Energy Prices and Inflation in Tanzania

The role of pass-through effects on the CPI

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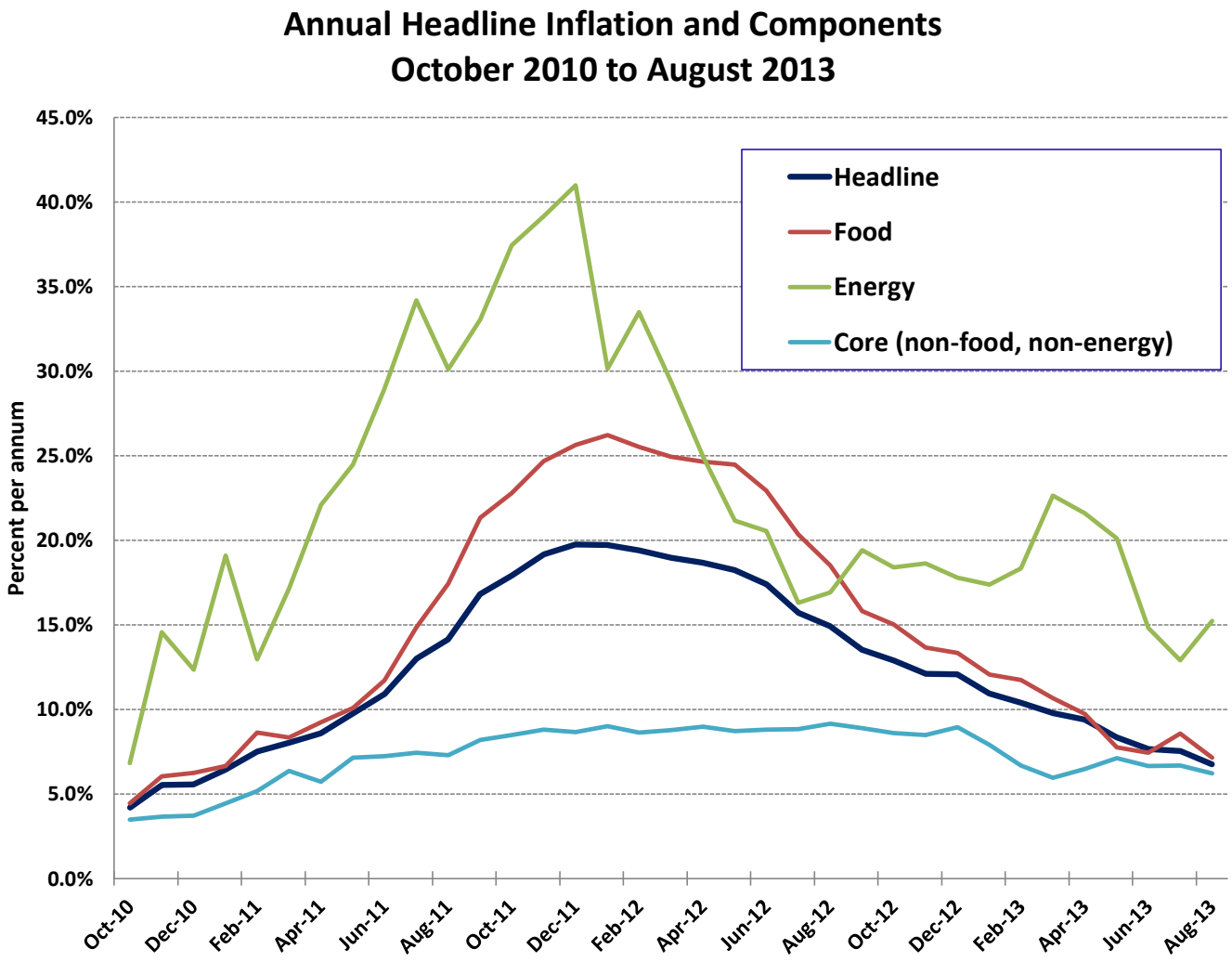
Bank of Tanzania Research Seminar
October 24, 2013

Outline

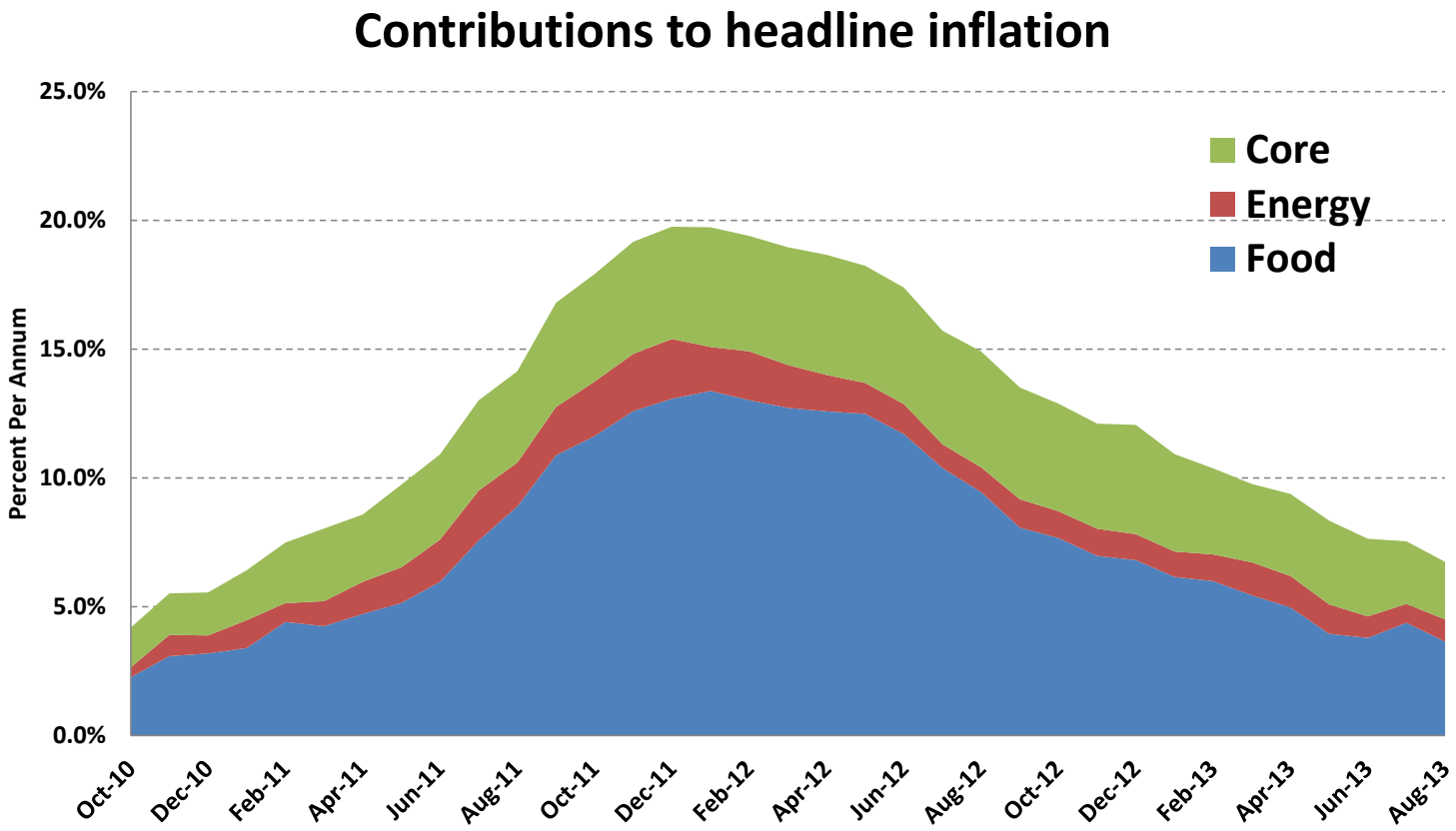
Background: energy prices and pass-through

- Tanzania is highly energy dependent (in power and transport)
  - wholly dependent on imported fuel
  - challenging power generation environment
  - prospects for improved generation on the horizon
- Energy prices the most volatile component of CPI
  - although share in CPI relatively small
- Effective inflation forecasting requires 'good' models of energy price pass-through
  - and good models of role of energy as an intermediate input

Figure 1: Energy price inflation and volatility



Food contributes 3.6 percentage points to inflation, core 2.2 percentage points and the remaining 1 percentage point comes from energy inflation.



Energy as an intermediate input

- Large distances / low density and poor infrastructue means high energy and transport costs damaging to growth and development
- E.g. cost per ton of grain / 100km around US$15 in East Africa compared to US$5 in Midwest US (<$3 if by river)
- Distorts location of economic activity and underpins persistently high "rural-urban productivity gap"
  - Addressing cost structure central to realizing *Vision 2025* transformation

Reduced form econometic evidence on the energy price pass-through

- Long-run versus short-run co-movement in energy and fuel prices
- Econometric evidence on pass-through of fuel prices
- Evidence of price-gouging and pricing-to-market?

Figure 2: Long-run energy price pass-through

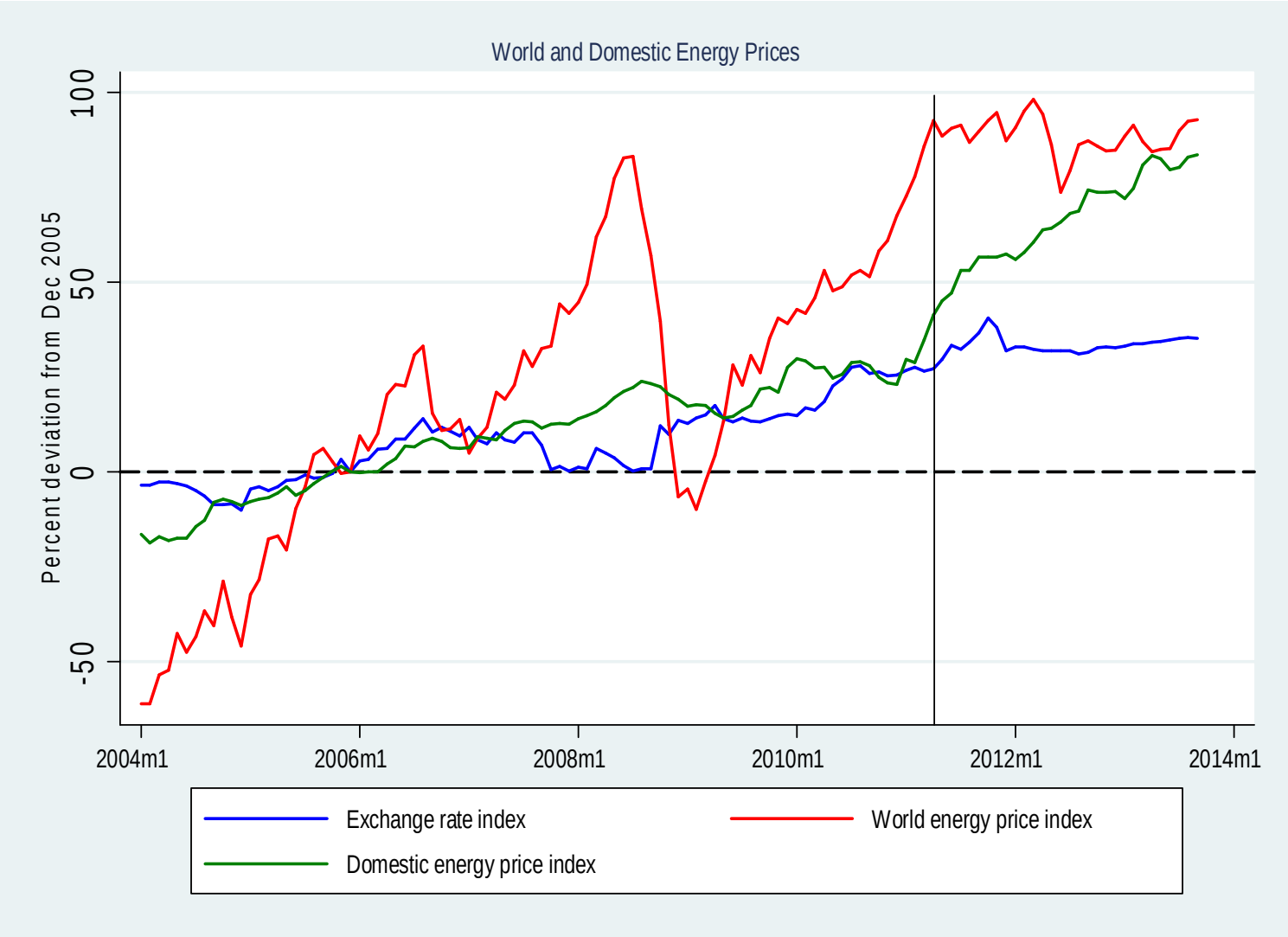


Figure 3: Long-run fuel price pass-through

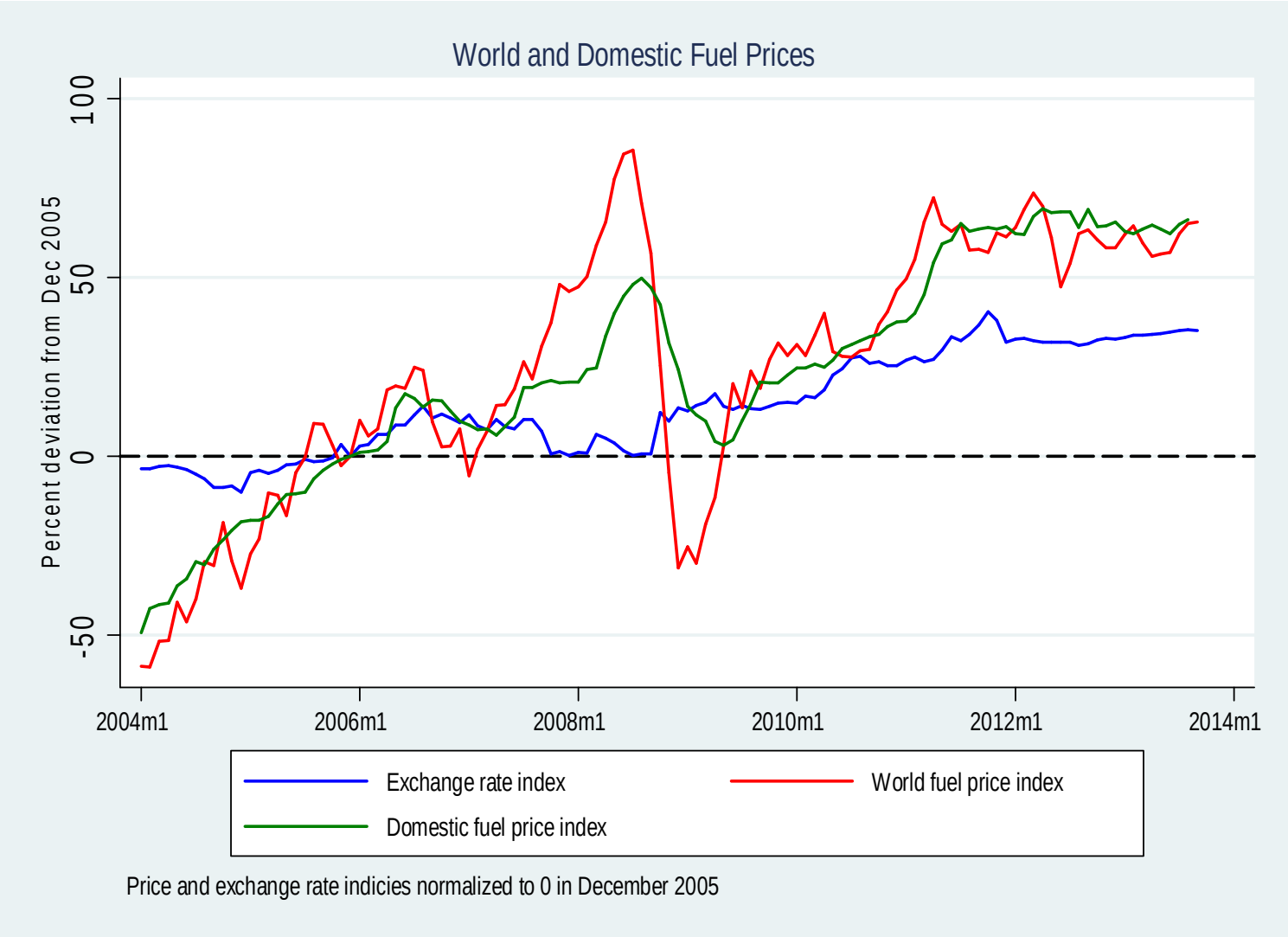
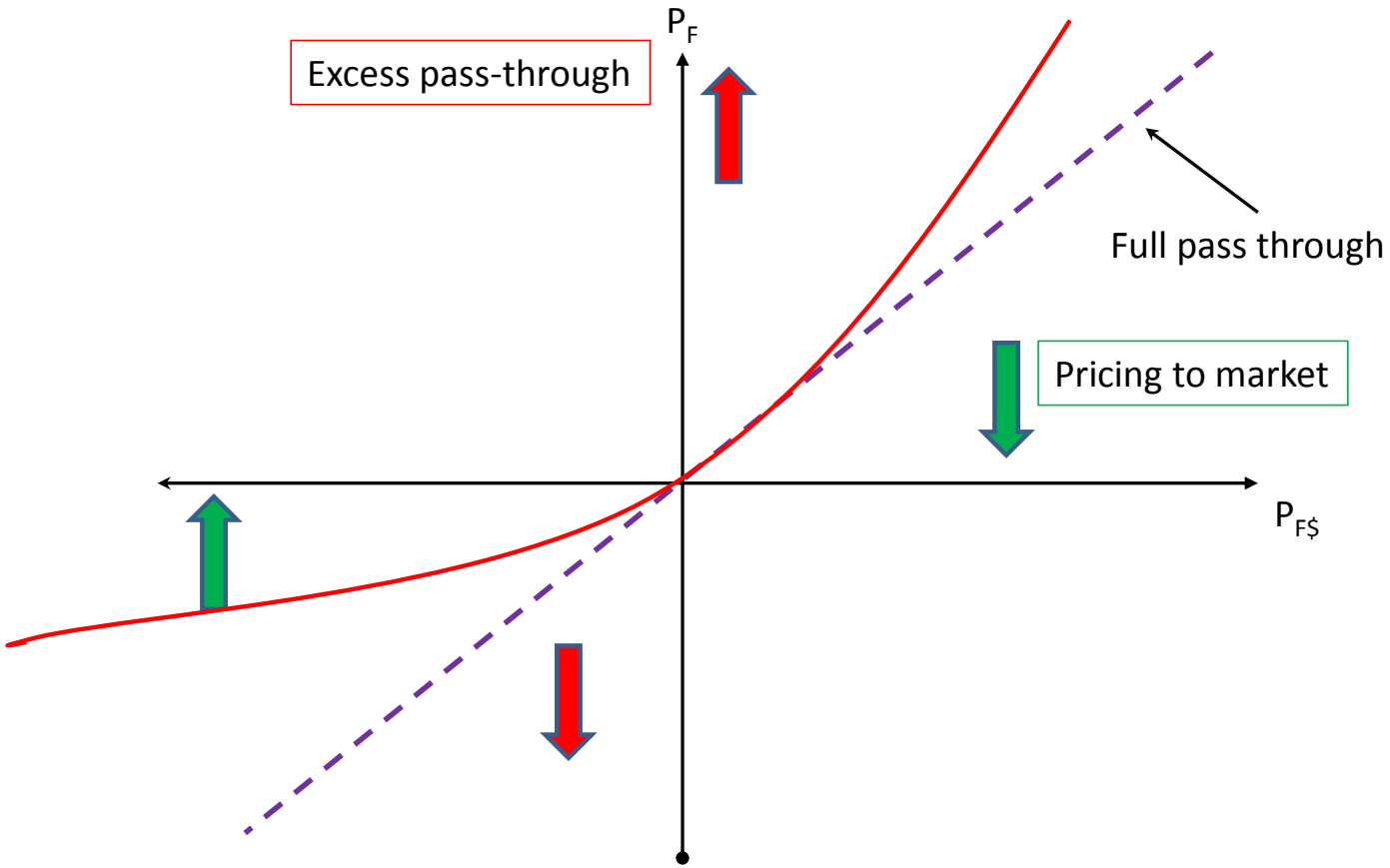


Figure 4: Price gouging and pricing-to-market

With monopoly power, we expect to observe excess pass-through in response to positive Shocks and pricing-to-market in response to negative shocks.



Long-run vs short-run pricing to market

- We use a standard vector error correction model to examine long- and short-run pass-through for fuel prices.
- Similar (but not identical) results on energy price index
  - World and domestic energy mix differs and regulated prices

Table 1: Asymmetric pass-through in the short-run

Long run pass-through relationship

$$lnp_t^f = 0.15 + 0.96 lnp_t^*$$

Dependent variable: percentage change in monthly fuel price ($\triangle lnp_t^f$)

Variable	*Baseline*		*Asymmetric adjustment*			
	2004-2013		2004-2013		2009-2013	
$\triangle lnp_{t-1}^f$	0.08	*	0.10	*	0.16	*
$\triangle lne_{t-1}$	0.15	*	0.15	**	0.32	**
$\triangle lnp_{t-1}^w$	0.04	*	0.05	*	0.03	
ecm_{t-1}	-0.24	***				
$ecm - pos_{t-1}$			-0.19	***	-0.08	
$ecm - neg_{t-1}$			-0.28	***	-0.28	***
R^2	0.58		0.59		0.47	
n	114		114		48	

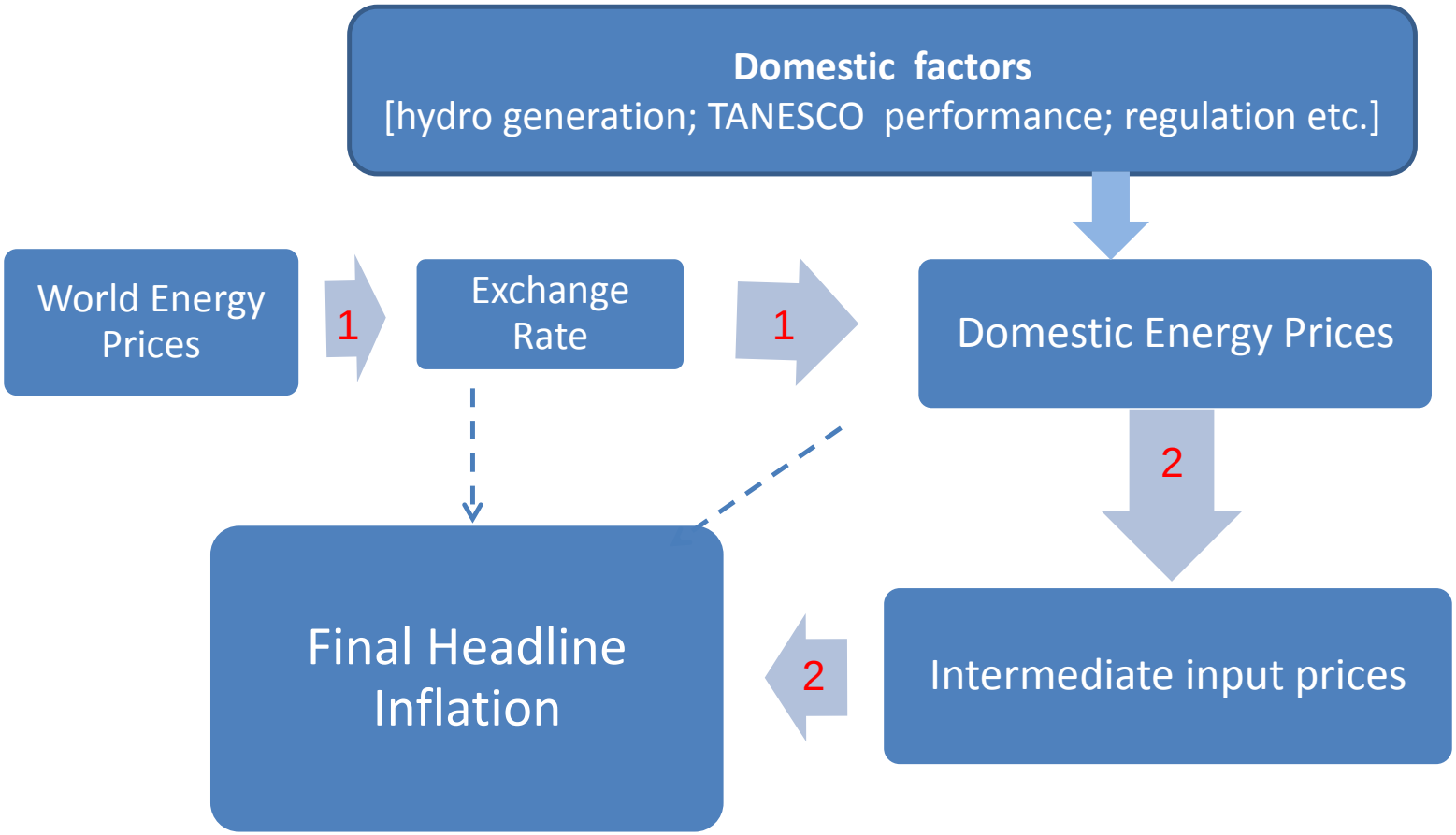
Statistical significance: 10% (*), 5%(**), 1%(***)

Note: $ecm - pos$ denotes domestic price exceeds world price; $ecm - neg$ world price exceeds domestic price.

Summary

- Strong evidence of cointegration => full long-run pass-through, at least for fuel
- But short-run behavior (weakly) consistent with gouging/pricing-to-market hypothesis
- Arguably the more important dimension is the role of energy as an intermediate input.

Structural evidence: direct and indirect pass-through



Measuring indirect pass-through

- Headline prices consists of energy prices P_E and non-energy prices P_N. Energy weight denoted θ.

$$P = P_E^{\theta}(P_N(P_E))^{1-\theta}$$

- In terms of inflation

$$d.p = [\theta + \omega(1-\theta)]d.p_E$$

- where ω summarizes *Input-Output* link from energy to other prices

The Input-Output Table

Tanzania Input-Output Matrix (2001)

	AGR	MIN	AGPR	MAN	SRV	EGY
AGR	0.073	0.003	0.599	0.103	0.013	0.000
MIN	0.000	0.031	0.000	0.000	0.000	0.000
AGPR	0.001	0.001	0.025	0.000	0.005	0.000
MAN	0.024	0.026	0.011	0.224	0.061	0.050
SRV	0.051	0.054	0.070	0.120	0.486	0.197
EGY	0.007	0.038	0.011	0.093	0.007	0.134

Notes: Sector are: Agriculture (AGR); Mining (MIN); Agro Processing (AGRP); Manufacturing (MAN); Services (SRV); Energy (EGY)

Source:

Thurlow, J. and Wobst, P. (2003) "Poverty-focused Social Accounting Matrices for Tanzania", Trade and Macroeconomics Discussion Paper No. 112, International Food Policy Research Institute, Washington, D.C. http://www.ifpri.org/divs/tmd/dp/papers/tmdp112.pdf

- Each cell measures the input of column *i* per unit of row *j.*
- IO Table is based on an industrial survey at a given point in time (and hence on technology and relative prices prevailing at this time).
- Latest Tanzanian IO Table is for 2001.
- Even this was an update from the 1992 IO Table, therefore severe concerns about subsequent changes in **technology** and **relative prices**

The Input-Output multiplier

- Each element of the IO matrix A, denoted a_{ij}, denotes the physical quantities of input good i required to produce a unit of good j.
- If good j is also used as an input, higher prices in j feeds into prices of all other goods.
- Ultimate effect of initial price effect is determined by the *general equilibrium multiplier* .
- Suppose the 'impulse' to energy prices is $d\tau_E$ (for example a world oil price shock) and the 'impulse' to non-energy prices $d\tau_N$, the eventual general equilibrium effect on overall prices is

$$\begin{bmatrix} dP_E \\ dP_N \end{bmatrix} = [1 - A]^{-1} \begin{bmatrix} d\tau_E \\ d\tau_N \end{bmatrix}$$

The Input-Output multiplier

- Can be interpreted as pass-through from input prices to output prices if:
  - elasticity of substitution between inputs (and between intermediates and factors) is zero
- The pass-through will be lower if:
  - firms substitute away from energy if energy prices high
  - firms absorb higher costs in lower profits
- IO multiplier is thus an *upper-bound* on the pass-through

Using the IO Table to estimate pass-through

- But set against this, perhaps the energy-intensity of economic activity has increased in last 20 years
- Within-sector energy efficiency savings outweighed by structural shift from low-energy to high-energy activities
- Relative price of energy has also increased over time
- IO mutiplier may actually *understate* pass-through effects.

Applying the method

Price level effects of a 1% increase in energy prices:
each percentage point increase in energy prices may raise headline prices by around 0.6%, principally through indirect effects

		…results in increases in energy, non-energy and headline prices of				
		Energy prices	Non-energy prices ↓		Headline CPI	
		Direct CPI effect	Initial impact	With full pass-through	Initial impact	Total prices
A 1% increase in energy prices… →	2001 IO Matrix	0.057%	0.139%	0.280%	0.196%	0.337%
	High energy intensity	0.057%	0.275%	0.566%	0.332%	0.623%

Caveats and qualifications

- Input-output table is very out of date. It is reasonable to believe that GDP is significantly more energy intensive even than suggested by 'high energy intensive' scenarios => *estimates possibly too low?*
- But these calculations assume full pass-through of input costs to output costs. This is unlikely:
  - Firms absorb some of the rise in input costs by substituting away from high-cost inputs and via lower profits and wages.
  - Income effect of prices rises reduces demand and hence price pressure.
  - Price rises may induce tightening of monetary policy.

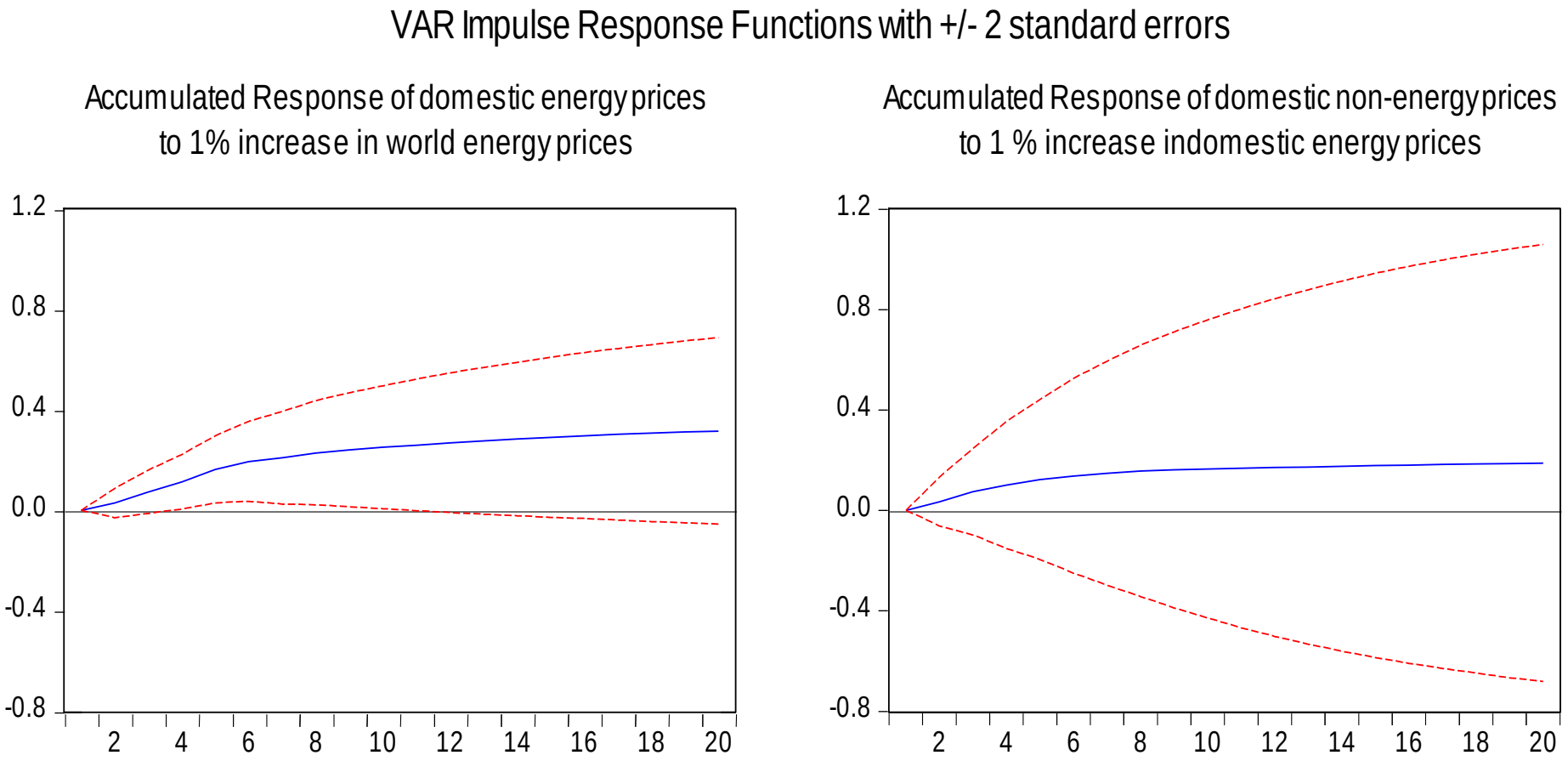
Cross checking with the econometic evidence

- We use monthly price data from Jan 2005 to March 2013 to estimate the response of non-energy prices to energy price shocks.
- Estimate a Vector Autoregression model of the form

$$\begin{bmatrix} \triangle p^E \\ \triangle p^N \end{bmatrix}_t = B(L) \begin{bmatrix} \triangle p^E \\ \triangle p^N \end{bmatrix}_{t-1} + \Gamma \begin{bmatrix} \triangle p^{*E} \\ \triangle p^{*N} \end{bmatrix}_t + \begin{bmatrix} \varepsilon^E \\ \varepsilon^N \end{bmatrix}_t$$

- We use this model to estimate the impact of:
  - the impact of a change in world energy prices on domestic energy prices;
  - the impact of a change in domestic energy prices on domestic non-energy prices;

Cross-checking with econometric evidence



Cross-checking with econometric evidence

- VAR suggests 1% increase in domestic energy prices translates into a 0.20% increase in non-energy prices (although this is not statistically significant)
- Lower than the 'full pass-through' IO-based estimates (0.288% to 0.566%)
- Consistent with firms absorbing part of input price increase or substituting away from energy intensive inputs.

Transport costs and structural transformation: widening the net

- Recent revival of research in area of urbanization, agglomeration and sturctural transformation
- A major new theme for the IGC
- Adam, Bevan, Gollin and Mkenda (2012 and 2013) explore the consequences of reduction in transport costs on the spatial distribution of economic activity, rural-urban migration and welfare.

Adam et al (2013) approach

- Develop a simulation model – currently based on 2001 Social Accountng Matrix – to explore spatial distribution of economic activity and growth.
- Examine effects of alternative public investment (and financing) across locations and skill groups .
  - Distinguishes between rural economy and two distinct urban locations (Dar and 'secondary' cities).
  - Explores long-run changes (a V2025 horizon, not conventional macro horizon).

Public Interventions

- Transport infrastructure infrastructure have across-the-board benefits
  - appear to have the strongest impact on the well-being of the unskilled.
- Key mechanism is that improved market integration – via lower transport costs – allows efficient rural-urban migration
  - Accelerated if there are agglomeration effects in urban areas
  - Reduction in wage goods (food) makes non-food sector more productive
- Skilled rural workers benefit consistently from public investments in agriculture, but unskilled workers do not.
- Increases in public capital targeted to the non-agriculture sector appear to do a somewhat better job of reducing poverty – including rural poverty – than investments targeted specifically to the agricultural sector.