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The Effects of the Frequency and Implementation Lag of Basket Updates on the Canadian CPI

Ning Huang, Waruna Wimalaratne and Brent Pollard

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Outline

- Motivation
- Target Index in this Study
- Approaches for Reducing Upper-level Substitution Bias
  - Use an alternative index number formula
  - Update baskets more frequently
  - Implement new baskets in a more timely fashion
- Conclusions

Motivation

- Inherent limitation of the Lowe index number formula
  - Consumer Prices Division (CPD) at Statistics Canada currently uses the Lowe index formula for the upper level aggregation of its CPI
  - It cannot take into account consumers' price-induced substitution behaviour due to the fixed-basket concept

    => Upper-level substitution bias

Motivation

- Statistics Canada's actions in 2013
  - Moved to a more frequent basket update schedule

    Every four years to every two years
  - Implemented the 2011 basket with shorter implementation lag

- Questions remaining:
  - Should we update baskets every year?
  - Is there an optimal month for implementing new baskets?

Motivation

- Existing literature about reducing the substitution bias
  - Other approaches
    - Greenlees and Williams (2009): annual basket updates generate an index that more closely resembles a target index
    - Généreux (1983): "***what appears to be desirable is not necessarily a more frequent updating of the CPI basket but a more timely one***"
- Investigate the impacts of the frequency and implementation lag of basket updates on reducing the substitution bias in the Canadian CPI

Target index in this study

- Superlative indexes: Fisher, Walsh, and Törnqvist

$$P_F^{t/0} = \left(\frac{\sum_i p_i^t q_i^0}{\sum_i p_i^0 q_i^0} \times \frac{\sum_i p_i^t q_i^t}{\sum_i p_i^0 q_i^t} \right)^{1/2} = \left(P_L^{t/0} \times P_P^{t/0} \right)^{/12}$$

$$P_W^{t/0} = \frac{\sum p_i^t \sqrt{q_i^0 q_i^t}}{\sum p_i^0 \sqrt{q_i^0 q_i^t}} \qquad P_T^{t/0} = \prod_i \left(\frac{p_i^t}{p_i^0} \right)^{\frac{1}{2}\left(s_i^0 + s_i^t\right)}$$

- Treat the prices and quantities in both periods symmetrically
- Closely approximate each other
- Approximate the underlying unconditional cost-of-living index based on a flexible functional form
- Recommended by the ILO CPI Manual as the theoretical target index

Target index in this study

Superlative Price Index (2003=100)

	Fisher		Walsh		Törnqvist	
	Index	Annual Inflation (%)	Index	Annual Inflation (%)	Index	Annual Inflation (%)
2003	100.000	2.483	100.000	2.483	100.000	2.482
2004	101.728	1.728	101.730	1.730	101.730	1.730
2005	103.746	1.984	103.750	1.986	103.750	1.986
2006	105.475	1.667	105.480	1.668	105.482	1.669
2007	107.401	1.826	107.409	1.829	107.410	1.828
2008	109.624	2.069	109.632	2.070	109.633	2.069
2009	109.670	0.042	109.684	0.047	109.688	0.050
2010	111.404	1.581	111.422	1.585	111.422	1.581
2011	114.389	2.679	114.408	2.680	114.405	2.677
Average Growth Rate		1.695		1.697		1.696

Approaches to reducing substitution bias

- Update baskets more frequently
- Implement new baskets in a more timely fashion
- Choose an alternative index number formula

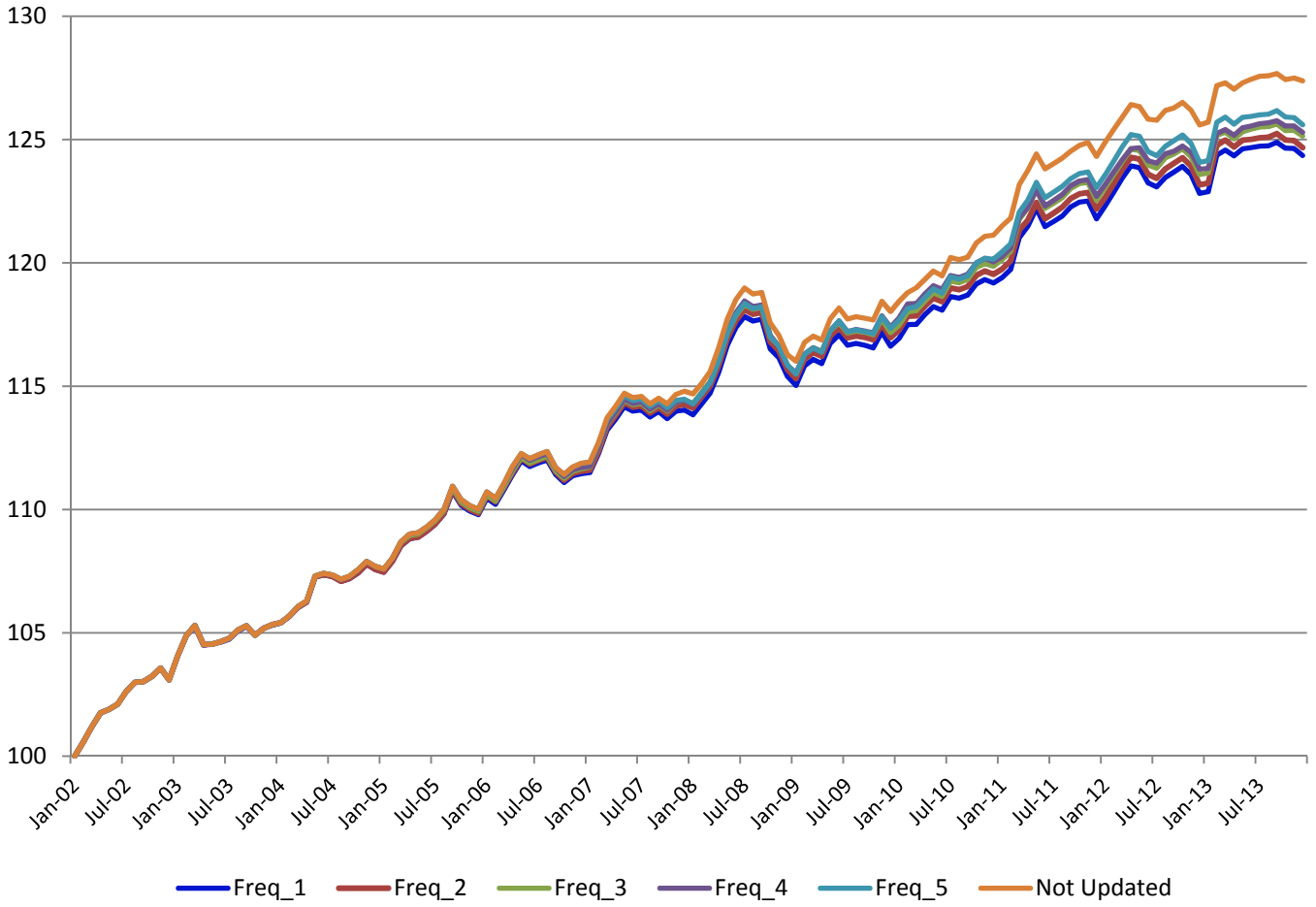
Impact of basket-updating frequency

- Calculate the All-items CPI for the period from January 2002 to December 2012

  - Use different frequencies of basket-updating
    - Update every year, every 2 years, every 3 years, every 4 years, every 5 years and not update at all;
  - Fix the implementation lag: 13 months

    e.g. The 2000 CPI basket is used in the CPI practice from February 2002 (current month) and the link month is January 2002

Impact of basket-updating frequency



Impact of basket-updating frequency

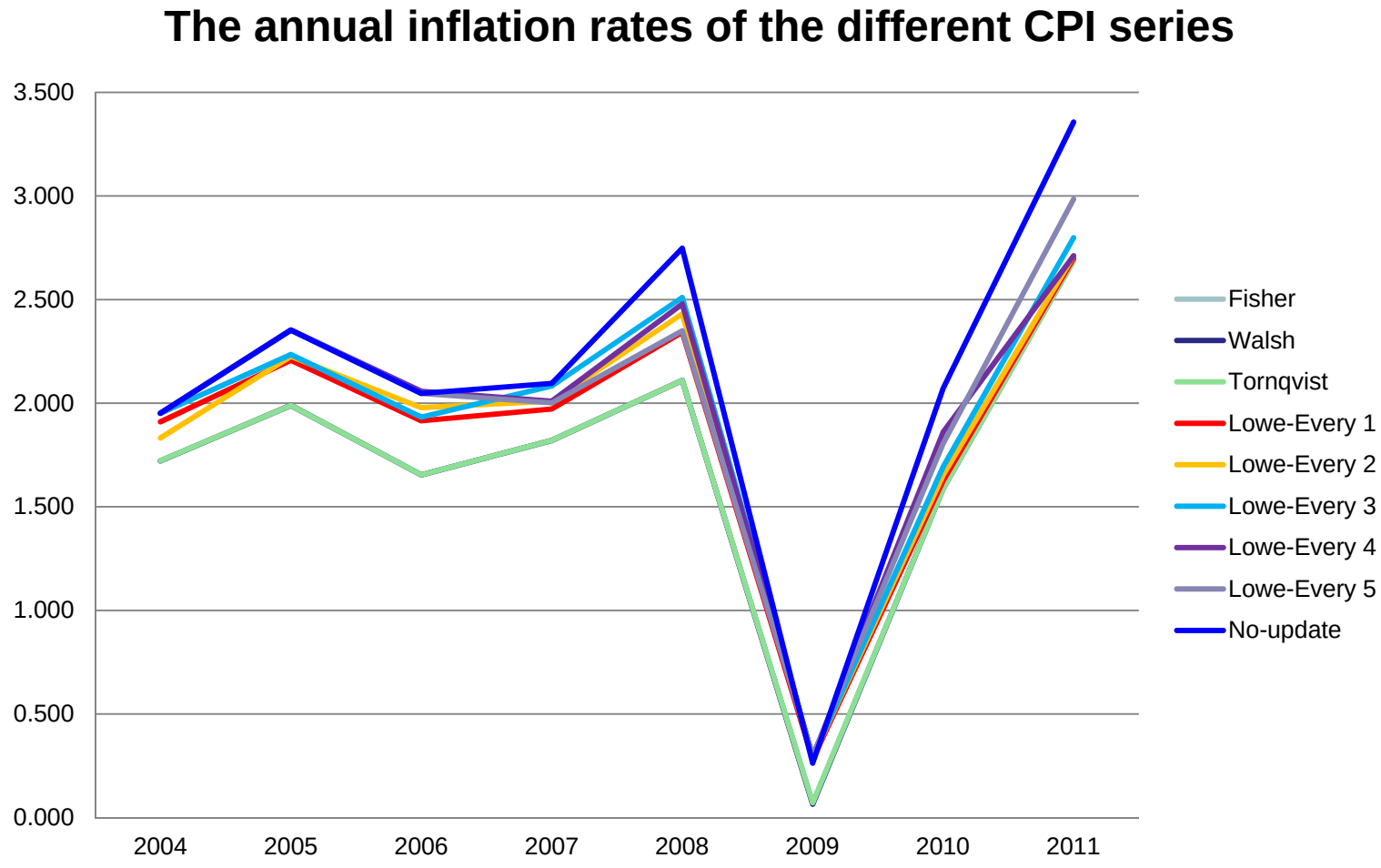
	Index (2003=100)	Difference in Indices	Annual Growth Rate	Difference in Annual Growth Rate
	2003-2011		(%)	(%)
Fisher	114.389	0.000	1.695	0.000
Lowe-Every year	115.857	1.468	1.857	0.162
Lowe-Every 2 years	116.153	1.764	1.889	0.195
Lowe-Every 3 years	116.547	2.157	1.932	0.238
Lowe-Every 4 years	116.645	2.256	1.943	0.249
Lowe-Every 5 years	116.918	2.528	1.973	0.278
Lowe index-Not updated	118.009	3.620	2.091	0.397

Impact of basket-updating frequency

- If we increase the frequency of updating CPI baskets from every 2 years to every year, we can reduce the substitution bias from 0.195% to 0.162%, a 0.033 percentage point

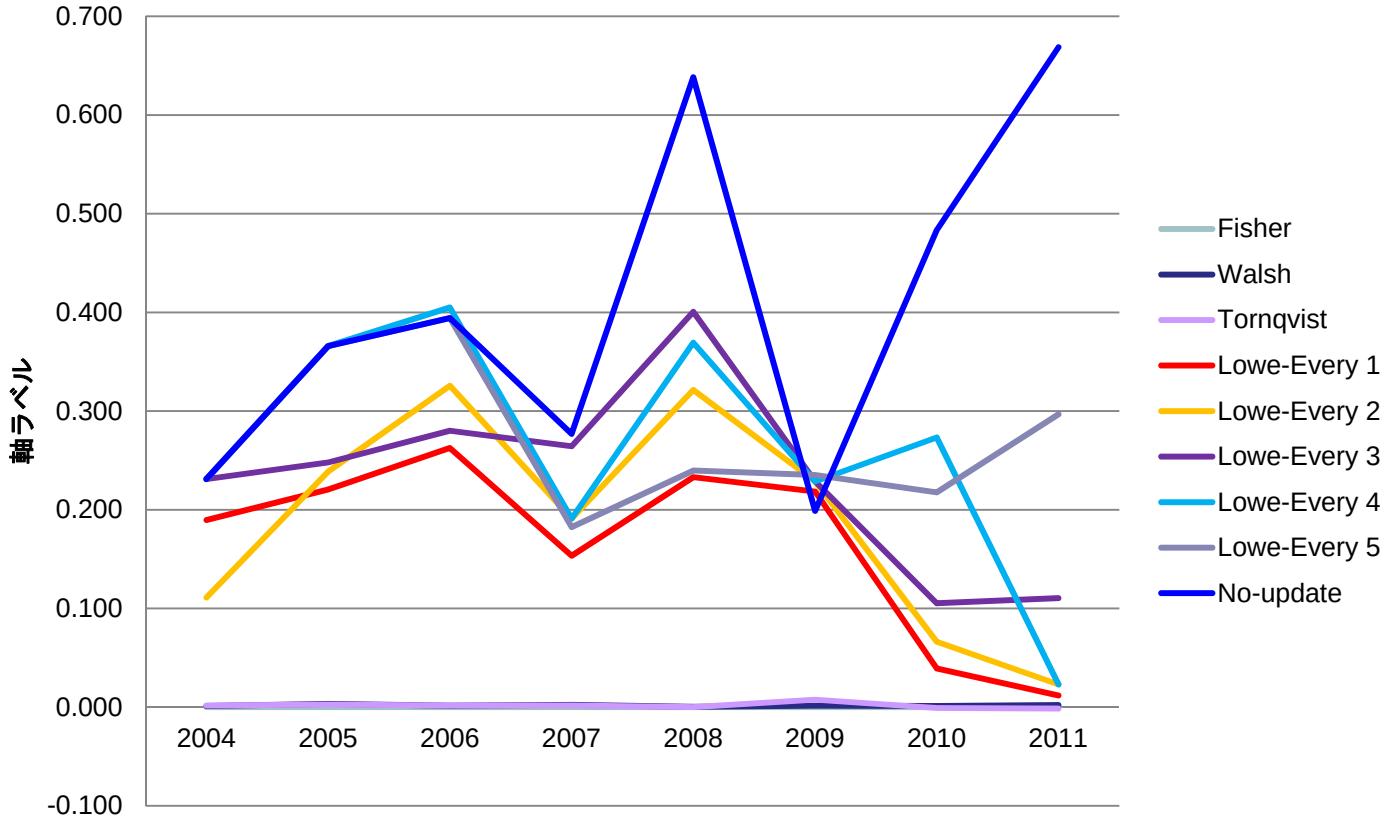
- The major gains were made when we moved from a 4-year to a 2-year basket update schedule (the substitution bias was reduced from 0.249% to 0.195% or 0.054 p. p.)

Impact of basket-updating frequency



Impact of basket-updating frequency

Differences in the annual inflation rates between the Fisher series and different CPI series



Impact of implementation lag

- Due to the timeline of the Survey of Household Spending (SHS), it is impossible for a new CPI basket to be implemented at the basket reference period.

- There is a certain time lag between the basket reference period and the time of implementation.
  - We call this time lag "*implementation lag*".

- It is widely recognized that shortening the implementation lag of a new CPI basket can lower the upward bias in the Lowe index.

Impact of implementation lag

- Basic setting
  - Assume that we have two baskets available, namely 2005 and 2009 baskets, for the period going from January 2009 to December 2012
  - Two possible link months for introducing the 2009 basket
    - December 2010 and April 2011

Impact of implementation lag

- Index calculation
  - CPI for December 2012 (2009=100)
    - Use December 2010 as link month:

$$P_{ChLo}^{2010,12}(p^{2009}, p^{2012,12}, q^{2009}) = \frac{\sum_i p_i^{2012,12} \times q_i^{2009}}{\sum_i p_i^{2010,12} \times q_i^{2009}} \times \frac{\sum_i p_i^{2010,12} \times q_i^{2005}}{\sum_i p_i^{2009} \times q_i^{2005}}$$

    - Use April 2011 as link month:

$$P_{ChLo}^{2011,04}(p^{2009}, p^{2012,12}, q^{2009}) = \frac{\sum_i p_i^{2012,12} \times q_i^{2009}}{\sum_i p_i^{2011,04} \times q_i^{2009}} \times \frac{\sum_i p_i^{2011,04} \times q_i^{2005}}{\sum_i p_i^{2009} \times q_i^{2005}}$$

Impact of implementation lag

- Bias comparison
  - Conditions for the following difference to be negative:

$$\left[P_{ChLo}^{2010,12}(p^{09},p^{2012,12},q^{09})-P_{target}\right]-\left[P_{ChLo}^{2011,04}(p^{09},p^{2012,12},q^{09})-P_{target}\right]$$

$$=P_{ChLo}^{2010,12}(p^{09},p^{2012,12},q^{09})-P_{ChLo}^{2011,04}(p^{09},p^{2012,12},q^{09})$$

$$=\frac{\sum_i p_i^{2012,12}\times q_i^{09}}{\sum_i p_i^{09}\times q_i^{05}}\times\frac{\sum_i p_i^{2010,12}\times q_i^{05}}{\sum_i p_i^{2011,04}\times q_i^{09}}\times\left(\frac{\sum_i p_i^{2011,04}\times q_i^{09}}{\sum_i p_i^{2010,12}\times q_i^{09}}-\frac{\sum_i p_i^{2011,04}\times q_i^{05}}{\sum_i p_i^{2010,12}\times q_i^{05}}\right)$$

Impact of implementation lag

- Decomposition of the difference

$$\left(\frac{\sum_i p_i^{2011,04} \times q_i^{09}}{\sum_i p_i^{2010,12} \times q_i^{09}} - \frac{\sum_i p_i^{2011,04} \times q_i^{05}}{\sum_i p_i^{2010,12} \times q_i^{05}} \right)$$

$$= \sum_i \left(\frac{p_i^{2011,04}}{p_i^{2010,12}} - P_{Lo}(p^{2010,12}, p^{2011,04}, q^{09}) \right) \times$$

$$\left(\frac{q_i^{09}}{q_i^{05}} - Q_{Lo}(p_i^{2010,12}, q^{05}, q^{09}) \right) \times \frac{s_i^{2010,12:05}}{Q_{Lo}^{09}(p_i^{2010,12}, q^{05}, q^{09})}$$

$$\left(\frac{p_i^{2009}}{p_i^{2005}} - P_{Lo}(p^{2005}, p^{2009}, q^{09}) \right)$$

Impact of implementation lag

- The longer the implementation lag is, the higher the upward bias will be, provided that the price trends between the ***two basket reference years*** are same as those ***between the two possible link months***.
  - The price trend between the two basket reference years, in general, represents the long-term price trend;
  - The price trend between two possible link months contains short-time price fluctuation, resulting in uncertain trends in the price change, especially with the seasonal market

Impact of implementation lag

- Different link months for introducing the 2009 CPI basket

Possible Link Month	$\frac{\sum_n p_n^{2011,04} \times q_n^{2009}}{\sum_n p_n^{link} \times q_n^{2009}}$ (A)	$\frac{\sum_i p_i^{2011,04} \times q_i^{2005}}{\sum_i p_i^{link} \times q_i^{2005}}$ (B)	Difference (A)-(B)
	2009 basket	**2005 basket**	
December-2010	102.0339	102.0011	0.0329
January-2011	101.7826	101.7540	0.0287
February-2011	101.4966	101.4701	0.0266
March-2011	100.4137	100.4076	0.0062

Impact of implementation lag

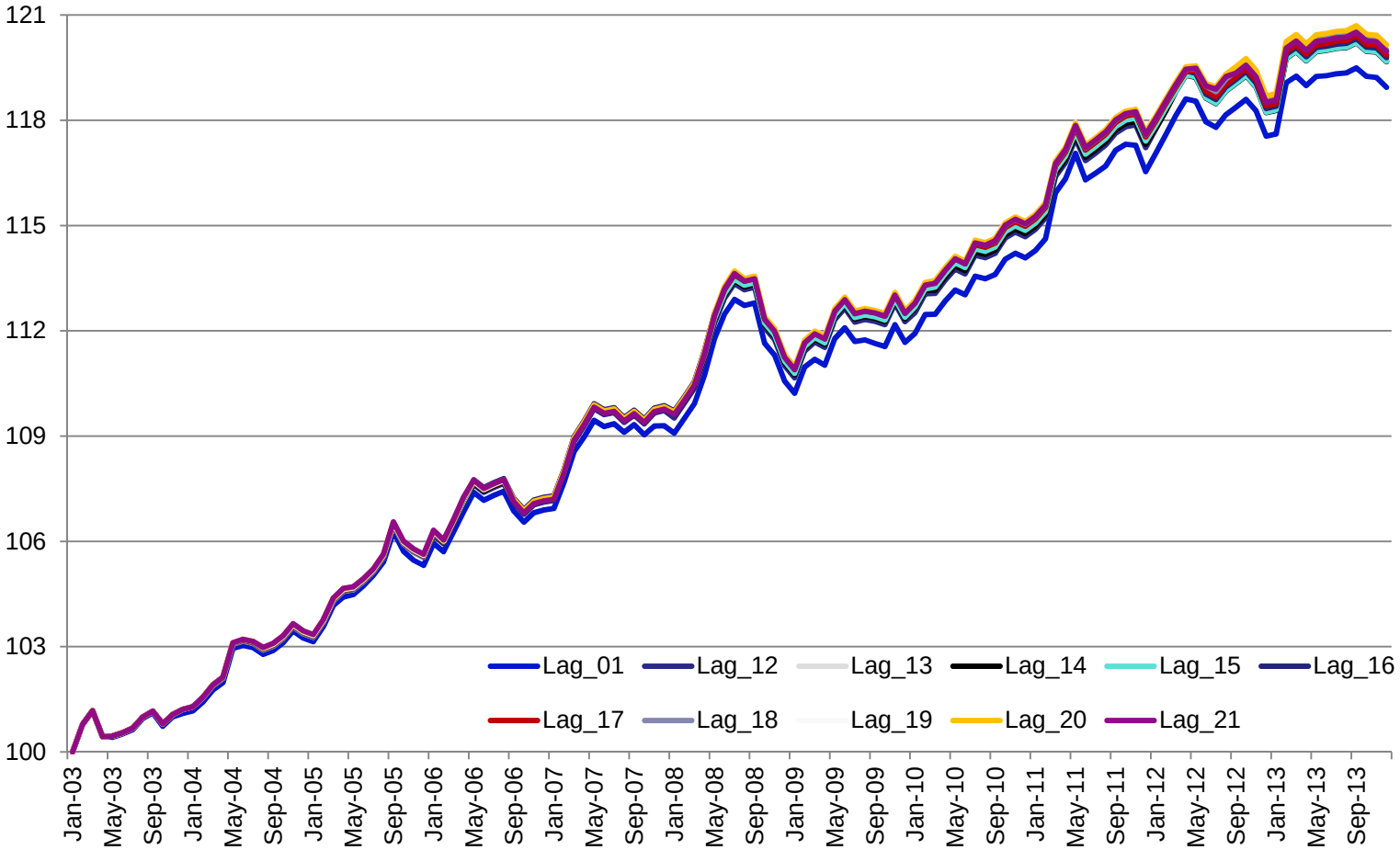
- Different link months for introducing the 2011 CPI basket

Possible Link Month	$\frac{\sum_n p_n^{2013,1} \times q_n^{2011}}{\sum_n p_n^{link} \times q_n^{2011}}$ (A)	$\frac{\sum_i p_i^{2013,1} \times q_i^{2009}}{\sum_i p_i^{link} \times q_i^{2009}}$ (B)	Difference (A)-(B)
	2011 basket	**2009 basket**	
December-2012	100.0678	100.0567	0.0111
January-2013	100.0000	100.0000	0.0000
February-2013	98.8240	98.8067	0.0173

Impact of implementation lag

- Calculate the All-items CPI for the period from January 2003 to December 2012 under the following situations:
  - Fix the frequency of updating CPI baskets at every 2 years
  - Vary the implementation lag: between 12 months and 21 months (within the timeline of the SHS)
  - Show the CPI series using one month as the implementation lag, which is operationally impossible.

Impact of implementation lag



Impact of implementation lag

	Indices 2003-2011	Annual Growth Rate (%)	Difference in Annual Growth Rate (%)
Fisher	114.389	1.695	0.000
Lowe, 1 month lag	115.484	1.816	0.121
Lowe, 12-Month lag	115.980	1.870	0.176
Lowe, 13-Month lag	116.153	1.889	0.195
Lowe, 14-Month lag	116.075	1.881	0.186
Lowe, 15-Month lag	116.164	1.891	0.196
Lowe, 16-Month lag	116.300	1.905	0.211
Lowe, 17-Month lag	116.282	1.903	0.209
Lowe, 18-Month lag	116.340	1.910	0.215
Lowe, 19-Month lag	116.432	1.920	0.225
Lowe, 20-Month lag	116.413	1.918	0.223
Lowe, 21-Month lag	116.348	1.911	0.216

Impact of implementation lag

- The table indicates how the inflation rate changed with the implementation lag.
- Even though using 12 months as the implementation lag yielded the lowest inflation rate; the difference in the inflation rate between using 12 months and using 14 months as the implementation lag was only 0.01%.
- The table shows that the impact of the implementation lag on the CPI was not predictable, especially when we decrease or increase the lags by 1 or 2 months.

Conclusions

- Substitution bias is reduced by changing the basket-updating frequency from a 4 year to a 2 year interval.
  - Going from a biennial to an annual update reduces the substitution bias to a lesser extent.

- The gain of shortening implementation lag is not predictable.