How Well Does "Core" CPI Capture Permanent Price Changes?

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Motivation

- Interest in and use of a “core” measure of prices or inflation as a monetary policy variable has been growing.
  - For example, the Bank of Canada uses a measure of core inflation as its operational guide.
  - The Federal Reserve pays “particular attention” to core inflation (Mishkin, 2007).
- One argument for a core measure is that it eliminates transitory price movements that do not contribute to a sustained increase in the general price level.
- The most widely used core measure, a price index that excludes food and energy prices, is thought to better measure permanent price level movements as opposed to temporary swings in food and energy prices.
- To the extent that temporary price level movements will be reversed, central bank responses to the temporary movements should be different from the response to permanent movements.

Critical Assumptions

- In this paper we explore two critical assumptions generally made about the exclusion approach core price index:
  - **Does core reflect primarily permanent or persistent price level movements?**
  - **Do food and energy price indices reflect primarily transitory price movements?**
- These are critical assumptions that underlie both the use of core measures and the prescribed policy responses to movements in such measures.
  - If some movements in excluded items are permanent then their exclusion is not warranted.
  - Similarly, if the measure of core includes temporary as well as permanent price movement, then the use of core as a measure of “long-run” price movement might also need to be re-evaluated.
  - Finally, if these assumptions about transitory and permanent price movements do not hold, the monetary policy response to these components should be reconsidered.

What We Do In This Paper

- In this paper we investigate the empirical evidence favoring these assumptions by estimating an unobserved components model for the Consumer Price Index (CPI).
- An unobserved components model is a natural framework for such an investigation because it simultaneously decomposes price level movements into their permanent and transitory parts.
- We specifically use Morley, Nelson, and Zivot's (2003) correlated unobserved components model because this model provides the most general decomposition with the fewest *a priori* assumptions about the relative role of the permanent versus transitory components.
- We use Sinclair's (2009) multivariate extension of the correlated unobserved components model to jointly decompose core CPI, food CPI, and energy CPI into their respective permanent and transitory components.
  - One benefit of this approach is we can create generalized impulse response functions to **permanent** shocks to the various series and see how they impact both headline and core measures.

The Relationship between Volatility and Persistence

- There is often an implicit assumption in macroeconomic analysis that a volatile series is not a persistent series, and vice versa.
- One of the key aspects of the correlated unobserved components model, however, is that the permanent component may be more variable than the series itself because we may see offsetting transitory movements.
- The model does not force the permanent component to be more variable than the series, but it is a possibility.

The Model

- An intuitive way to think about any time series which experiences both permanent and temporary movements is within the unobserved components (UC) framework (Harvey 1985):

$$p_{it} = \underbrace{\tau_{it}}_{\text{permanent component}} + \underbrace{c_{it}}_{\text{transitory component}}$$

$$\tau_{it} = \mu_i + \tau_{it-1} + \eta_{it}$$

$$c_{it} = \phi_{i1} c_{it-1} + \phi_{i2} c_{it-2} + \varepsilon_{it}$$

The Variance-Covariance Matrix

- The model not only permits estimation of the permanent and transitory components of each variable but also permits correlation between the shocks to all the components, following Sinclair's (2009) multivariate extension of Morley, Nelson, and Zivot (2003).

$$\begin{bmatrix} \eta_{1t} \\ \eta_{2t} \\ \eta_{3t} \\ \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix} \sim N(0, \Sigma_1), \quad \Sigma_1 = \begin{bmatrix} \sigma^2_{\eta 1} & \sigma_{\eta 1 \eta 2} & \sigma_{\eta 1 \eta 3} & \sigma_{\eta 1 \varepsilon 1} & \sigma_{\eta 1 \varepsilon 2} & \sigma_{\eta 1 \varepsilon 3} \\ \sigma_{\eta 1 \eta 2} & \sigma^2_{\eta 2} & \sigma_{\eta 2 \eta 3} & \sigma_{\eta 2 \varepsilon 1} & \sigma_{\eta 2 \varepsilon 2} & \sigma_{\eta 2 \varepsilon 3} \\ \sigma_{\eta 1 \eta 3} & \sigma_{\eta 2 \eta 3} & \sigma^2_{\eta 3} & \sigma_{\eta 3 \varepsilon 1} & \sigma_{\eta 3 \varepsilon 2} & \sigma_{\eta 3 \varepsilon 3} \\ \sigma_{\eta 1 \varepsilon 1} & \sigma_{\eta 2 \varepsilon 1} & \sigma_{\eta 3 \varepsilon 1} & \sigma^2_{\varepsilon 1} & \sigma_{\varepsilon 1 \varepsilon 2} & \sigma_{\varepsilon 1 \varepsilon 3} \\ \sigma_{\eta 1 \varepsilon 2} & \sigma_{\eta 2 \varepsilon 2} & \sigma_{\eta 3 \varepsilon 2} & \sigma_{\varepsilon 1 \varepsilon 2} & \sigma^2_{\varepsilon 2} & \sigma_{\varepsilon 2 \varepsilon 3} \\ \sigma_{\eta 1 \varepsilon 3} & \sigma_{\eta 2 \varepsilon 3} & \sigma_{\eta 3 \varepsilon 3} & \sigma_{\varepsilon 1 \varepsilon 3} & \sigma_{\varepsilon 2 \varepsilon 3} & \sigma^2_{\varepsilon 3} \end{bmatrix}$$

The Data

- Monthly US CPI data (consumer price index for all urban consumers), seasonally adjusted:
  - All Items Less Food and Energy (or Core) CPI,
  - Food CPI,
  - Energy CPI.
  - We specifically chose to work with the “regular” CPI (as compared to a chained index) because we want to be able to easily aggregate the three series back to a measure of headline CPI.
- January of 1983 through December of 2007 (August 29, 2008 vintage)
  - Our data begin in 1983 to avoid the definitional change regarding shelter in the CPI.
  - The 1983 start date also allows us to avoid issues of different monetary policy regimes.

Stationarity and Structural Breaks

- Based on the KPSS stationarity test we reject trend stationarity for all three (log) price level series for our sample. However, for the first differences (i.e. inflation) we cannot reject trend stationarity for any of the three series at the 5% level.
  - Therefore we model the (natural log of the) price level in the unobserved components model.
- We found three structural breaks in the drift terms.
  - June of 1991 (based on univariate results for Food CPI)
  - April 1993 (based on univariate results for Core CPI)
  - February 2002 (based on univariate results for Energy CPI)
  - Our model allows all three series to break at each of these dates.

Key Findings

- Core CPI series is not characterized exclusively by all permanent movements.
- The food and energy series are not all temporary movements.
- Furthermore, the temporary movements in Core CPI are mostly offsetting permanent movements, therefore the permanent component of Core CPI is more variable than the Core series.

Table 1a

Series	Estimated Parameters (Standard Errors in Parentheses)							
	σ_η	σ_ε	μ_1	μ_2	μ_3	μ_4	ϕ_1	ϕ_2
Core	0.155 (0.008)	0.198 (0.009)	0.366 (0.012)	0.281 (0.018)	0.215 (0.010)	0.178 (0.010)	0.922 (0.020)	0.015 (0.019)
Food	0.178 (0.009)	0.128 (0.013)	0.359 (0.022)	0.067 (0.045)	0.234 (0.016)	0.210 (0.022)	1.197 (0.034)	-0.244 (0.033)
Energy	2.485 (0.091)	0.992 (0.056)	-0.089 (0.056)	-0.028 (0.058)	0.297 (0.062)	0.862 (0.067)	-0.370 (0.051)	-0.353 (0.024)

Table 1b

Shock	Perm Core	Perm Food	Perm Energy	Trans Core	Trans Food	Trans Energy
Perm Core	1					
Perm Food	0.561 (0.068)	1				
Perm Energy	0.759 (0.014)	-0.112 (0.083)	1			
Trans Core	-0.913 (0.012)	-0.618 (0.061)	-0.629 (0.021)	1		
Trans Food	0.455 (0.097)	0.249 (0.047)	0.305 (0.078)	-0.069 (0.103)	1	
Trans Energy	-0.674 (0.033)	0.112 (0.090)	-0.901 (0.018)	0.568 (0.034)	-0.249 (0.075)	1

Ratio of the Variance of the Permanent Shocks to the Variance of the Transitory Shocks

- The relative size of the variance of the permanent shocks is smallest for the core series. This stands in contradiction to the assumption that the core series contains permanent price movements while the two excluded series contain mostly temporary price movements.

Core	0.613
Food	1.934
Energy	6.275

Figure 1a: Core CPI and Components

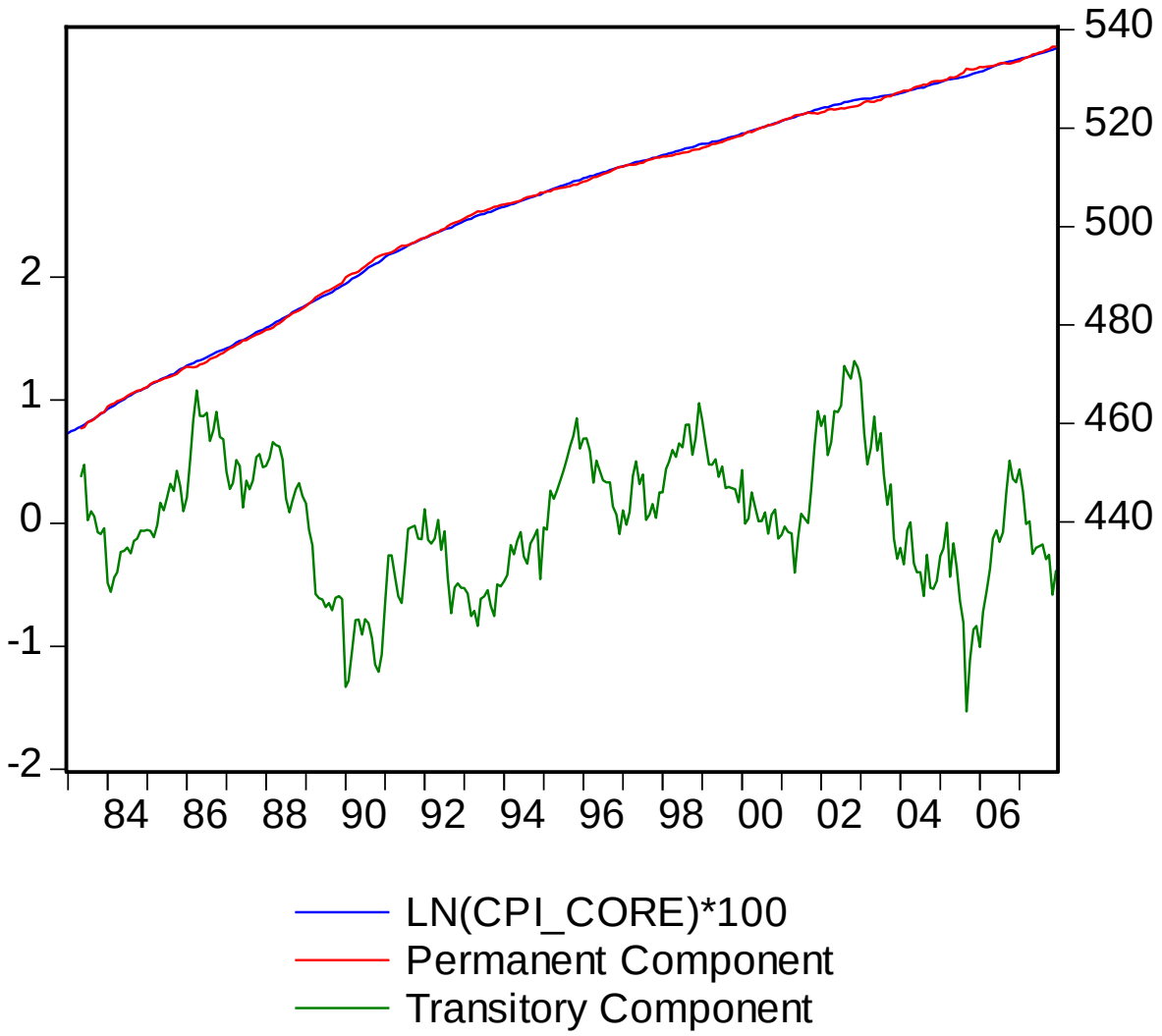


Figure 1b: Food CPI and Components

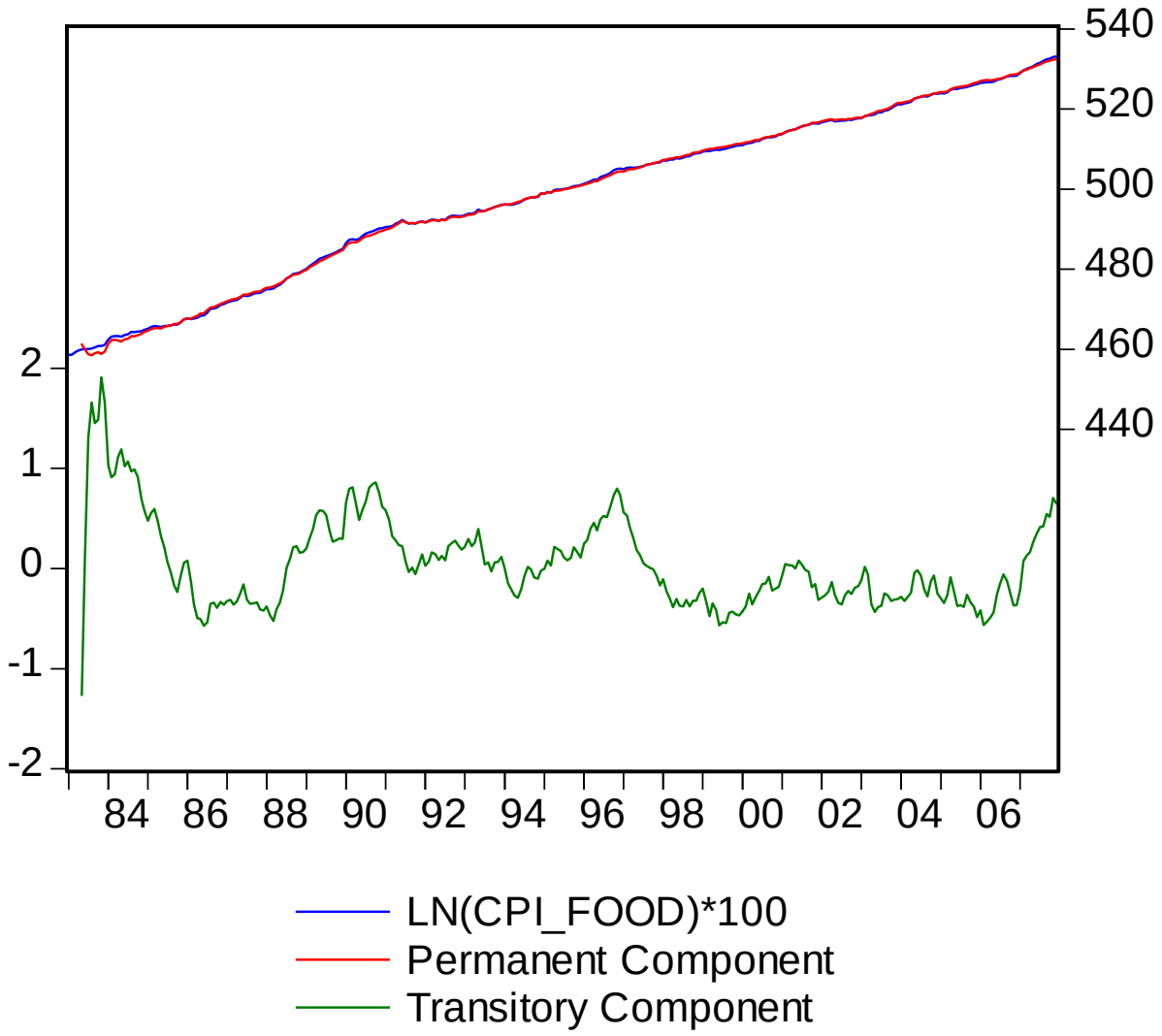
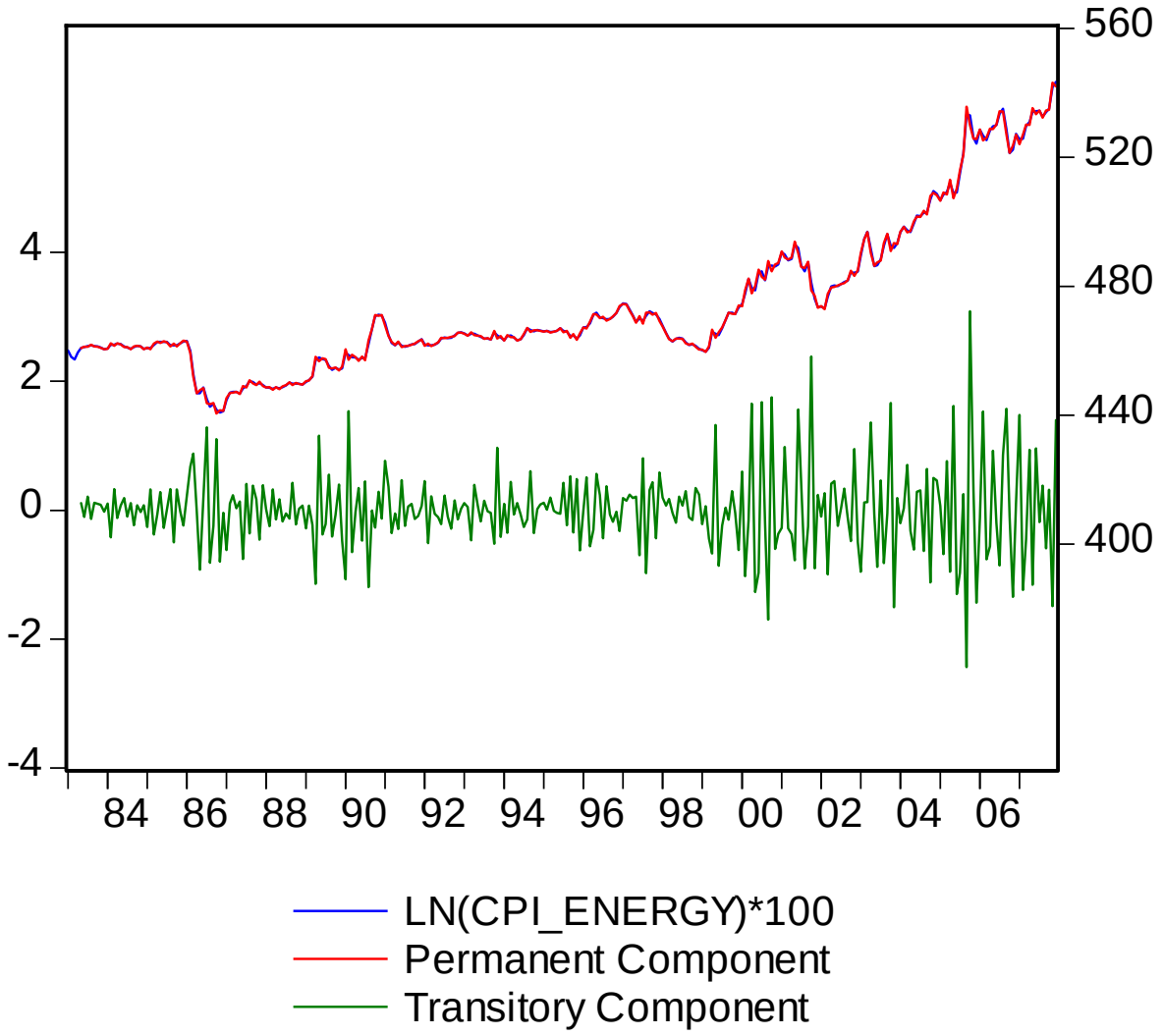


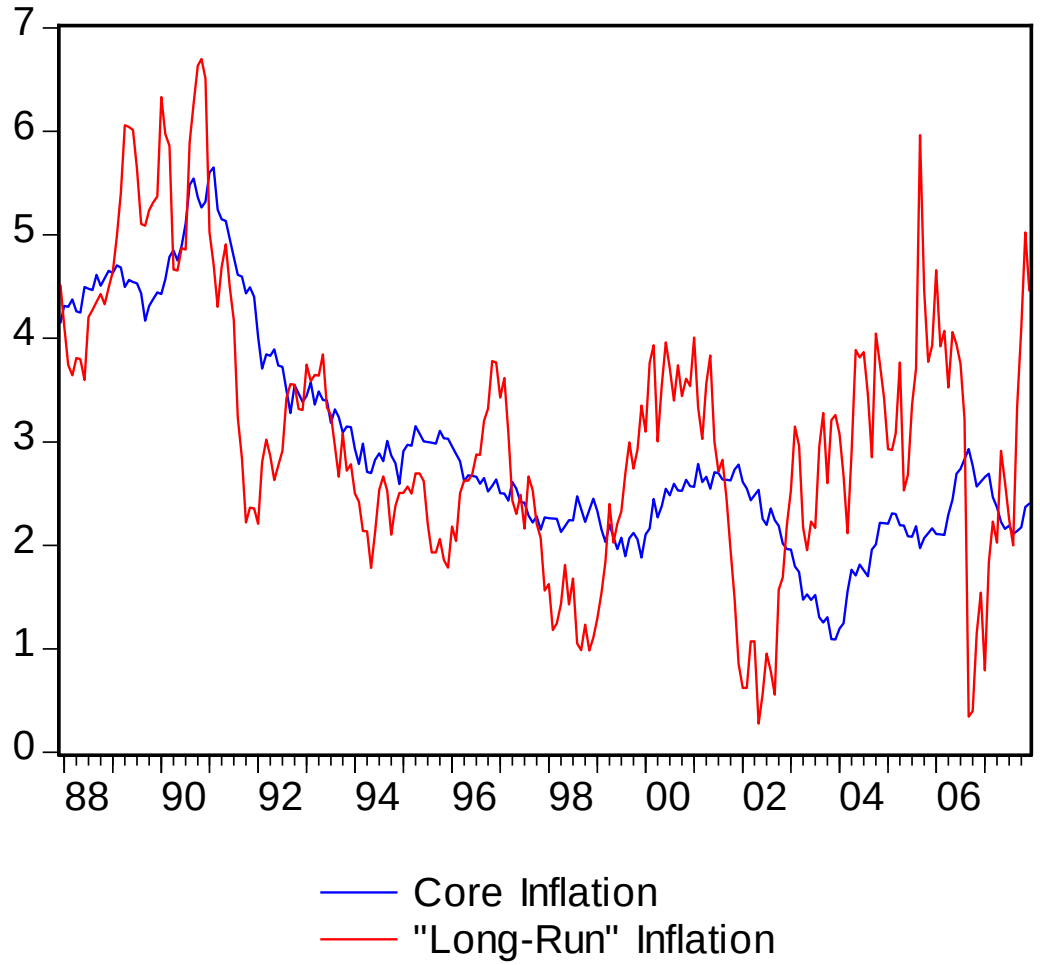
Figure 1c: Energy CPI and Components



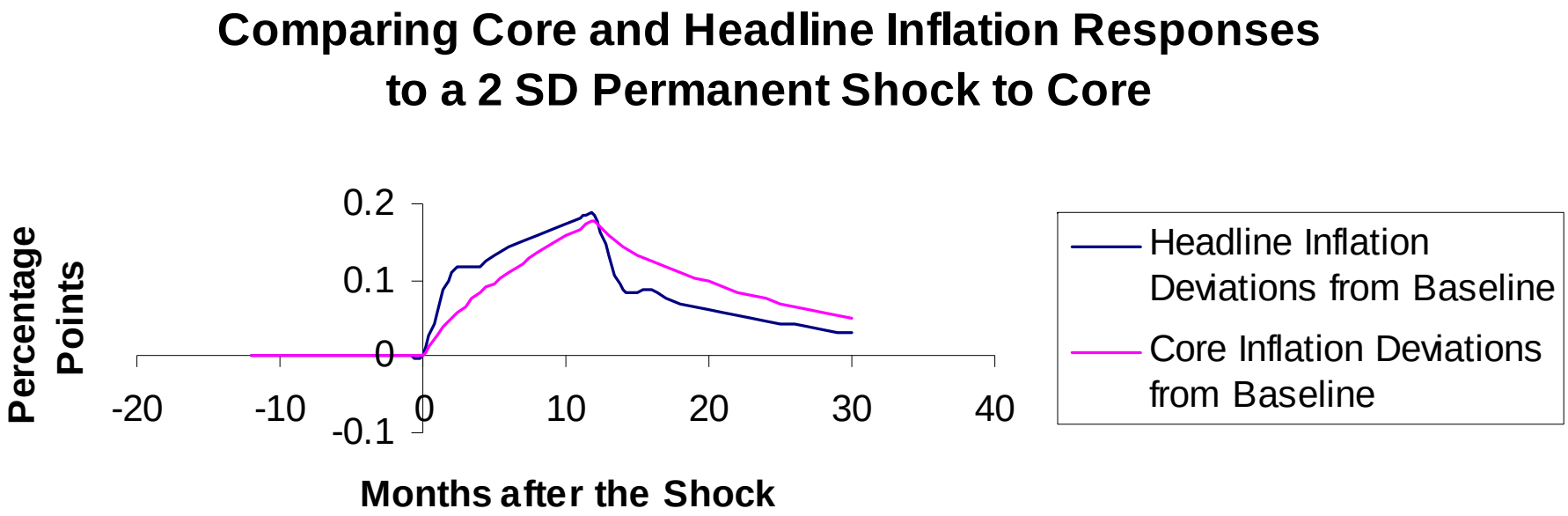
Long-Run CPI

- We construct long-run CPI as the appropriately weighted sum of the three permanent components.
- Theoretically, the core measure is supposed to strip out volatile, temporary movements in prices that do not contribute to long run inflation.
- However, we find that there are important permanent movements in the price level that the core index does not capture.
- We calculate inflation rates as the year-over-year changes in the respective price levels.
- It is true that the core inflation rate is significantly smoother than headline, but this reflects the fact that the core also includes offsetting short run price movements.
  - It is actually smoother because of more temporary movements, not fewer.

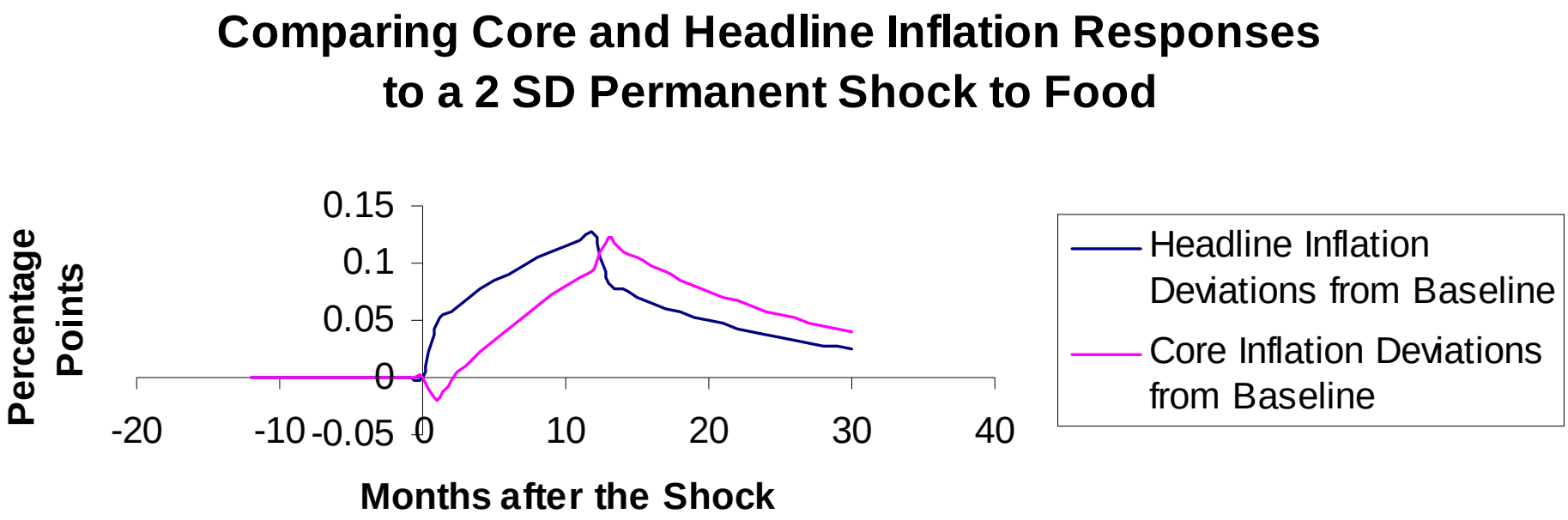
Figure 5: Core CPI Inflation and Long Run Inflation



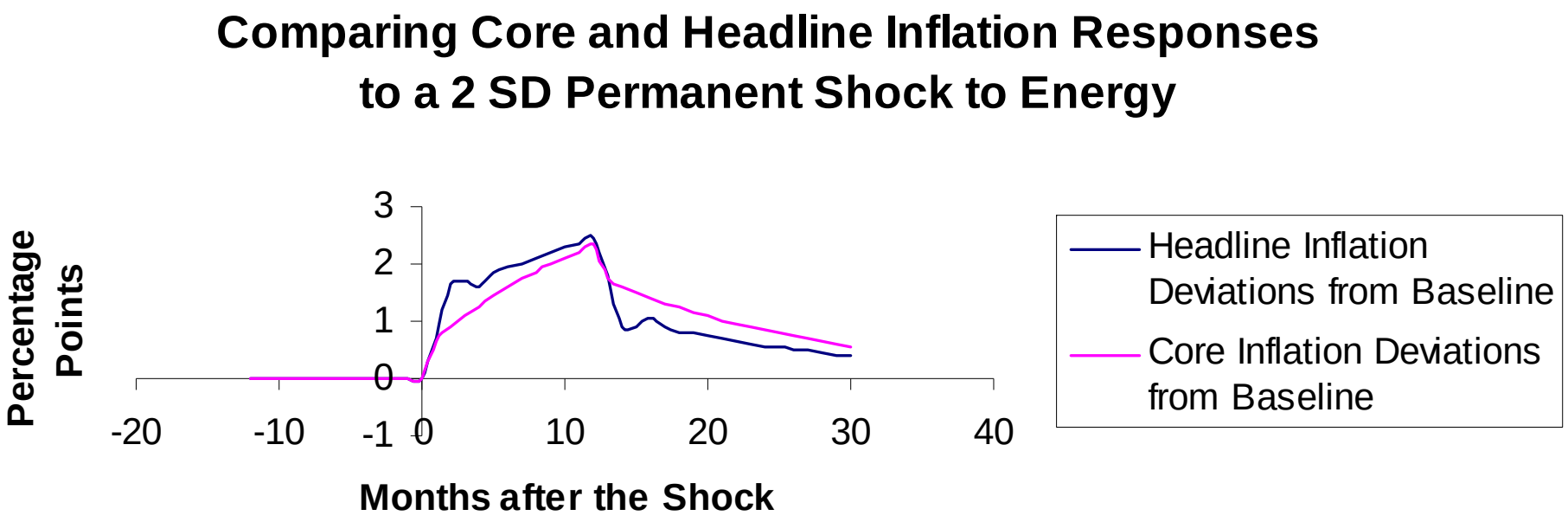
Impulse Responses: Core Shock



Impulse Responses: Food Shock



Impulse Responses: Energy Shock



Conclusions

- In this paper we explore two critical assumptions generally made about the exclusion approach core price index:
  - Does core reflect primarily permanent or persistent price level movements?
    - Our answer is no – there are significant temporary movements in core.
  - Do food and energy price indices reflect primarily transitory price movements?
    - Our answer again is no – there are significant permanent movements in these two series that policymakers may not want to ignore.