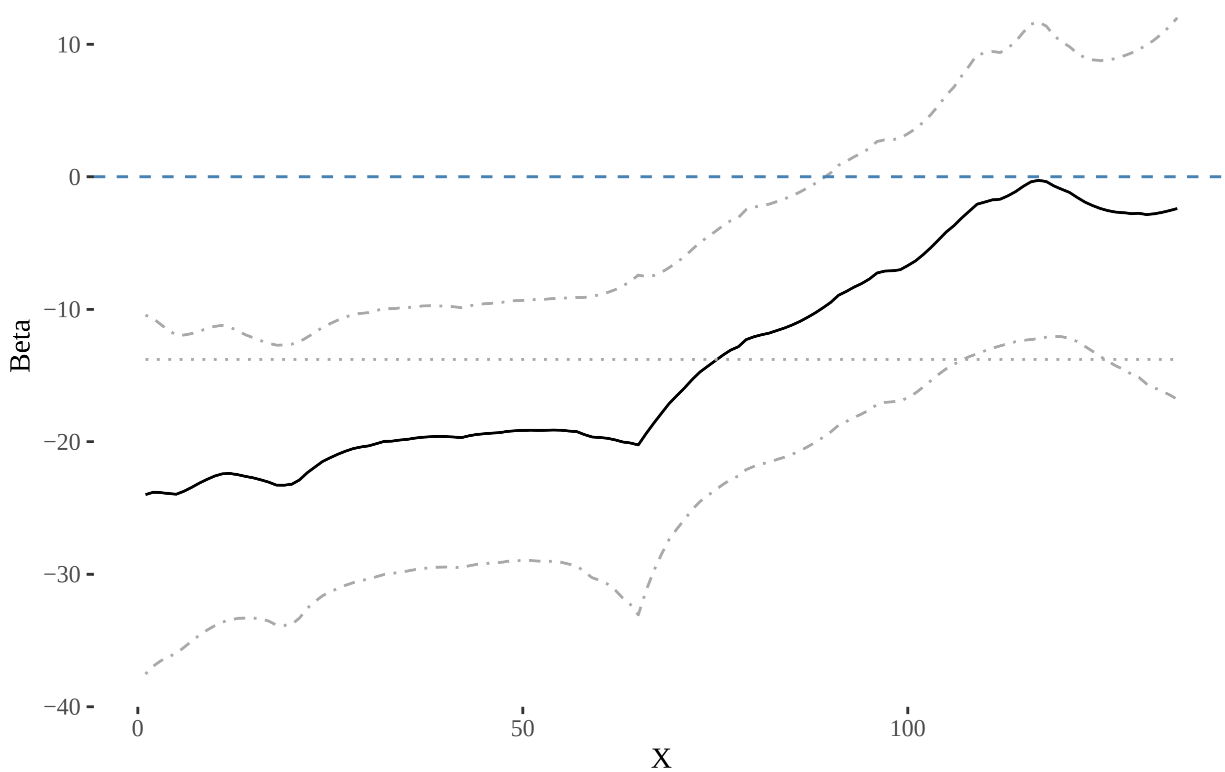
7 Discussion - A comparison of methods

8 Conclusion

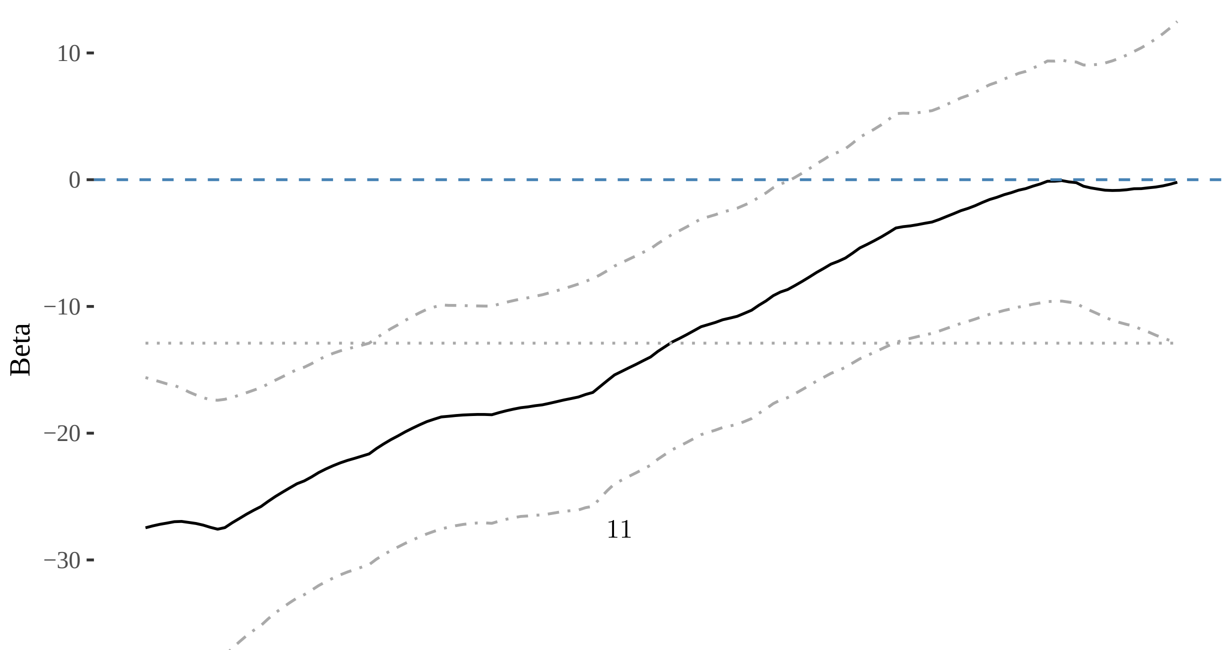
9 Appendix

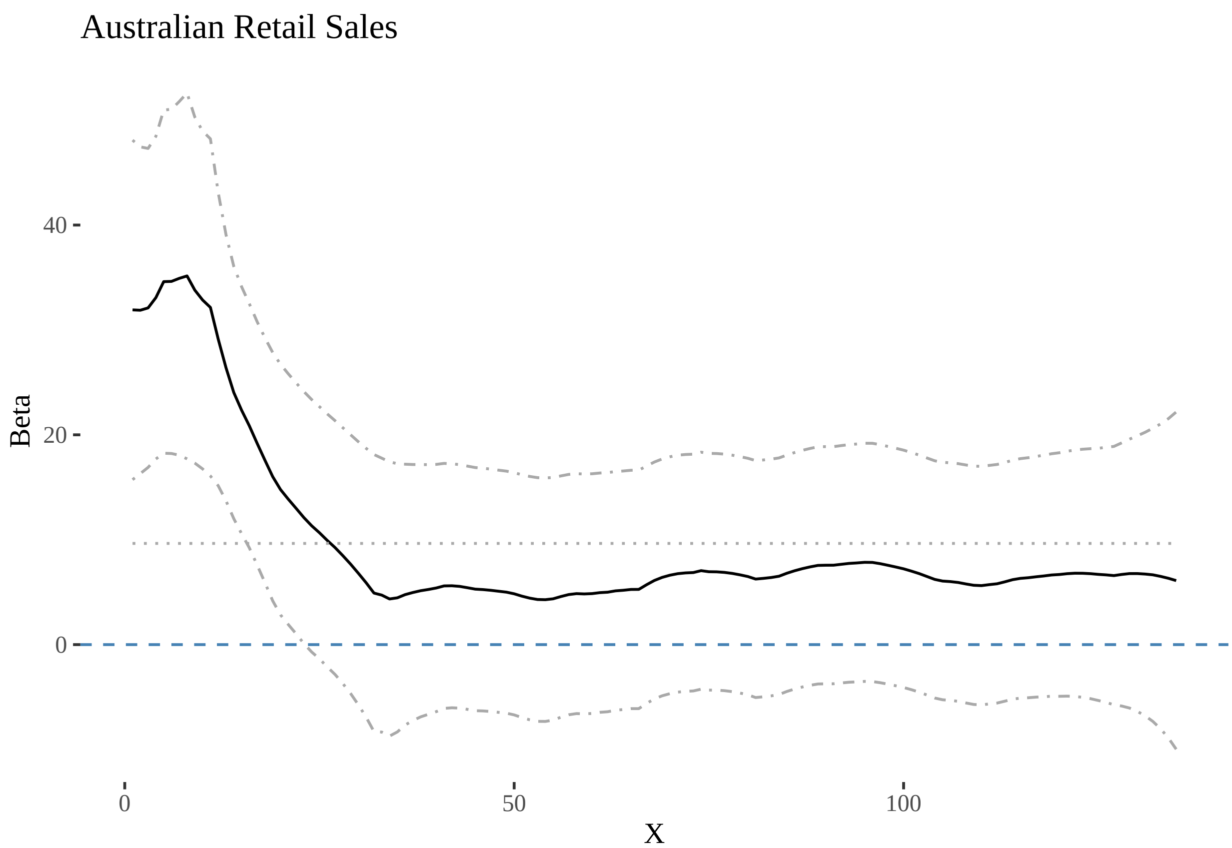
9.1 Parameter Paths

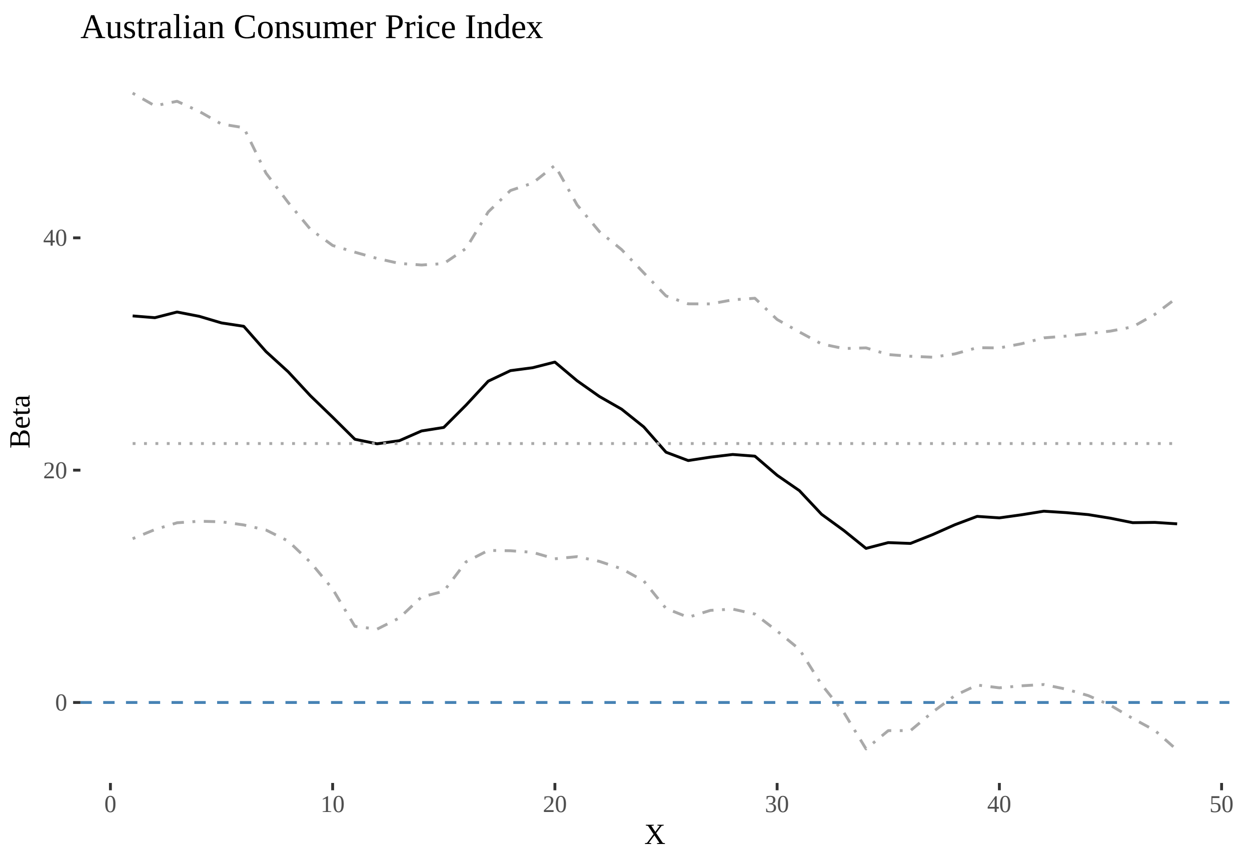
Canadian Core Retail Sales



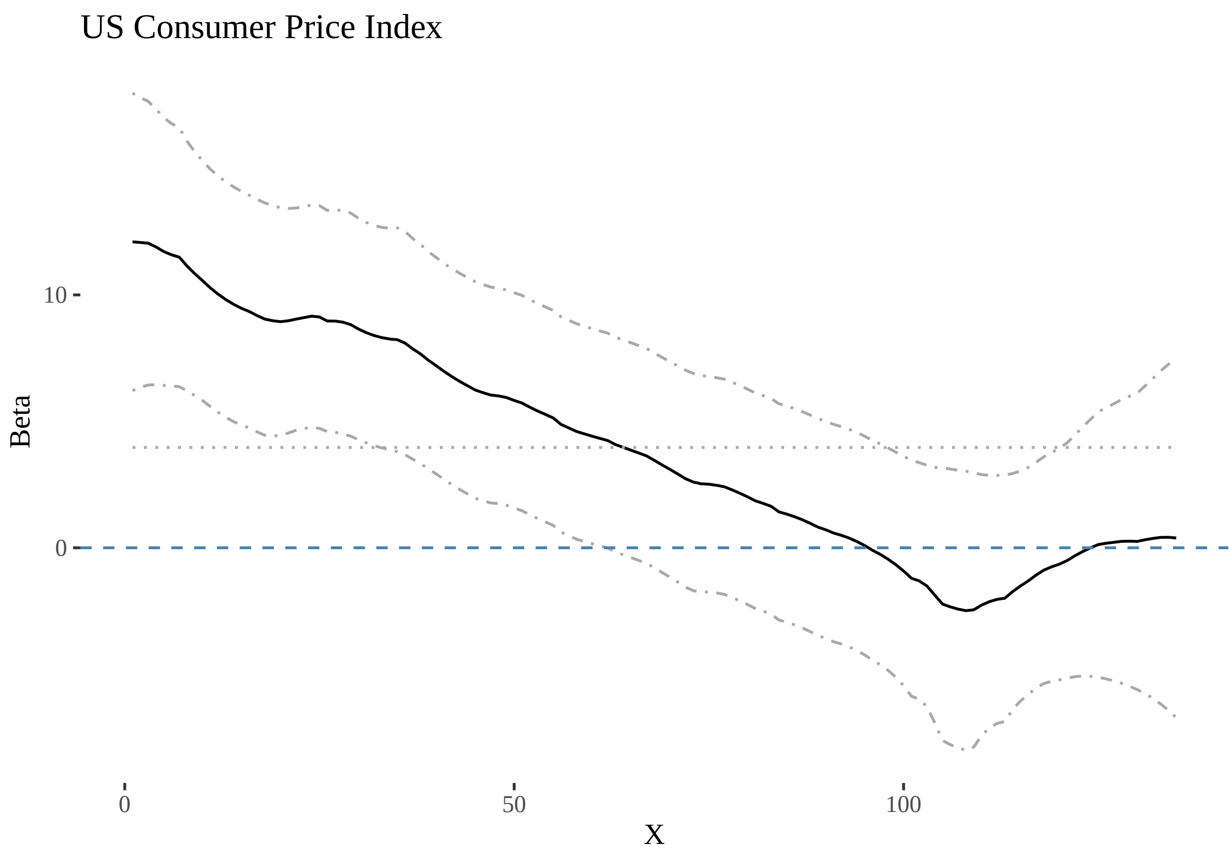
Canadian Consumer Price Index

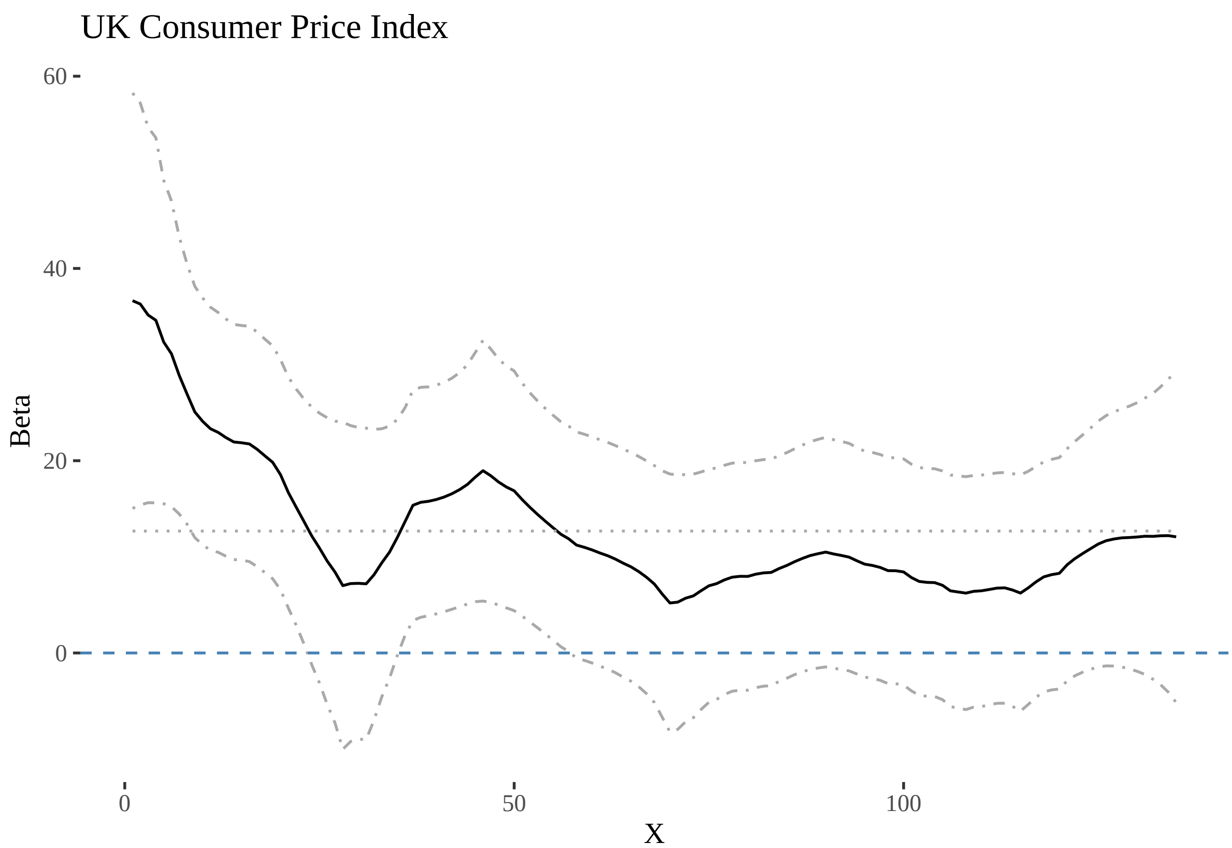



Australian Retail Sales
Beta
40
20
0
0
50
100
X



Australian Consumer Price Index
Beta
40
20
0
0
10
20
30
40
50
X


US Consumer Price Index
Beta
10
0
0
50
100
X


UK Consumer Price Index
Beta
60
40
20
0
0
50
100
X

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