



Policy-Relevant Exchange Rate Pass-Through to U.S. Import Prices

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What we do (1/2)

- We investigate three sources of downward bias in standard estimates of exchange rate pass-through to U.S. import prices:

 - Selection biases in the entry of items in the index,
 - Selection biases in their exit,
 - Improper lag selection.



What we do (2/2)

- We use both Calvo and menu-cost models to relate these biases to micro price behavior and illustrate our strategies to mitigate their effects.
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- Consistent with central bank practice, we focus on the dynamic response over the first two years following an exchange rate movement (policy-relevant horizon).

Economic environment (1/3)

- We consider the following data-generating process

$$\Delta p_{it} = \begin{cases} u_{it} + \beta \Delta x_t + \varepsilon_{it} & \text{if } \mathcal{I}_{it}^f = 1 \\ 0 & \text{if } \mathcal{I}_{it}^f = 0 \end{cases},$$

where

Δx_t exchange rate movement;

\mathcal{I}_{it}^f indicators of price-change;

u_{it} past price pressure,

and u_{it} evolves according to $u_{it+1} = \begin{cases} 0 & \text{if } \mathcal{I}_{it}^f = 1 \\ u_{it} + \beta \Delta x_t + \varepsilon_{it} & \text{if } \mathcal{I}_{it}^f = 0 \end{cases}.$

Economic environment (2/3)

- Two versions of what causes I_{it}^f to change.
 - Calvo: constant probability f of changing price $P(I_{it}^f = 1) = f$.
 - Menu cost: change price if $|u_{it} + \beta \Delta x_t + \varepsilon_{it}| > K$.

- Calibration
 - Δx_t is AR(1) with Gaussian shocks set to match mean, variance, and persistence of U.S. nominal exchange rate (broad, end-of period).
 - Exchange rate pass-through (β) is set to 0.3.
 - Remaining parameters are chosen to match median size of individual price changes of 6.5 percent.

Economic environment (3/3)

- After simulating data from the model, we estimate the following regression

$$\Delta p_t = \int \Delta p_{it} di = a + \sum_{l=0}^L b_l \Delta x_{t-l} + r_t.$$

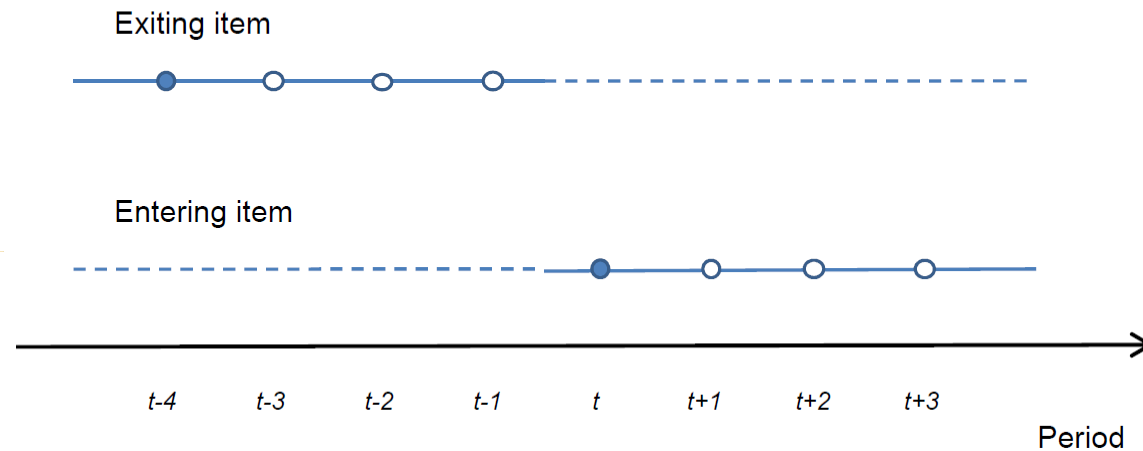
- In the special case of Calvo with uncorrelated shock, the (plim) coefficient on the l -th lag is

$$b_l = b_l = f (1 - f)^l \beta.$$

Bias 1: Selective Entry

- Nakamura and Steinsson (NS, 2009) argue that accounting for a “product replacement bias” would roughly double the estimate of long-run exchange rate pass-through to non-oil U.S. imports (from an elasticity of $0.2-0.4$ to $0.6-0.7$).
- This bias occurs when items entering the basket are *systematically* less sensitive to past movements in the exchange rate than items in general.

Illustration of a product replacement



Notes: Price changes are indicated by full circles and constant prices by empty ones.

- The entering item is a poor proxy for the exiting item because its price already reflects movements in the exchange rate up to period t (as opposed to up to period $t-4$). Its next price change will thus be less sensitive to past exchange rate movements.

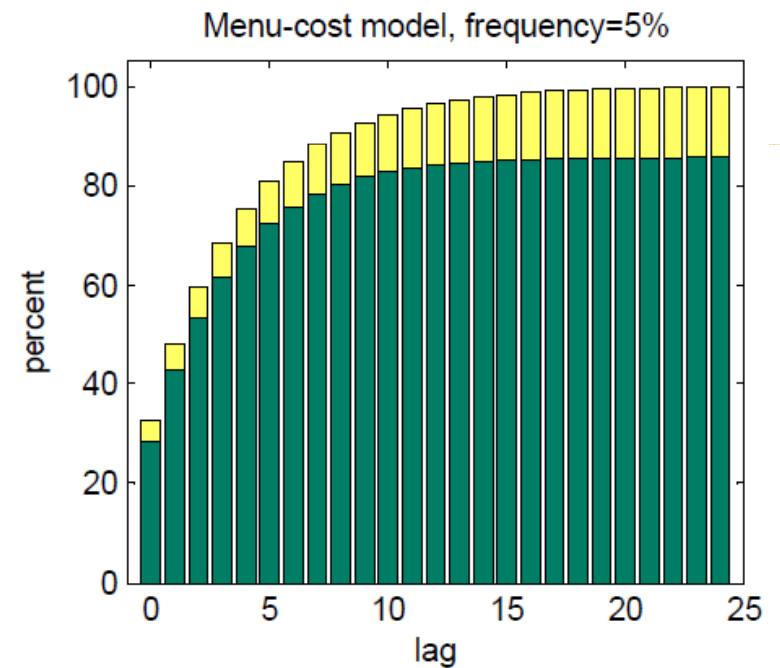
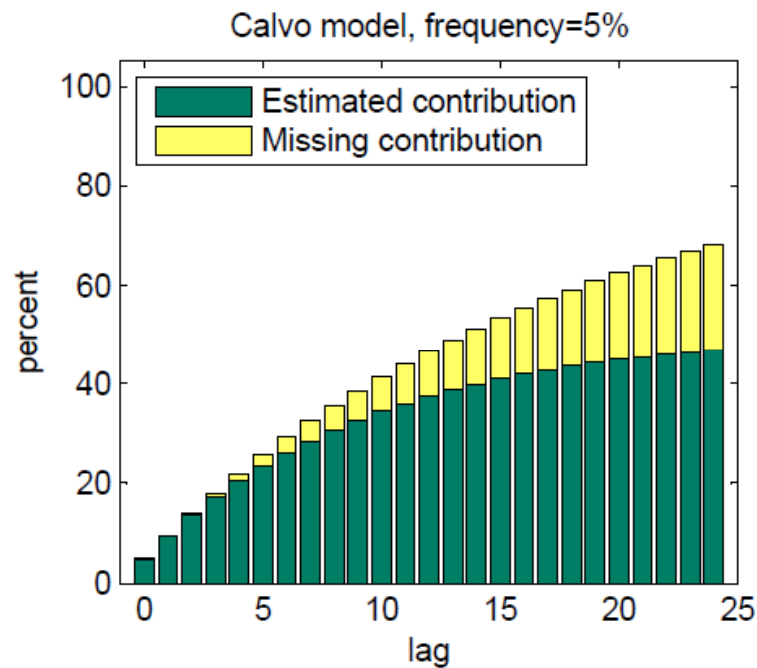
Modeling selective entry

- Suppose a fraction s of items are exogenously substituted every period. Let a fraction n of substitutes be sampled *systematically* from price trajectories with $u_{it} = 0$ and the remainder be drawn from the general population.
- Under a Calvo model with uncorrelated shocks, the (plim) coefficient on the l -th lag is

$$b_l = f (1 - f)^l (1 - sn)^l \beta.$$

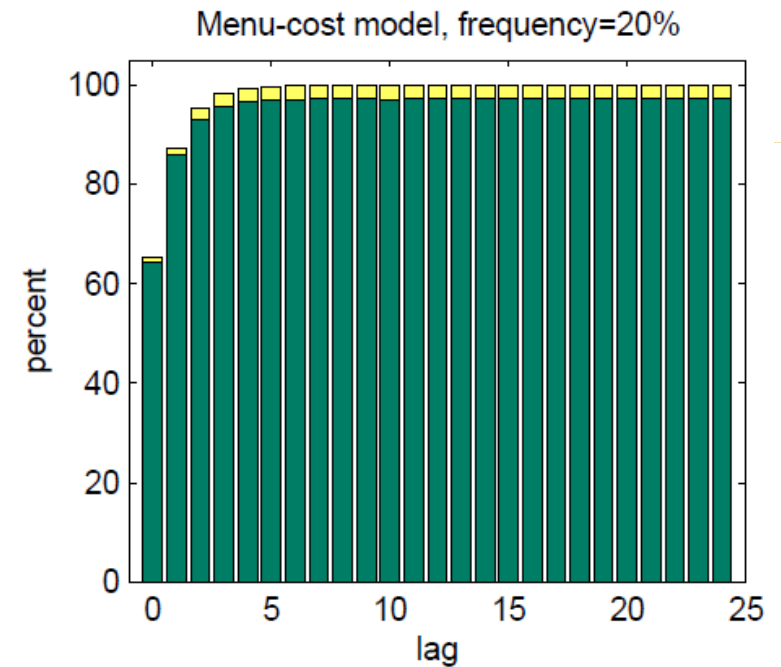
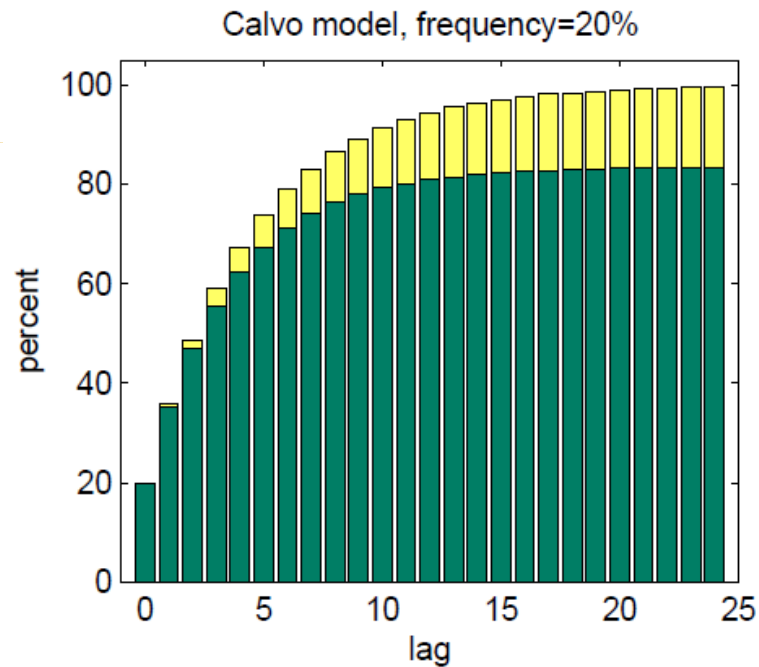
Worse case scenario ($n=1$) with low frequency of updating prices.

Cumulative contribution of coefficients on lagged exchange rate variables
($n = 1, s = 0.05$)



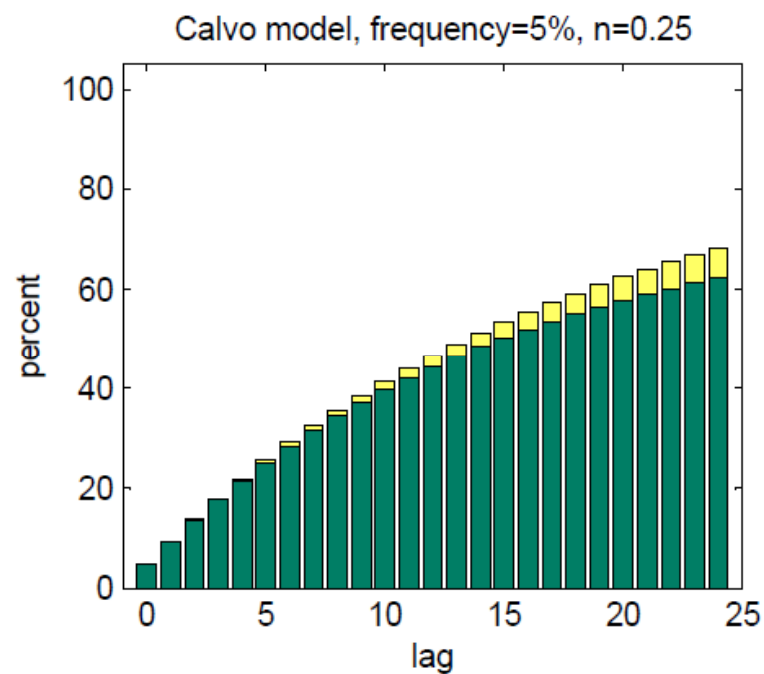
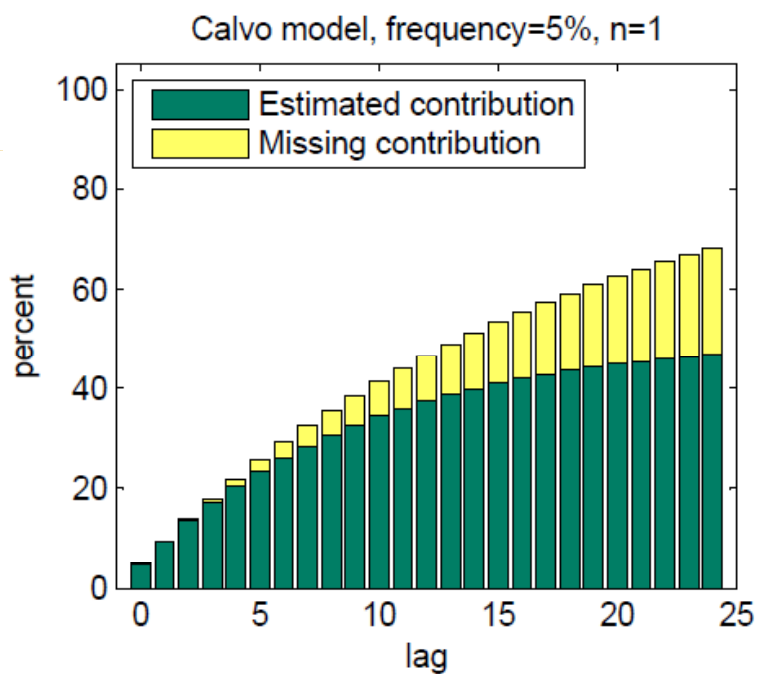
Worse case scenario ($n=1$) with medium frequency of updating prices.

Cumulative contribution of coefficients on lagged exchange rate variables
($n = 1, s = 0.05$)



Considering smaller n

Cumulative contribution of coefficients on lagged exchange rate variables
($s = 0.05$)



- The reduction in bias is roughly proportional to $1-n$.

Mitigating the product replacement bias

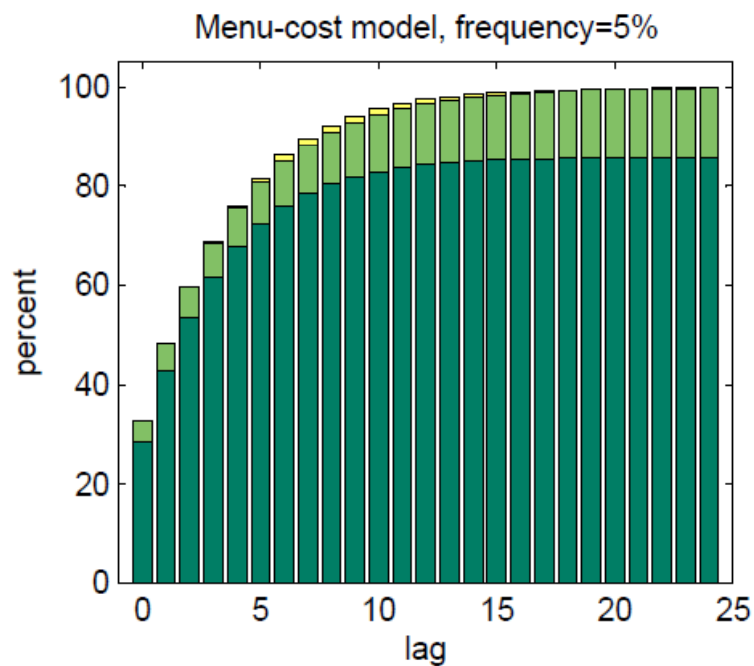
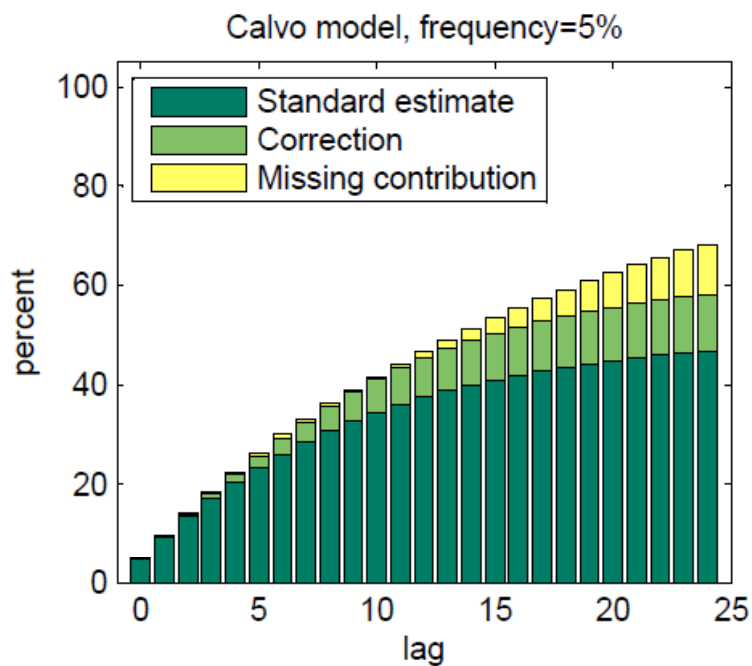
- We intend to construct a new price index using existing BLS observations, where the entry of items in the basket is delayed by M periods.
- Under Calvo with uncorrelated shocks,

$$b_l = \begin{cases} \beta (1 - f)^l f & \text{if } l \leq M \\ \beta (1 - f)^l (1 - sn)^{l-M} f & \text{if } l > M \end{cases}$$

- Our trick eliminates the bias on the first M coefficients in the regression and lowers it by a factor of $(1 - sn)^M$ for subsequent lags.

A corrected response

Cumulative contribution of coefficients on lagged exchange rate variables in
($n = 1, z = 0.05, M = 6$)



How much is at stake in U.S. data?

Enduse	Weight (2006)	Freq.	Entry	Exit	Abs. Size
		All			
210 Oil drilling, mining & const. machinery	1.0	9.1	3.3	3.8	5.8
211 Industrial & service machinery, n.e.c.	5.8	5.4	3.1	3.4	6.4
212 Agricultural machinery & equip.	0.4	7.3	3.5	3.3	4.4
213 Computers, periph. & semiconductors	7.0	11.1	5.2	4.9	8.9
214 Telecommunications equip.	2.2	5.4	5.1	4.8	8.7
215 Business mach. & equip., ex. Computers	0.5	6.9	4.1	3.7	5.1
216 Scientific, hospital & medical machinery	1.4	4.8	4.1	4.5	9.1
300 Passenger cars, new & used	7.5	4.9	3.4	4.2	2.3
301 Trucks, buses, & special-purp. vehicles	1.3	5.2	5.1	4.9	2.8
302 Parts, engines, bodies, & chassis	5.1	7.0	3.7	3.7	6.3
400 Apparel, footwear, & household goods	6.2	3.7	4.9	4.6	6.4
401 Other consumer nondurables	4.7	5.1	3.7	4.6	10.5
410 Household goods	5.7	4.8	4.3	5.1	8.5
411 Recreational equip. & materials	2.1	3.7	4.3	4.7	6.6
412 Home entertainment equip.	2.9	6.0	5.7	5.6	6.7
413 Coins, gems, jewelry, & collectibles	1.2	8.8	4.0	4.5	7.3

Selecti

Empirical regressions

- We use monthly three-digit Enduse price indexes for the finished goods categories (automotive products, consumer goods, and capital goods excluding computers and semi-conductors).
- For each category, we use a category-specific trade-weighted exchange rate and foreign producer price inflation.
- For 1994:M1 to 2010:M3, we estimate

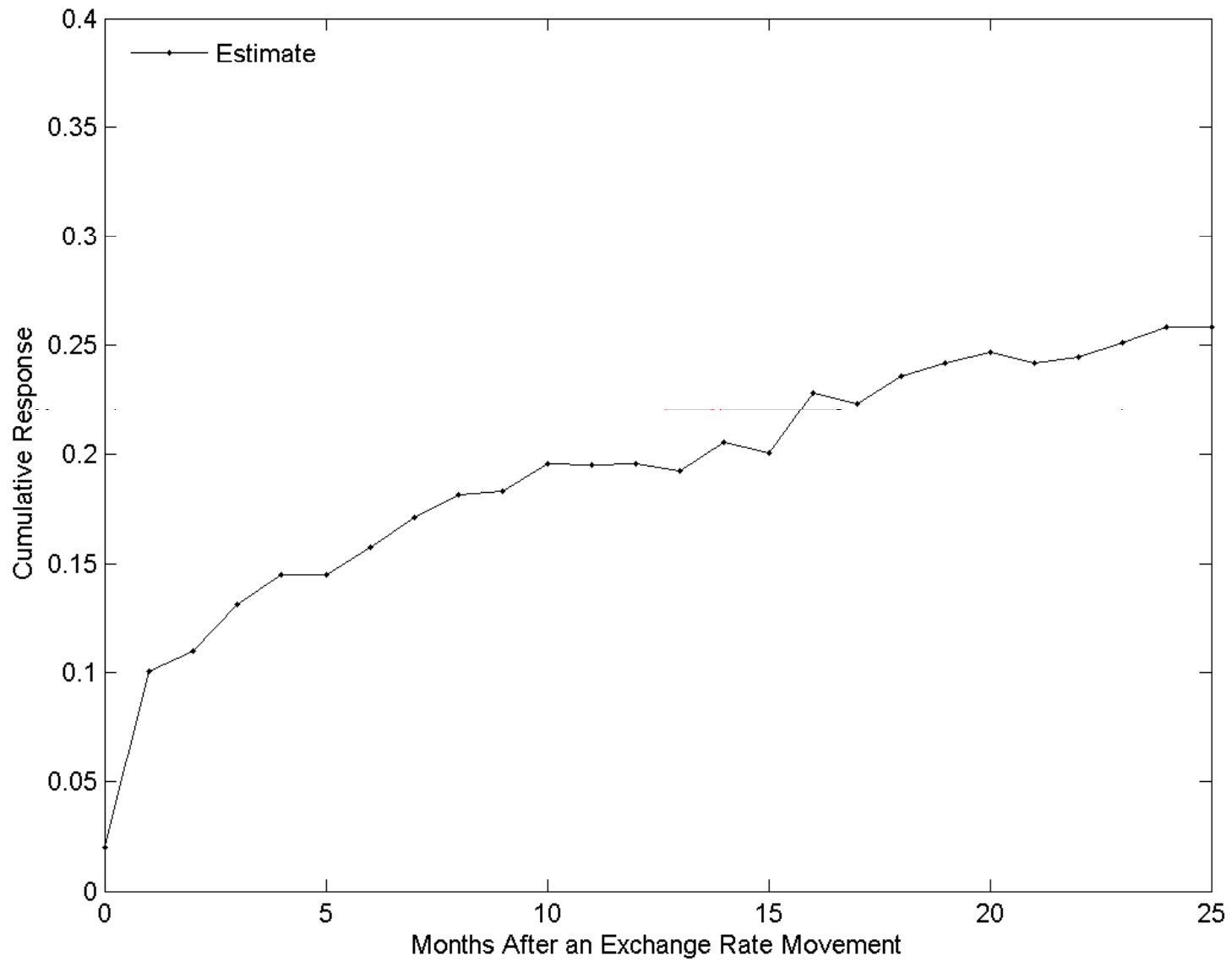
$$\pi_{i,t} = \alpha + \sum_{l=0}^{24} b_{i,l} \Delta NEER_{i,t-l} + \sum_{l=0}^{24} c_{i,l} \pi_{i,t-l}^* + \varepsilon_{i,t}$$

Empirical regressions

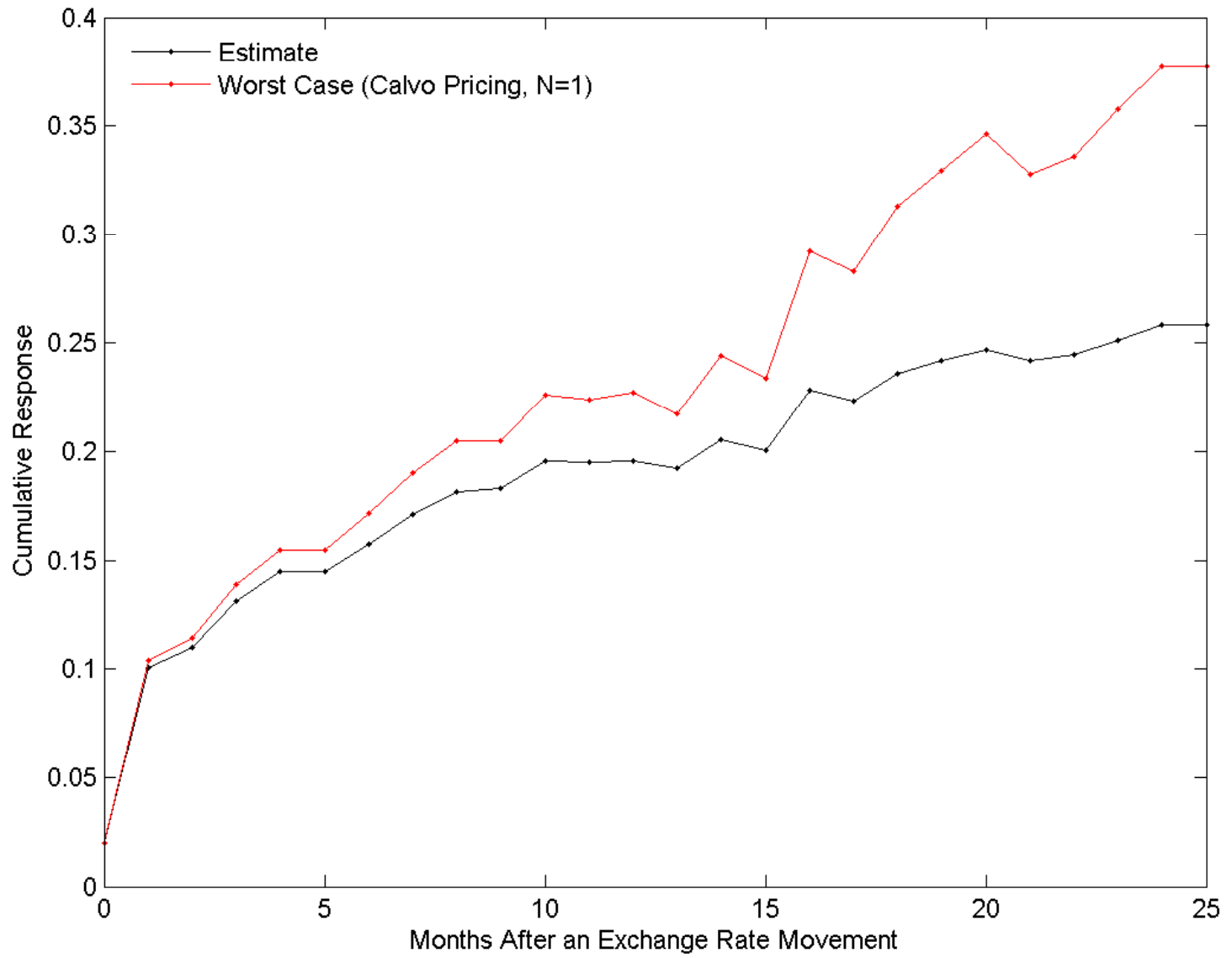
- Aggregate up the individual coefficients using 2008 trade weights,

$$b_l = \sum_i w_i b_{i,l} (1 - s_i n)^l.$$

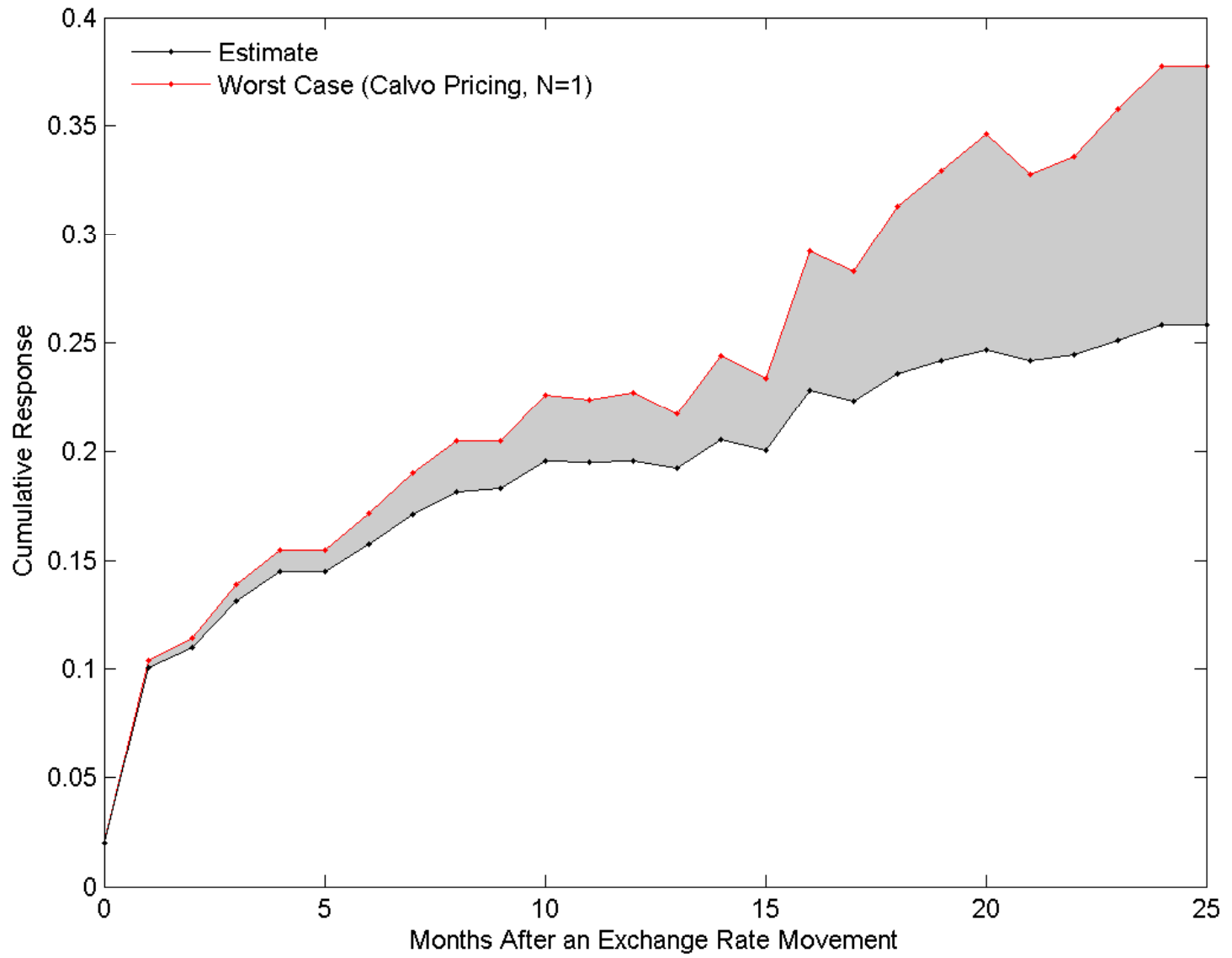
- When $n=0$, this is the standard weighted estimates.
- When $n=1$, this is full correction required for data generated by the Calvo model if the price of all entering items has been reset.



Selective entry



Selective entry



Selective entry

Some observations

- For the product replacement bias to be important empirically
 - pass-through must be slow;
 - the horizon of interest must be the medium to long term;
 - prices of a non-negligible proportion of items entering the basket must have responded much more to recent exchange rate movements than items already in the basket.
- Even with no items exiting the basket (hence no “replacement”), any entry of items could result in a product replacement bias if the prices of these added items are *systematically* less responsive than other prices to past movements in the exchange rate.
- We are presently implementing our fix using micro BLS data (stay tuned for the results!).

Bias 2: Selective Exit

- Pass-through estimates may be biased downward if price changes are censored through exit from the basket.
- No bias arises from random exits. However, exit associated with re-pricing can arise to a selection bias.
- To model such selection bias, we assume that, conditional on the decision to change an item's price, a firm faces an exogenous probability e of adjusting the item's characteristics instead of the nominal price.
- Price collectors do not link the price of new and old models. Instead, they look for a substitute. With probability n , this substitute is the new model, and thus has $u_{it} = 0$. With probability $1-n$, the substitute is drawn randomly from the population.

- In Calvo model with uncorrelated exchange rate shocks, the initial response is biased downward,

$$b_0 = \frac{(1 - e)}{1 - ef} f\beta.$$

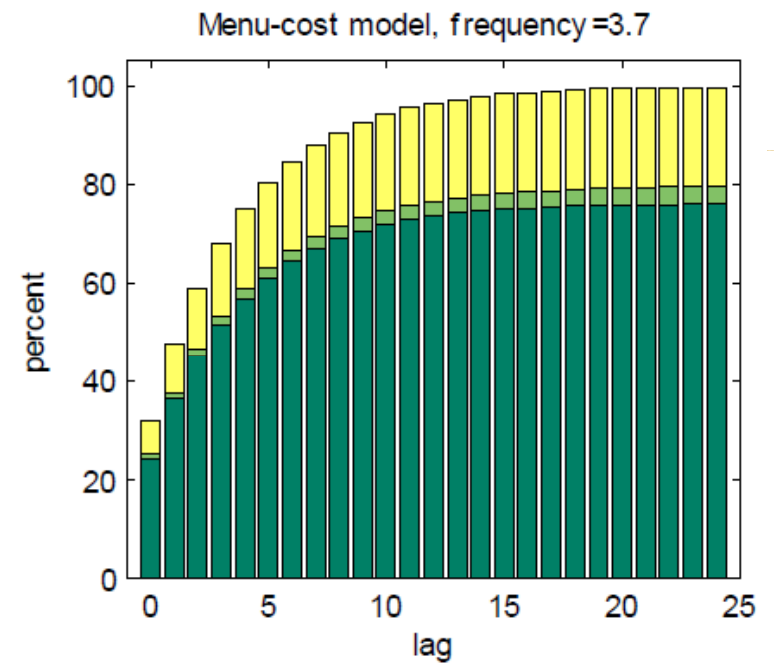
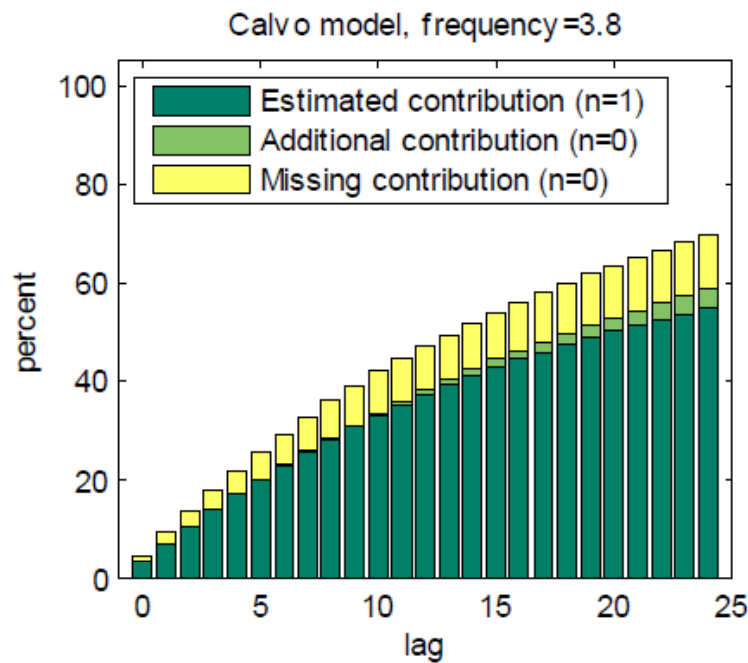
- The bias on subsequent lags,

$$b_l = \left(\frac{1 - e}{1 - fe} \right) (1 + l(1 - n) fe) (1 - f)^l f\beta,$$

depends on strongest of two opposing forces: the censoring of price changes (lower exchange rate sensitivity) and their replacement by items that may not have experienced a price change (higher exchange rate sensitivity).

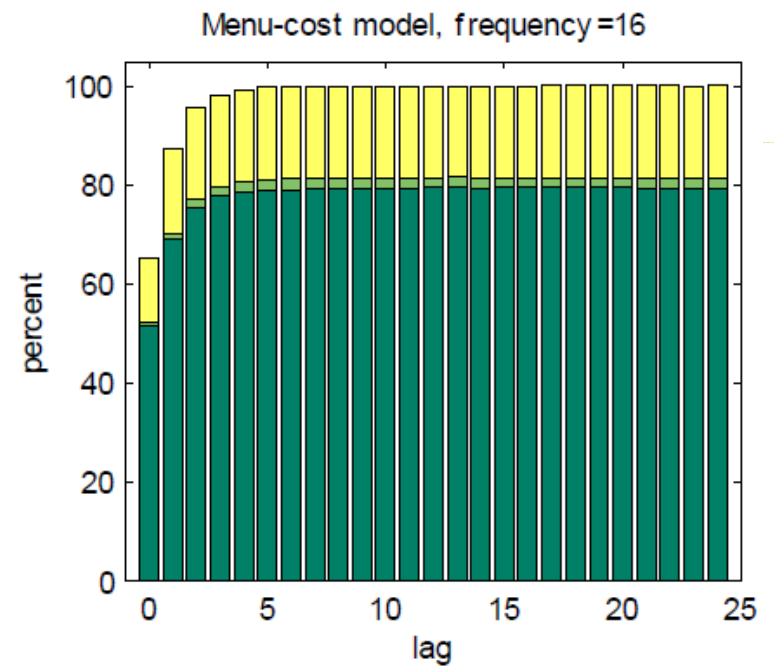
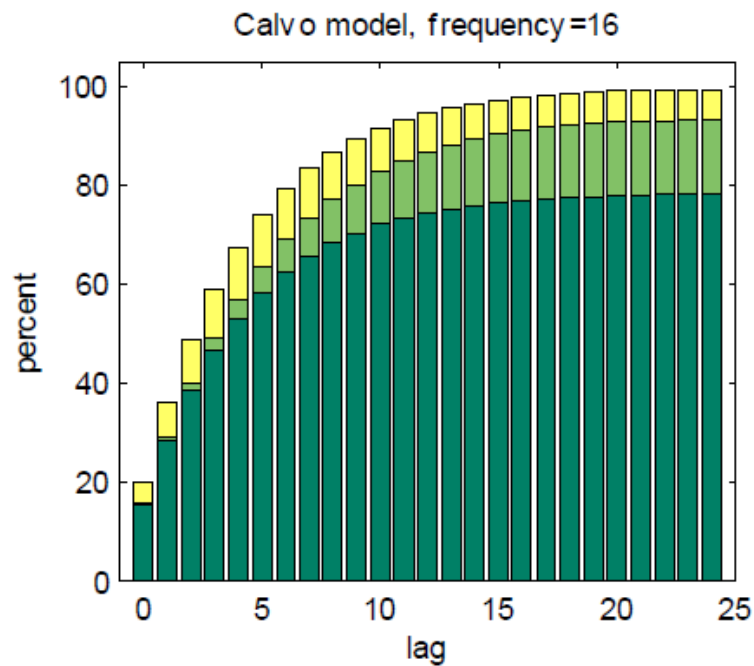
Impact of selective exit with low frequency of updating prices.

Cumulative contribution of coefficients on lagged exchange rate variables
($e = 0.25$)



Impact of selective exit, with medium frequency of updating prices.

Cumulative contribution of coefficients on lagged exchange rate variables in
($e = 0.25$)



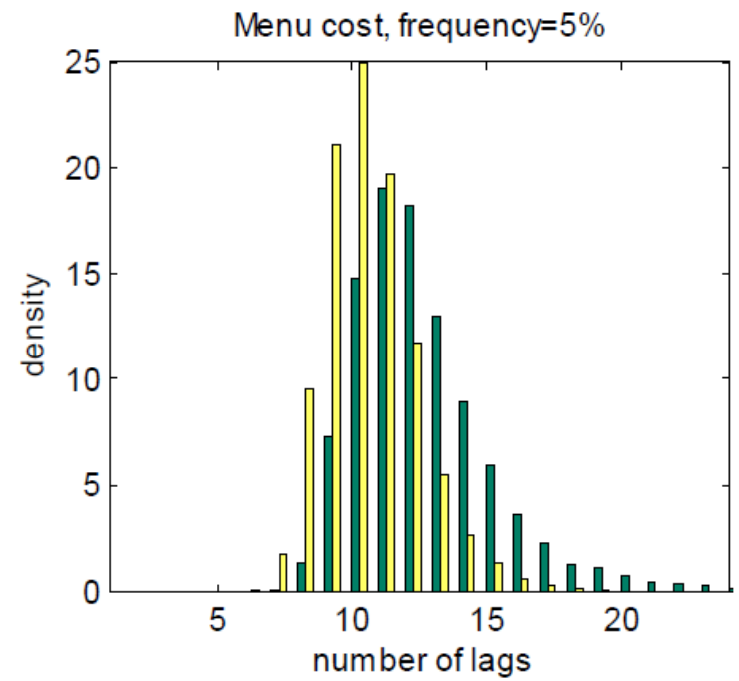
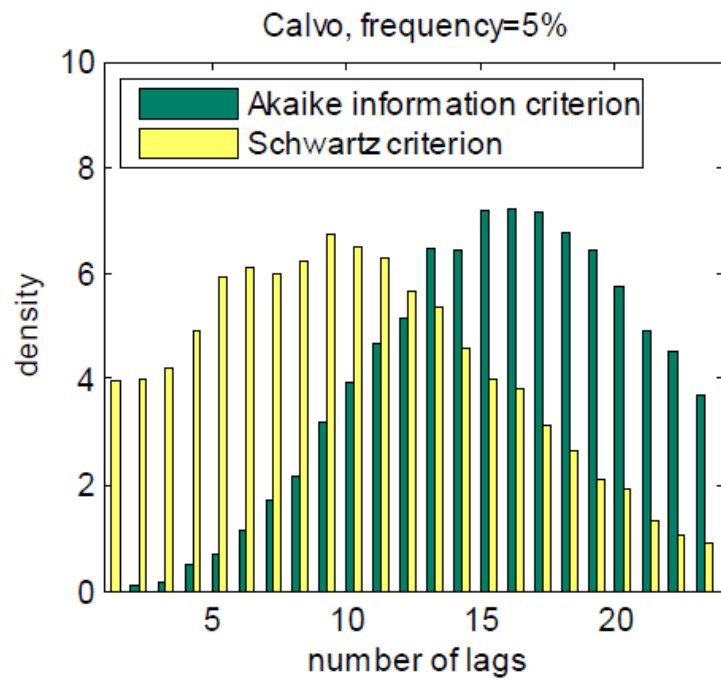
Some observations

- Correcting for selective exit appears more challenging than for selective entry (hastening exits won't work).
- Medium-term pass-through regressions (Gopinath, Itskhoki, and Rigobon, 2010) are immune to this bias, but they do not speak to the dynamic response.
- Perhaps the most promising way forward is to gain a better understanding of what triggers exits from the basket and of how entering items are chosen.

Bias 3: Lag length selection

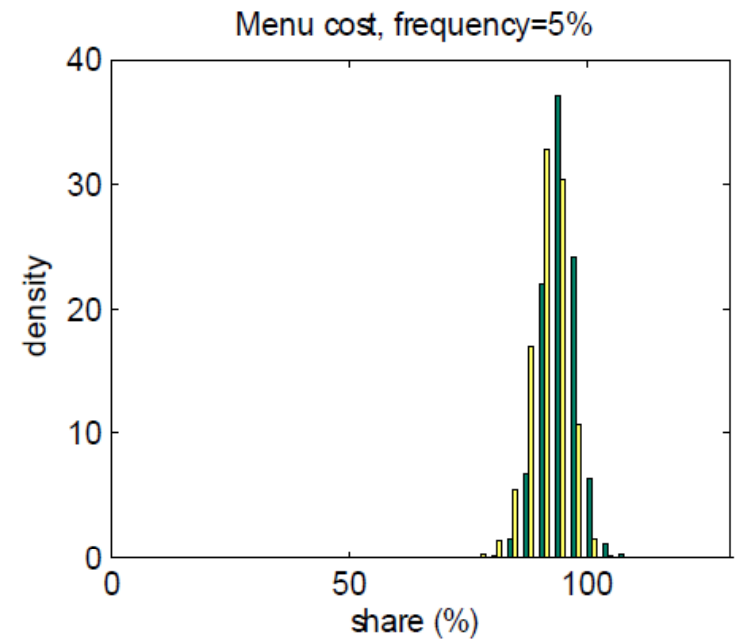
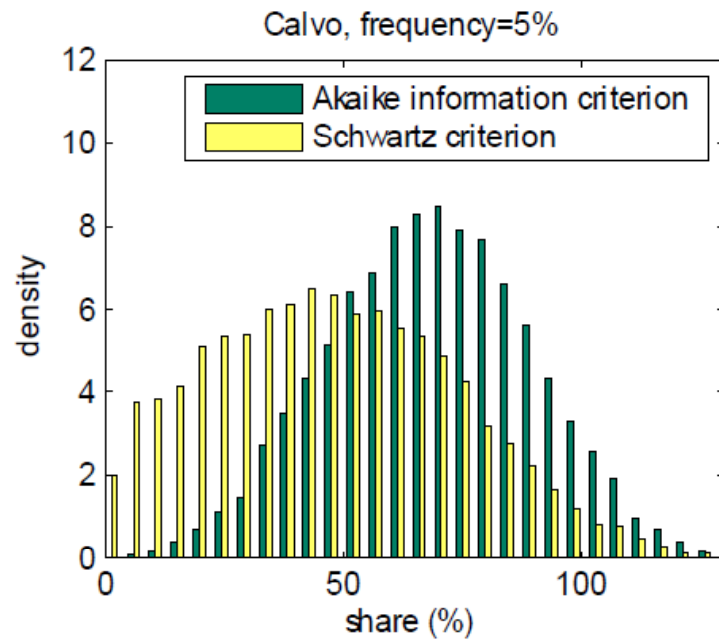
- When pass-through is slow, standard lag length selection criteria have a tendency to recommend a small number of lags, which may not be appropriate when the object of interest is the response over the policy-relevant horizon.
- The issues arises from a mismatch of objectives
 - lag length selection criteria generally are designed to limit forecast errors of the immediate reaction.
 - econometrician may be interested in measuring pass-trough at the end of the forecast horizon or shape of the entire impulse response function.

Distribution of lag length recommendations in Monte-Carlo simulations



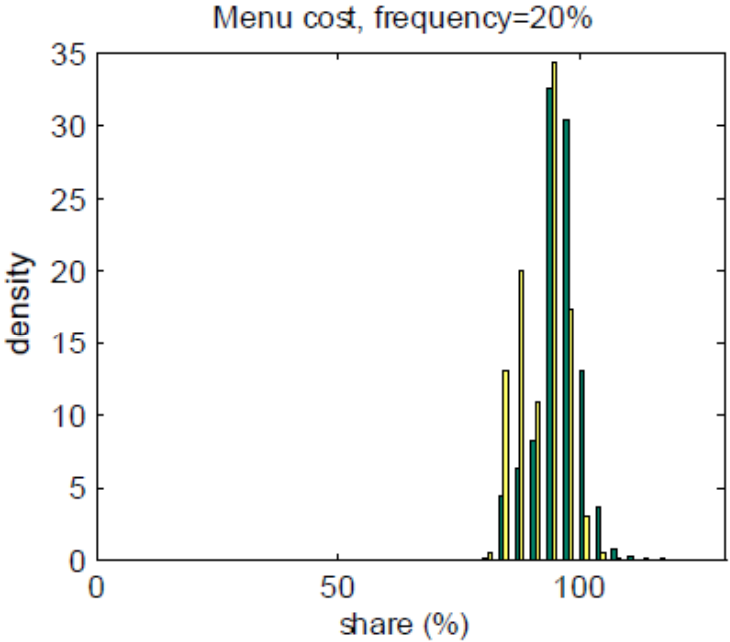
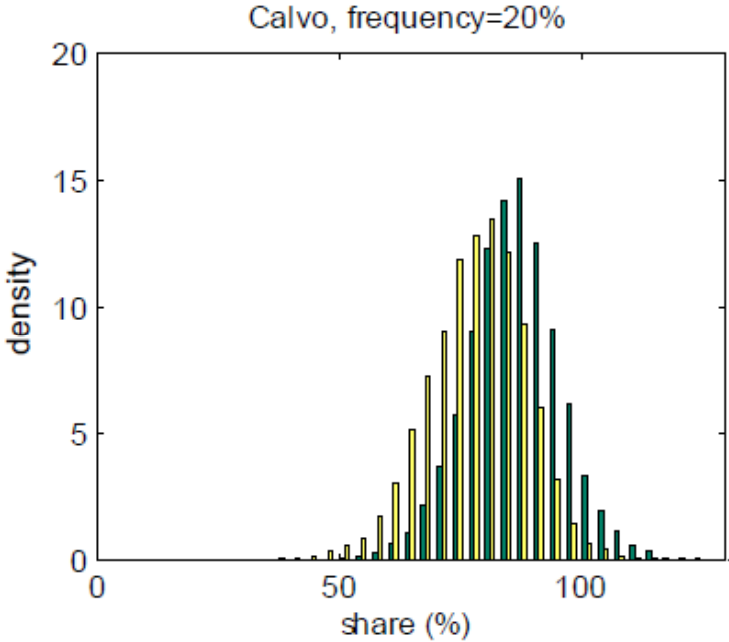
Lag length selection

Distribution of cumulative pass-through after 24 months in Monte-Carlo simulations when using the recommended lag length



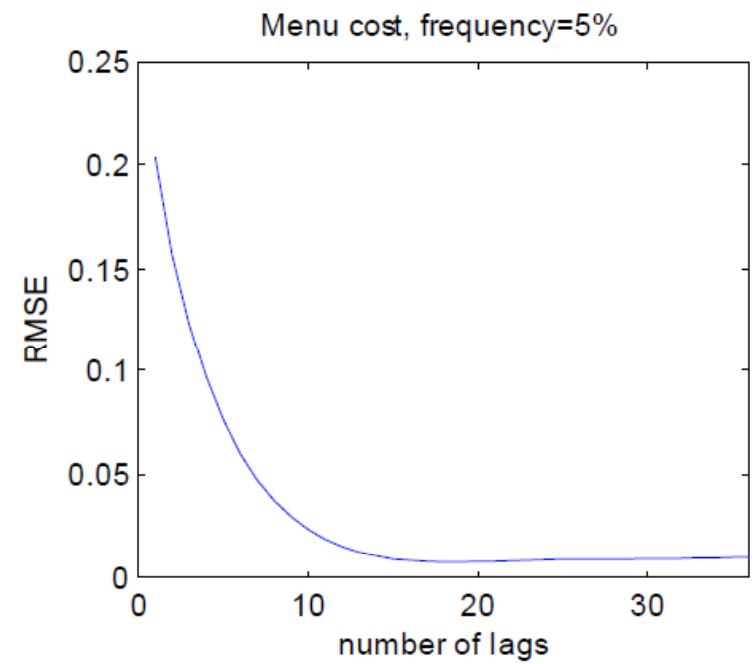
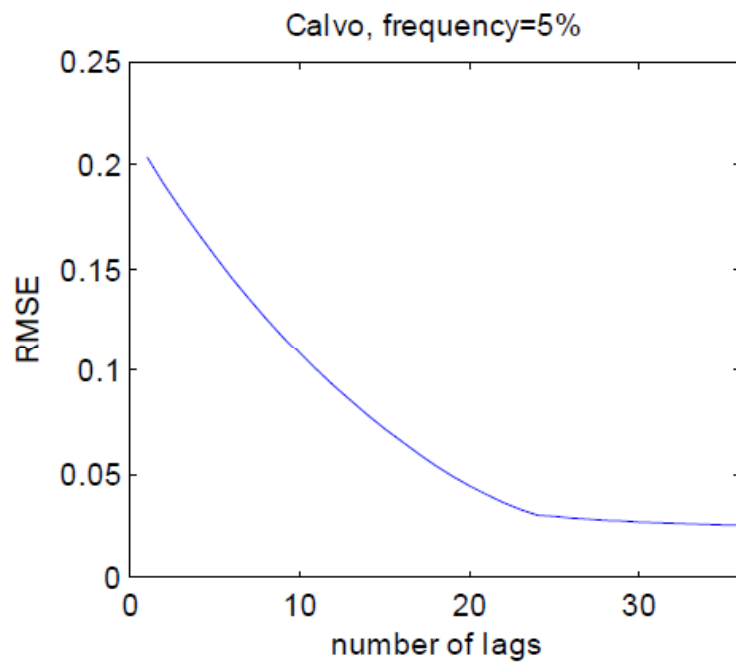
Lag length selection

Distribution of cumulative pass-through after 24 months in Monte-Carlo simulations when using the recommended lag length



Lag length selection

Root mean square error (RSME) of predicted pass-through after 24 months in Monte-Carlo simulations



Lag length selection



Some observations

- The simulations suggest that the risk of overfitting the regression by adding a few extra lags beyond the recommendation of standard lag-length selection criteria is minimal, while the gains are potentially large.
-
- Parsimony may still be desirable when breaks are present, as suggested by recent empirical estimates for the United States.



Concluding remarks

- Selection biases in the entry and exit of items in the import price index can bias the dynamic response to a shock over the policy-relevant horizon.
- The product replacement bias (selective entry) is sensitive to the speed at which shocks are transmitted to prices. It matters mostly at medium to long-term horizons. It can be partly corrected through the construction of alternative price indexes.
- The selective exit bias can matter whether pass-through is slow or not, affects the response at all horizons, and is more difficult to control for.
- Future research should aim at better identifying the causes of item exits as well as the characteristics of added items.



Additional slides

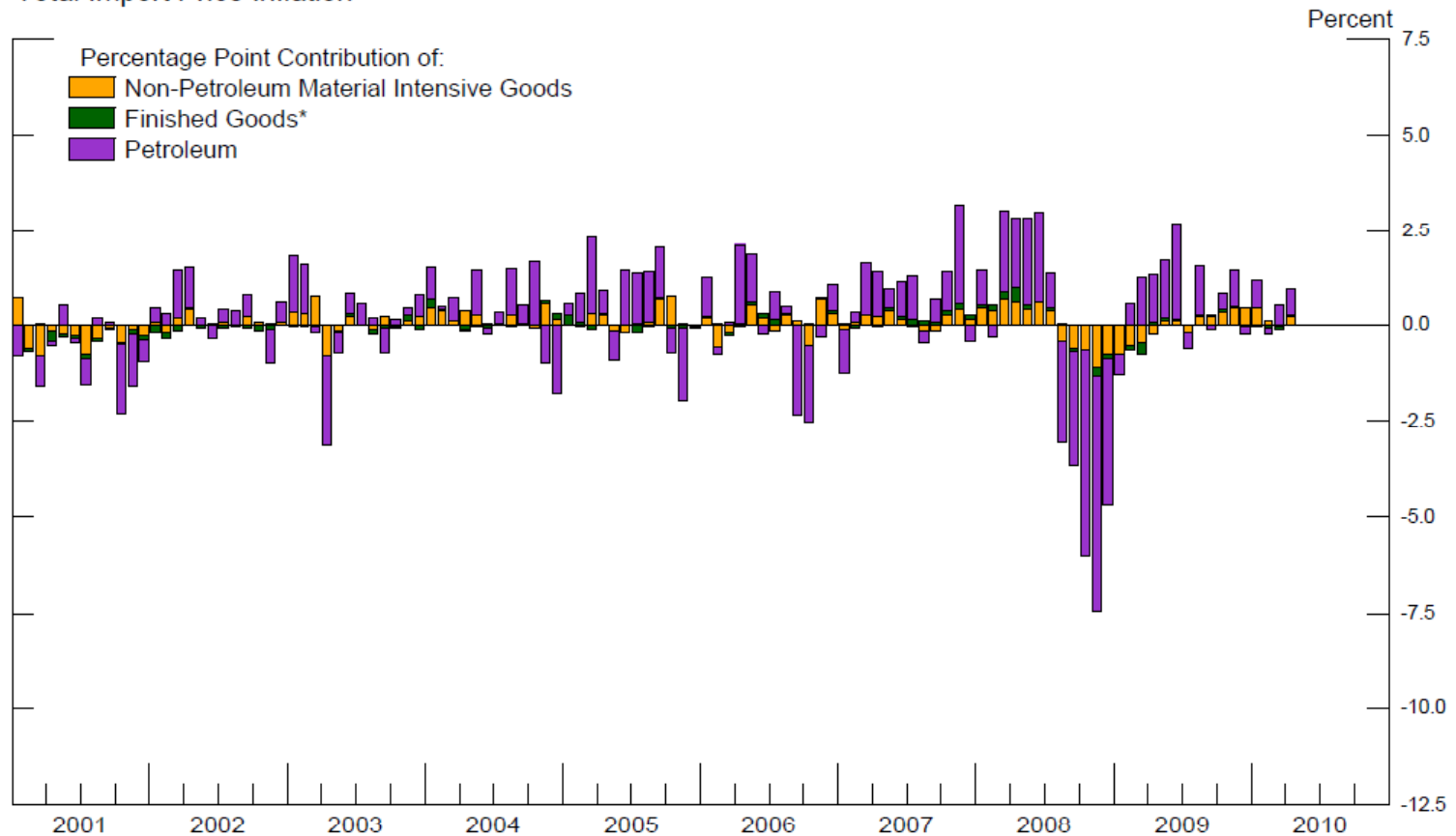
Inflation objectives and policy horizons

Economy	Target rate (%)	Target horizon	Forecast horizon
Australia	2-3	average over business cycle	2 years
Canada	1-3	6 to 8 quarters	2 to 3 years
Euro area	just below 2	medium term	current year and next
Japan	0-2 ^a	medium to long term	current fiscal year and next
New Zealand	1-3	medium term	3 years
Norway	2.5	1 to 3 years ahead	3 to 4 years
Sweden	1-3	2-year ahead	3 to 4 years
Switzerland	less than 2	medium term	3 years
United Kingdom	2	informal 2-year	3 years
United States ^b	no target	n.a.	2 to 3 years

Notes: (a) 0-2% is consistent with the distribution of Board members' understanding of medium to long-term price stability. (b) Based on the forecasts released periodically by FOMC members. The staff's forecasts ("Greenbook") most recently made publicly available have horizons ranging from about 1 and half to 2 and half years.

Contribution to Monthly Import Price Inflation

Total Import Price Inflation



*Material-intensive categories are foods and non-petroleum industrial supplies; finished goods categories are automotive products, machinery, and consumer goods.



Item additions to BLS indexes (1/2)

Based on *BLS Handbook of Methods* and personal conversations with BLS staff, we conclude that not all item additions contribute to the product replacement bias:

- *Basket updates/enlargements initiated by the BLS.* The added items typically are selected based on their volume of transactions, and as such are mature products that are no more likely to have an updated price than other goods. (Little if any bias.)
- *Out-of-business/refusal to report.* The BLS resamples from the universe of firms or reweights existing items. (Little if any bias.)

Item additions to BLS indexes (2/2)

- *Changes in specifications/discontinued items.* The BLS has several options:
 - Does not replace the item. The BLS reweights existing items in the basket (no product replacement bias).
 - Replaces the item by resampling from the universe of firms (little if any product replacement bias).
 - Replaces the item with a similar one.
 - BLS links prices. Analysts makes quality-adjustment and reports a price change (no product replacement bias).
 - BLS does not link prices. Only subsequent price changes affect the index (risk of product replacement bias).

Standard Quarterly Regression

	Variable	Estimate
• Price Index for Finished Goods (automotive products, consumer goods, and capital goods excluding computers and semi-conductors.)	Exchange rate	
	Current	- 0.11
	Lag 1	- 0.08
	Lag 2	0.00
	Lag 3	0.00
• First Differences Specification	<i>Total Response</i>	0.19
• Broad Dollar	Foreign Inflation	
• Period: 1990:Q1 to 2010:Q2	<i>Total Response</i>	0.46