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Exchange Rate Pass-Through to Consumer Prices in South Africa: Evidence from Micro-Data

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ABSTRACT *A sizeable literature examines exchange rate pass-through to disaggregated import prices, but few micro-studies focus on consumer prices. This article explores exchange rate pass-through to consumer prices in South Africa, for 2002–2007, using a unique data set of highly disaggregated data at the product and outlet level. The empirical approach allows pass-through to be calculated over various horizons for different goods and services. The heterogeneity of pass-through for food sub-components is considerable. Switches between import and export parity pricing of maize are found significant for five out of ten food sub-components. Using actual weights from the CPI basket, overall pass-through to the almost 63 per cent of the CPI covered is about 30 per cent after two years, and higher for food.*

1. Introduction

The ‘Great Moderation’, a term coined by Stock and Watson (2002) for an almost universal global decline in inflation and in inflation and output volatility in the two decades to 2007 relative to preceding decades, has heralded a new research focus on the evolution of the inflation process. Understanding the influences on prices, especially of commodity prices and exchange rates where the pass-through of each to import and domestic consumer prices seems to have fallen in industrialised countries since the late 1980s, is of great interest to monetary policy-makers, not least in inflation targeting countries. Accordingly, a burgeoning research topic for emerging market and developing countries in the last decade has been measuring the extent of exchange rate pass-through (ERPT) to aggregate import and consumer price indices and its possible decline in recent years (see review by Aron, MacDonald & Muellbauer, 2014).

A new and productive strand of research examines price change behaviour and price stickiness and exchange rate pass-through using monthly sub-components of aggregate price indices and micro-data sets of the thousands of their underlying prices. Most of the small body of research pertains to the US and euro area (for example, Gopinath & Itskhoki, 2010; Gopinath, Itskhoki, & Rigobon, 2010; and survey in Klenow & Malin, 2010). Rigobon (2010) examines commodity price pass-through to micro-data which includes emerging market and developing countries. To our knowledge there are few

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studies in general, and none published for emerging market countries, which examine ERPT to micro-consumer price data.¹

Emerging market countries comprise the largest set of those countries which have adopted inflation targeting or more credible monetary policy regimes over the last two decades. Of the African countries, the key exemplar is South Africa (SA), which adopted inflation targeting in 2000 and has presided over a sustained fall in inflation from double-digit levels for most of the 1990s to below 4 per cent by 2011. With volatile food and energy prices so important in the inflation process in SA and other African countries, supplementing analysis at the aggregate level (Aron, Farrell, Muellbauer, & Sinclair, 2014; Aron & Muellbauer, 2007, 2009) and sector level (Aron & Muellbauer, 2012; Aron, Muellbauer, & Pretorius, 2009) with micro-level investigations, should advance the understanding of these and other underlying drivers of inflation in SA (see also Parsley, 2012).

This article employs a unique data set of micro-consumer price data at the product level, covering six years from December 2001, to explore ERPT into micro-prices and some of the key sub-categories underlying the aggregate consumer price index (CPI). We examine over one thousand product groups (and over 2.5 million price observations) covering almost 63 per cent by index weight of the prices in SA's CPI (Table A1 in the Online Appendix). The period under study spans a shift from relatively high inflation (in mid-2002 to mid-2003) consequent on an exchange rate shock in late 2001 (Figure 1), to a period of lower inflation (mid-2003 to the end of 2006) and back to relatively high inflation (from the end of 2006 to the end of 2007)(see Figure 2).

We use a panel data approach and single equation models that control for matching foreign prices and domestic unit labour costs, and relatively parsimonious lag structures in the exchange rate, domestic unit labour costs and foreign prices, given that the short time period implies limited degrees of freedom. Nevertheless, it is flexible enough to be able to distinguish pass-through at 6-, 12-, 18- and 24-month horizons. Pass-through for individual micro-prices is aggregated up to the components of the CPI and to the CPI itself. The heterogeneity of pass-through for different sub-components of food, and the role of switches between import and export parity pricing of maize, are specifically investigated. An important feature of this article is that the actual weights in the CPI basket from the official Consumer Expenditure Survey are used to aggregate the CPI and its sub-components.² Hence, calculated pass-through is to a price aggregate that closely reflects the official CPI inflation measure targeted by the central bank.

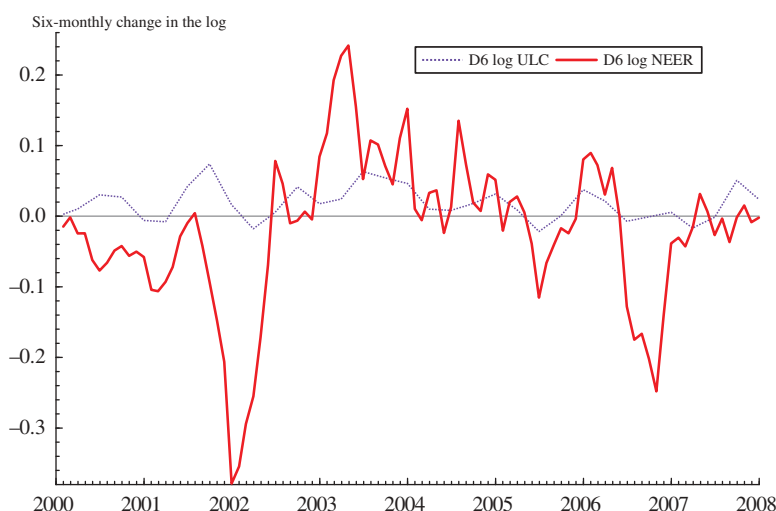


Figure 1. The nominal exchange rate and unit labour costs.

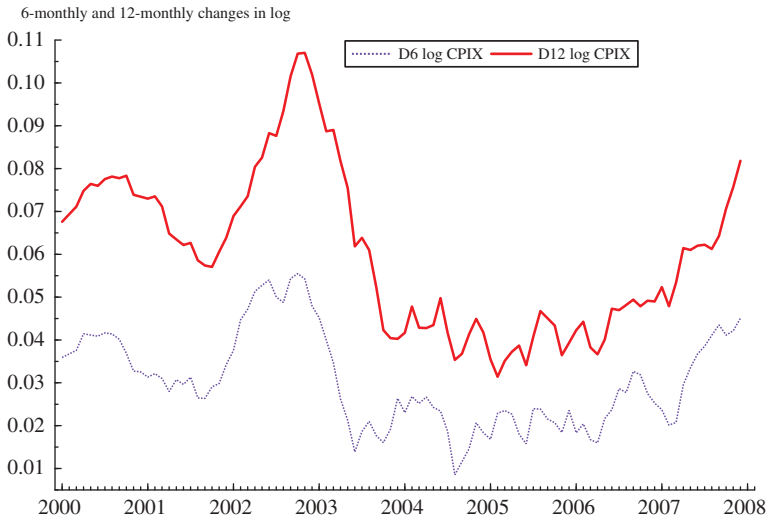


Figure 2. Consumer price indices and inflation in South Africa.

Note: Uses CPIX (metropolitan and other urban areas), which is the overall consumer price index, excluding interest rates on mortgage bonds; *source:* South African Reserve Bank.

In the remainder of the article, Section 2 lays out conceptual issues and the empirical specification. The methodology and data are discussed in Section 3, and the results of the empirical estimations in Section 4. Section 5 concludes.

2. Empirical Specification and Methodology

The empirical specification is based on a partial equilibrium, micro-founded mark-up equation, and commonly used in the empirical analysis of pass-through with aggregate and disaggregated price data. Aron, MacDonald & Muellbauer (2014) outline this model, which generalises the formulation of Campa and Goldberg (2005) by introducing the importing country's domestic costs into the mark-up function and exogenous commodity prices into the foreign exporter's marginal cost function. This can be expressed as a long-run log linear regression specification for *Stage 1 pass-through* of exchange rates to import prices, determined by the nominal exchange rate, domestic and foreign costs and demand variables.

The *Stage 2 pass-through* of import prices to consumer prices can be thought of as a weighted combination of import price pass-through to producer prices, and producer price pass-through to consumer prices, down the price distribution chain to retail prices. By substituting the determinants of import prices into an equation for producer prices, and then doing the same for producer prices in an equation for consumer prices, both import prices and producer prices can be eliminated. Then the reduced form equation for ERPT to the CPI will have the same form as the equation for *Stage 1 pass-through* to import prices, though the coefficients will be different. This represents *overall pass-through* from exchange rates to consumer prices, combining the two stages. A higher coefficient on domestic unit labour costs and domestic demand conditions, and lower coefficients on the exchange rate and foreign prices of goods and commodities, would be expected than in the equation for *Stage 1 pass-through* to import prices. Thus, the log of CPI can be written as

$$cpi_t = c + be_t + a_1w_t^M + a_2w_t^X + a_3pcom_t^X + a_4y_t^X + a_5y_t^M + \varepsilon_t \quad (1)$$

where for all variable expressed in logs, c is a constant, e is the (nominal) exchange rate,³ w^X and w^M are control variables representing exporter costs and domestic costs, $pcom^X$ captures a further element of exporter's costs stemming specifically from commodity prices such as grain or oil prices, and y^M

and y^X control for demand of the destination market and exporter's market. The omission of such control variables if they are correlated with exchange rates could result in biased estimates of the pass-through coefficient, b .

Plausible theoretical restrictions on Equation (1) are as follows: long-run homogeneity (lack of money illusion) at a given exchange rate implies $a_1 + a_2 + a_3 = 1$. Long-run homogeneity taking into account variations in the exchange rate implies, for the foreign prices, $b = -(a_1 + a_2)$. Then long-run pass-through is measured by $b = -(1 - a_3)$. At one extreme, complete pricing to market in the long run to the domestic market (local currency pricing) would imply $b = 0$; and at the other, complete pass-through (that is, with producer currency pricing) would mean $b = -1$ and $a_3 = 0$. In the short run, these long-run restrictions might not hold. The long run is here defined as conditional on domestic unit labour costs. In the very long run, these domestic costs might themselves be influenced by the exchange rate and foreign prices; some consumer price pass-through in the long run could rise through these feedback effects. A drawback of single equation methods is that they assume the exogeneity of all the variables on the right-hand side of Equation (1), and hence exclude such feedback effects, potentially introducing biases.⁴

Many studies address potential non-stationarity problems in Equation (1) by differencing the data to form stationary series. Prices and cost variables are typically I(1) or trending series (on longer samples than used in this study) and need to be differenced to achieve stationary or I(0) series, for which statistical inference in ordinary least squares (OLS) regressions is valid (see Granger, 1981). Then a first-differenced version of Equation (1) is estimated (often with smaller subsets of the control variables), and with up to n lags on the different variables to allow for a gradual adjustment to the exchange rate. Neglecting long-run terms by differencing will tend to bias the reported pass-through measures if co-integration between these long-run level variables is present (see Aron, Macdonald & Muellbauer, 2014). The ERPT is measured in the differenced equation as the sum of coefficients on the change in the log of the exchange rate term (Δe_t), for the chosen number of lags.

2.1. Micro-Specification

An innovation in this article is that the various specifications are estimated at a highly disaggregated product level. The monthly data have information on the prices of an individual product, for various units in which the product is sold, across the outlets that sell the product. Price changes can thus be observed in an individual product (i) sold in the specified unit (j) at a particular store (k). The products for which there are monthly price data comprise over 60 per cent of the CPI.

The dependent variable is the six-month difference in individual prices. The majority of prices do not change every month (Creamer & Rankin, 2008), and thus using one month differences would result in a dependent variable that is overwhelmingly zero. Figure A1 (in the Online Appendix) illustrates the unweighted mean and median six-month changes in prices. As shown by the median, even for six-month changes, the majority of prices do not change in a number of six-month intervals. Furthermore, we are interested in medium-run pass-through of six months to two years, rather than short-term monthly pass-through. Given the highly disaggregated nature of the dependent variable prices, the standard errors are expected to be larger than for other similar studies that utilise price indices.

We use the differenced empirical specification common in much of the literature, although our data are at a far more disaggregated level than is usual.⁵

$$\Delta_6 cpi_{i,j,k,t} = c_i + \sum_{n=0}^3 [b_n \Delta_6 e_{t-6n} + a_{1,n} \Delta_6 w_{t-6n}^M + a_{i,2,n} \Delta_6 w_{i,t-6n}^X] \quad (2)$$

where cpi is the price of product i sold in units j at outlet k in period t , c is a constant, e is the nominal exchange rate, w^X is a control variable that captures foreign costs and w^M is a control variable that captures domestic labour costs. In Equation (2), pass-through after six months is given by b_0 , one-year

pass-through by $\sum_{n=0}^1 b_n$, pass-through after 18 months by $\sum_{n=0}^2 b_n$ and two-year pass-through by $\sum_{n=0}^3 b_n$.

The expected signs for the coefficients of the exchange rate are negative (where a rise denotes an appreciation) and those for cost proxies are positive, and the coefficient estimates should fall between zero and one.

Equation (2) is estimated for each individual product using pooled OLS. For each product i (for example, milk) there are a number of different units of sale, j (for example 1 and 2 litre units) which are measured across a number of different outlets, k . Each of the estimations is carried out at the product level (for example, for milk). Using pooled OLS, therefore, the dependent variable is the change in price at the specific product-unit-outlet level (for example, 1 litre milk at outlet 1), but the constant c_i in the equation is common to all the relevant j (units) and k (outlets) for this product. In essence, we have imposed a restriction that the 'base' change within a product is constant across units and outlets. A less restrictive specification would allow this to vary.⁶

Numerous equations are run for each CPI component (for example, 255 separate OLS regressions are run for the food component alone). The coefficient estimates, as well as associated variances, are then aggregated based on the individual weightings of the products in the CPI.⁷ To calculate effects for the overall CPI a similar approach is followed, but aggregating up to the CPI as a whole rather than to a component of the CPI. The variance estimates, and hence reported standard errors, for weighted average coefficient estimates are based on the estimated variances for the micro-estimates. This ignores potential covariances between the micro-parameter estimates. To the extent that these covariances might be positive because of omitted common factors, the reported standard errors will be biased downwards. Well-specified models should help protect against such biases.

2.2. Institutional Features

There are two institutional features tested for in our pass-through regressions. The first feature is shifts between import parity pricing and export parity pricing for yellow and white maize. This is potentially important for the food component, and specifically for three or four of its sub-components – cereals, meat, dairy products and fats and oils. White maize is a staple food in SA with a weight of about 20 per cent in the cereals sub-component, and over 80 per cent of production is used for human consumption. Yellow maize is an important feedstuff for poultry and livestock, with over 90 per cent used in the meat, dairy, poultry and egg industries. The price of maize is vulnerable to periodic droughts and regional shortages, highlighted by the South African Reserve Bank in the Monetary Policy Review (April 2002) after grain prices more than doubled during 2001–2002.

The domestic price of maize fluctuates between an upper bound given by the import parity price and a lower bound given by the export parity price. In times of shortages, maize trades at close to import parity prices, and in times of surpluses closely matches export parity prices. Meyer, Westhoff, Binfield, and Kirsten (2006) propose a very simple model of wholesale maize prices for the intermediate regime, which they name 'near autarky', since regional trade continues to take place. The wholesale price is then a simple average of import parity and export parity prices. If we extend this and make the further assumption that transport and transactions costs for importers (b_1) are a fixed fraction of the import parity price, and that transport and transactions costs for exporters (b_2) are a fixed fraction of the export parity price, it is possible to derive a simple model of wholesale maize prices. We define an import parity price dummy IPD , which equals 1 when the import parity price prevails and a corresponding export parity price dummy, XPD , which equals 1 when the export parity price prevails. Then, if $PWMAIZE$ is the wholesale price of maize, we can derive an equation for it in terms of the international (US) price of maize translated at the dollar–rand exchange rate into rands, $PUSMAIZER$. Since the log import parity price is $(\log PUSMAIZER + b_1)$ and the export parity price is $(\log PUSMAIZER - b_2)$, the average of the two is $(\log PUSMAIZER + 0.5(b_1 - b_2))$, and this is assumed to apply in the near autarky regime when IPD and XPD are both zero. Thus:

$$\begin{aligned}\log PWMAIZE = & IPD(\log PUSMAIZER + b_1) \\ & + (1 - IPD - XPD)(\log PUSMAIZER + 0.5(b_1 - b_2)) \\ & + XPD(\log PUSMAIZER - b_2)\end{aligned}\quad (3)$$

This implies that:

$$\log PWMAIZE = 0.5(b_1 - b_2) + \log PUSMAIZER + 0.5(IPD - XPD)(b_1 - b_2) \quad (4)$$

This is a remarkably simple result, albeit based on simple assumptions, and suggests that (in logs) the wholesale price of maize is determined by the international price in rands plus a positive or negative shift, which depends on $(IPD - XPD)$. Then consumer prices of foods which depend partly on wholesale prices of maize should depend on current and lagged values of $(IPD - XPD)$ and of the rand international maize price, given lags in pass-through. An interesting feature of this result is that, on these assumptions, one should not expect a shift in ERPT with shifts between import parity pricing, near autarky and export parity pricing.

The second institutional feature is a test for a temporary switch from domestic currency invoicing to foreign currency invoicing for some imports, after the currency crisis in SA which began in late 2001. We follow Aron, Farrell, et al. (2014), who study pass-through to aggregate import prices, and test this hypothesis by interacting a dummy making a smooth transition over two years from the end of 2002 with the six-month change in the log nominal exchange rate. Aron, Farrell et al. suggest that pass-through declined from about 2003, which would be consistent with the re-adoption of local currency pricing for some imports once stability was perceived to have returned to the exchange rate. However, with a sample beginning in June 2002, there are too few observations before the interaction term begins in January 2003 for an effective test.

3. Data

In Table 1, the variables included in the model are defined with descriptive statistics. The construction of IPD and XPD dummies for white maize and for yellow maize was data intensive and is summarised in Table 1, with the definition of the currency invoicing dummy.

3.1. Aggregate Data Used in Micro-Pass-Through Regressions

The first set of variables comprises price variables: the micro-consumer prices discussed below; the nominal exchange rate; foreign cost proxies; and domestic cost proxies. We control for domestic and foreign costs. Our measure of domestic unit labour costs for the manufacturing sector is from the South African Reserve Bank, and is quarterly and seasonally adjusted. For the monthly regressions, a step function of the quarterly unit labour costs data is used, and smoothed with a three-month moving average.

It is difficult to find a primary control variable capturing the shifting relative costs of a country's aggregated trading partners. The nominal effective exchange rate ($NEER$) is shown in Figure 1, where a rise denotes appreciation. We first constructed trade-weighted foreign cost proxies for trading partners by computing $w^X = \log NEER + \log P - \log REER$. The corresponding real effective exchange rate ($REER$), sourced from the South African Reserve Bank, employs producer prices (P). This aggregate cost measure captures changing weights over time. It did not prove significant for components of the CPI, though it was used in an exercise with the same regressors for all 1,006 products. Thus, we also tested, as alternative cost measures, matching producer prices from the US Bureau of Labour Statistics' for the more tradeable groups of consumer goods. In addition to using price proxies for costs, we follow Marazzi et al. (2005) and Aron, Farrell, et al. (2014) and include measures of commodity prices relevant for sub-sectors, such as international oil and grain prices.

The second set of aggregate variables contains the demand controls. We opted for monthly advanced countries' industrial production indices and SA's manufacturing production index. Rates of growth were

Table 1. Data statistics and variable definitions

Empirical variable**	Theoretical nomenclature*	Definition of variables	Mean	Standard deviation	No. of observations
Consumer prices [†]	$cpi_{i,j,t}$	Measured below as the 6-month difference of the natural log of the price of product i , measured in unit j at time t .			
$\Delta_6 cpi_{i,j,t}$		Total CPI	0.0277	0.1541	1,006
$\Delta_6 cpi_{i,j,t}$		Food component	0.0334	0.1634	257
$\Delta_6 cpi_{i,j,t}$		Beverages and tobacco component	0.0388	0.0809	37
$\Delta_6 cpi_{i,j,t}$		Clothing and footwear component	0.0089	0.2068	210
$\Delta_6 cpi_{i,j,t}$		Housing component	0.0334	0.0736	11
$\Delta_6 cpi_{i,j,t}$		Furniture component	0.0159	0.2110	135
$\Delta_6 cpi_{i,j,t}$		Housing operations component	0.0284	0.1204	60
$\Delta_6 cpi_{i,j,t}$		Medical services component	0.0417	0.1216	29
$\Delta_6 cpi_{i,j,t}$		Transport component	0.0294	0.1357	95
$\Delta_6 cpi_{i,j,t}$		Recreation component	-0.0127	0.2382	98
$\Delta_6 cpi_{i,j,t}$		Personal care component	0.0279	0.1504	55
$\Delta_6 cpi_{i,j,t}$		Other components	-0.0055	0.0795	19
Foreign prices	w^X	Measured below as the 6-month difference of the natural log of an index of foreign prices. Choice of index varies over CPI components.			
$\Delta_6 w^X$		General CPI components – $w^X = \log NEER + \log P - \log REER$, using the real and nominal effective exchange rates and producer prices [Source: monthly, South African Reserve Bank]	0.0149	0.01379	59
$\Delta_6 maize_t$		Maize-containing food components – US maize prices price in dollars [Source: monthly, IFS]	0.0481	0.16655	59
$\Delta_6 ppiprocd_t$		Food and drinks – US PPI component for processed foods and feeds [Source: monthly, US BLS]	0.0200	0.0215	59
$\Delta_6 ppifurn_t$		Furniture – US PPI component for furniture and household durables [Source: monthly, US BLS]	0.0074	0.0068	59
$\Delta_6 ppichem_t$		Household operations – US PPI component for chemicals and allied products [Source: monthly, US BLS]	0.0356	0.0243	59
$\Delta_6 brentoil_t$		Transport – Brent oil price in dollars [Source: monthly, IFS]	0.1089	0.1540	59
$\Delta_6 ppicomp_t$		Recreation – Harmonised system import index: computer parts and accessories (EIUIP8473) [Source: monthly, US BLS]	-0.0167	0.0187	59
Other variables and dummies					
$\Delta_6 neer_t$	e	The 6-month difference of the natural log of the trade-weighted South African nominal effective exchange rate index, with base 2000 = 100. A rise is an appreciation.	0.0239	0.0870	59

(continued)

Table 1. (Continued)

Empirical variable**	Theoretical nomenclature*	Definition of variables	Mean	Standard deviation	No. of observations
$\Delta_6 ulc_t$	w^M	The 6-month difference of the natural log of unit labour costs in the SA manufacturing sector. Interpolated and smoothed in a three-month moving average for monthly regressions. [Source: quarterly, SARB]	0.0197	0.0209	59
$(IPD - XPD)_t^{white\ maize}$		Dummies for import and export parity pricing regimes: for daily white maize SAFEX prices and daily white maize import and export parity prices (Randfontein), dummies were constructed as follows: $IPD = 1$ if SAFEX price $> 0.9 \times$ import parity price; and $=0$ otherwise. $EPD = 1$ if SAFEX price $< 1.1 \times$ export parity price; and $=0$ otherwise. These daily dummies were then averaged to monthly data. [‡]			
$(IPD - XPD)_t^{yellow\ maize}$		As above but using yellow maize prices. [‡]			
DCURRINV _t		Dummy to capture changes in currency invoicing after 2001: defined as the 12-month moving average of the 12-month moving average of a dummy that is 1 from the beginning of 2003 and 0 otherwise. This smooths a transition from 0 at the end of 2003 to 1 in January 2005. Interaction effect: $\Delta_6 e_t \times DCURRINV_t$			

Notes: [†]Weighted, by product. The reported standard deviation is the weighted product level standard deviation;

[‡]We also experimented with a 0.85 cut-off for the IPD and EPD measures. **Lower case variables are in logs.

*For simplicity, the theory variables are written without being differenced.

defined from changes in the logs of these variables after seasonally adjusting them. The growth measures were smoothed with a three-month moving average. However, in common with many empirical studies, these measures were not significant. The short length of the sample, in any case, means there is unlikely to be sufficient variation to detect anything significant.

3.2. Micro-Price Data

This study uses a large micro-data sample at the unit level of SA's CPI. The original dataset comprises 3,930,977 price records gathered over a 73-month period from December 2001 to December 2007. Each individual price record corresponds to a precisely defined item, including both the type of item and the quantity or unit in which it is sold, sold in a particular outlet at a given point in time. This means that the pricing of individual items can be followed over time within the same outlet.

In March 2006, Statistics South Africa changed the price collection methodology from a fax-based approach to one of direct price collection by enumerators. Numeric outlet codes were also changed.

This results in a break in the data, since it is not possible to compare price changes at store level across this break. In this study we use only data which were recorded with an acceptable capture status.⁸ The analysis is confined to data which were collected at a monthly frequency.⁹ Since six-month changes in prices are constructed, a large number of observations are eliminated, particularly over the period where Statistics South Africa changed the survey methodology.

Table A1 provides a summary of the data for this study. Overall there are 2,524,822 price observations on 1,006 products.¹⁰ By comparison to the weighting of product CPI sub-categories in our data, services such as housing¹¹ and transport are particularly under-represented. Food, with the highest number of product lines (255), comprises the bulk of the observations in the sample, and it is by far the largest component (a weight of 25.15 per cent in total CPI). Other components with large numbers of product lines include clothing and footwear (210) and furniture (135), but their weights are only 3.01 and 2.86 per cent respectively in total CPI. Transport is the second-largest component in CPI (weight of 11.66 per cent) and medical services the third (weight of 4.59 per cent).

In Table 1, the mean six-month changes in prices are reported in the first row. These are first calculated at the product level and then aggregated using the CPI weights. This indicates that across the CPI sample the weighted average six-month price change is 2.8 per cent. Mean changes and standard deviations for the underlying CPI components are reported in the rest of the table. The average changes are highest in the following components: medical services (4.3 per cent); beverages and tobacco (4.0 per cent); food (3.4 per cent); and housing (3.4 per cent). Average changes are lowest for recreation (−1.3 per cent) and ‘other’ (−0.5 per cent) components. The average decrease in prices in recreation can be explained by the presence of personal computers in this component. Standard deviations also vary across sectors. The components recreation, furniture and clothing have the largest variation in price changes. The housing, beverages and tobacco, and ‘other’ components have the lowest variation in price changes, but they also are the components with the lowest number of product lines.

As indicated earlier, a justification for using six-month changes in prices is that the majority of prices in our sample do not change every month, so a monthly model would have highly heteroscedastic residuals. This is a common finding in the literature (see Klenow & Malin, 2010). In Figure A2 (online), this is illustrated by the proportion of prices that change month-on-month by CPI component. The figures also illustrate other salient features of the data. The first is the seasonal nature of the occurrence of some price changes (for example, the beverages and tobacco component demonstrates sharp price increases every March as ‘sin taxes’ announced in the February budget take effect). The second feature is that the average proportion of prices changing each month differs significantly across sectors. Only 8 per cent of prices change every month on average for clothes and footwear components. This compares with the components food, housing and ‘other’, where on average more than 20 per cent of prices change every month. This price stickiness is not specifically controlled for in this article. The third feature, see Figures 2 and A1, is quite distinct periods of price changes in the data: a rising inflation in 2002, falling from early 2003 to late 2004, then fairly flat until a mid-2007 rise. The changed survey methodology by Statistics South Africa in March 2006 is illustrated by a break in the data; as there are not comparable outlet codes across the break, price changes cannot be traced at the most disaggregated level across the break.

4. Results

Results are presented for empirical work which has four objectives. First, to examine ERPT using micro-data aggregated up to the main components of CPI and for the CPI itself, with coverage as shown in Table A1. Second, to focus on pass-through aggregated up to the food component of the CPI, and for the sub-components of food. Third, to test whether there is evidence for a change in currency invoicing behaviour after episodes of exchange rate depreciation. Fourth, to examine, for the food component and some of its constituents, the role of import parity pricing for yellow and white maize in times of drought and regional supply constraints, and of export parity pricing in times of surplus.

The full results across all components of the CPI are presented in Table 2. These estimates have imposed some broad sign priors on expected effects: thus, changes in unit labour costs and in foreign

Table 2. Full regression results – by CPI component

	(1) Food		(2) Beverages and tobacco		(3) Clothing and footwear		(4) Housing		(5) Furniture		(6) Household operations	
	Coeff.	Std error	Coeff.	Std error	Coeff.	Std error	Coeff.	Std error	Coeff.	Std error	Coeff.	Std error
$\Delta_6 ppi\text{procd}_t$			0.442	0.012								
$\Delta_6 ppi\text{procd}_{t-6}$												
$\Delta_6 ppichem_t$											0.120	0.035
$\Delta_6 ppichem_{t-6}$												
$\Delta_6 brent_t$												
$\Delta_6 brent_{t-6}$												
$\Delta_6 ppicompt$												
$\Delta_6 ppicompt_{t-6}$												
$\Delta_6 ulc_t$	0.120	0.015							0.422	0.141	0.836	0.066
$\Delta_6 ulc_{t-6}$									0.733	0.066	0.809	0.050
$\Delta_6 neer_t$							–0.090	0.008	–0.074	0.070	–0.116	0.012
$\Delta_6 neer_{t-6}$	–0.127	0.002	–0.032	0.002	–0.043	0.012	–0.080	0.005	–0.155	0.025	–0.173	0.007
$\Delta_6 neer_{t-12}$	–0.118	0.002	–0.002	0.002	0.002	0.011	–0.046	0.006	–0.072	0.062	–0.069	0.006
$\Delta_6 neer_{t-18}$			–0.069	0.002	–0.004	0.018	–0.004	0.005	–0.014	0.046	–0.019	0.006
$\Delta_6 maize_t$	0.069	0.002										
$\Delta_6 maize_{t-6}$	0.015	0.002										
$\Delta_6 maize_{t-12}$	0.049	0.002										
$(IPD - XPD)_t^{\text{white maize}}$	0.016	0.001										
March dummy			0.008	0.001								
September dummy			–0.010	0.001								
Constant			0.030	0			0.043	0.001	–0.001	0.006	–0.010	0.003
Share of CPI	25.15		3.95		3.01		2.21		2.86		1.65	
No of obs.	1,222,766		210,797		152,988		16,534		199,959		192,477	
Other					Month \times period dummies							

(continued)

Table 2. (Continued)

	(7) Medical care and health expenses		(8) Transport		(9) Recreation		(10) Personal		(11) Other		(12) Aggregate – weighted	
	Coeff.	Std error	Coeff.	Std error	Coeff.	Std error	Coeff.	Std error	Coeff.	Std error	Coeff.	Std error
$\Delta_6 \text{ pipiprocd}_t$												
$\Delta_6 \text{ pipiprocd}_{t-6}$												
$\Delta_6 \text{ ppichem}_t$												
$\Delta_6 \text{ ppichem}_{t-6}$												
$\Delta_6 \text{ brent}_t$			0.163	0.017								
$\Delta_6 \text{ brent}_{t-6}$			0.020	0.015								
$\Delta_6 \text{ ppicompr}_t$					0.177	0.161						
$\Delta_6 \text{ ppicompr}_{t-6}$												
$\Delta_6 \text{ ulc}_t$												
$\Delta_6 \text{ ulc}_{t-6}$												
$\Delta_6 \text{ neer}_t$	-0.002	0.010			-0.132	0.082			-0.167	0.020	-0.019	0.005
$\Delta_6 \text{ neer}_{t-6}$	0.021	0.005	-0.131	0.028	-0.186	0.085	-0.022	0.035	-0.329	0.007	-0.108	0.007
$\Delta_6 \text{ neer}_{t-12}$	-0.003	0.006	0.052	0.019	-0.098	0.050	-0.068	0.027	-0.270	0.008	-0.059	0.005
$\Delta_6 \text{ neer}_{t-18}$	-0.022	0.005	-0.068	0.017	0.014	0.042	-0.084	0.019	-0.035	0.009	-0.025	0.004
$\Delta_6 \text{ neer}_{t-24}$												
$\Delta_6 \text{ maize}_t$												
$\Delta_6 \text{ maize}_{t-6}$												
$\Delta_6 \text{ maize}_{t-12}$												
$\Delta_6 \text{ maize}_{t-18}$												
March dummy												
September dummy												
Constant	0.040	0.001	0.003	0.005	-0.003	0.006	0.024	0.004	0.003	0.001		
Share of CPI	4.59		11.66		2.37		3.96		1.53		62.92	
No of obs.	79,125		124,158		53,299		257,417		16,292		2,524,822	
Other												

Notes: Note that lower case variables are in logs, see Table 1.

prices and currency depreciation should have non-negative effects on the CPI components. Regressors which violated these sign priors were omitted, though temporary reversals in ERPT were permitted. Furthermore, while not all insignificant terms were excluded, reductions were made to fairly parsimonious specifications. White-corrected standard errors are reported, since the overlapping nature of the dependent variable induces serial correlation in the residuals, while the presence of many zeroes in the dependent variable creates heteroscedasticity. In Table 3, a summary is given of the cumulative ERPT over 6, 12 and 18 months. The results reported in Table 2 for the food component use the same regressors for all 255 food product lines, although different regressors are likely to be relevant for different components (for example, different foreign prices). More accurate results for food and its sub-components are given in Table 4, which focuses on food prices, and Table 5 gives a summary of the cumulative ERPT over 6, 12, 18 and 24 months.

These results indicate that pass-through varies dramatically across CPI components. Food, recreation and the residual category, 'other', all have pass-through rates of above 20 per cent over two years. Other components such as beverages and tobacco, clothing and footwear and medical care and health expenses have pass-through of 10 per cent or less. However, as illustrated by the analysis of the food sub-components, the choice of the foreign price proxy can have a substantial impact on pass-through estimates.

4.1. Pass-Through in the CPI and its Components

Turning first to Table 2, the detailed results are discussed for the CPI and its components. There are no foreign price controls for six of the components: clothing and footwear; housing; furniture; medical services; personal care; and 'other', as none of the plausible ones were significant. For the remainder, matching foreign price proxies were chosen (Table 1). The choice of lag structure for the domestic and foreign cost proxies differs amongst CPI components.

Three of the CPI components have *relatively low pass-through rates*: medical care and health expenses; clothing and footwear; and beverages and tobacco. Pass-through for these components is below 5 per cent after a year, reaching up to 10 per cent after two years. For medical care and health expenses, exchange rate changes have no impact on price changes over 6–24 months; this results from the dominance of services which comprise 80 per cent of the component: fees for doctors, dentists and other health-related services (such as medical aid and medical insurance payments). For clothing and footwear,¹² ERPT is 4.3 per cent over one year, changing little in the long term. This low figure hints at domestic currency pricing, with the lagged response linked with the infrequency of price changes for clothing and footwear. This may be due to the nature of the contracts retailers enter into with suppliers. It may also reflect a general fall in world prices of clothing and footwear associated with an increase in Chinese exports over this period, since we do not control for foreign prices. ERPT in the beverages and tobacco component¹³ is also relatively low at 3.2 per cent after one year and 10.2 per cent after two years. The three highest-weighted products comprising 40 per cent of this component – South African lager and Coca-Cola sold in cans and bottles – are locally produced for the domestic market. The remaining products, such as wine and spirits, are also largely South African produced.

Two further CPI components have *medium pass-through rates*: personal care and transport. Pass-through for these components lies between 10 and 20 per cent after two years. The personal care component¹⁴ of the CPI includes locally made products such as toothpaste, shampoos, lotions and cosmetics, and also non-tradable services such as haircuts. Pass-through is 2.2 per cent after one year, 9 per cent after 18 months and 17.4 per cent after two years. Pass-through for the transport component¹⁵ occurs mostly between six months and a year, and is 13 per cent after one year and 14.7 per cent after two. Petrol prices, set by the government every month, are a large proportion of this component. Less than half of the price paid at the pump is the basic fuel price. The remainder comprises taxes, retail and wholesale margins and transport and delivery costs. These non-traded costs temper the impact of exchange rate changes.

The remaining five CPI components have *relatively high pass-through rates*, between 20 and 50 per cent after a two-year period. Highest of all is the 'other' component of CPI, a residual component that

Table 3. Summary of pass-through by CPI components

	Food	Food [†]	Beverage and tobacco	Clothing and footwear	Housing	Furniture	Household operations	Medical care and health expenses	Transport	Recreation	Personal care	Other	Overall	Overall [‡]
Months														
6	0.000	-0.095	0.000	0.000	-0.090	-0.074	-0.116	-0.002	0.000	-0.132	0.000	-0.167	-0.019	-0.057
12	-0.127	-0.255	-0.032	-0.043	-0.170	-0.229	-0.289	0.019	-0.131	-0.318	-0.022	-0.496	-0.127	-0.178
18	-0.245	-0.421	-0.034	-0.041	-0.216	-0.301	-0.358	0.016	-0.079	-0.416	-0.090	-0.766	-0.186	-0.257
24	-0.245	-0.455	-0.102	-0.044	-0.220	-0.315	-0.378	-0.006	-0.147	-0.402	-0.174	-0.800	-0.211	-0.296

Notes: [†]With sub-component specific foreign prices; [‡]With sub-component specific foreign prices for food.

Table 4. Full regression results for food components – by sub-component

	(1) Cereal		(2) Meat		(3) Fish		(4) Milk, cheese, eggs		(5) Fats and oils	
	Coeff.	Std error	Coeff.	Std error	Coeff.	Std error	Coeff.	Std error	Coeff.	Std error
$\Delta_6 \text{ foreignprice}_t$					0.014	0.009	0.044	0.006		
$\Delta_6 \text{ foreignprice}_{t-6}$			0.196	0.006			0.049	0.006	0.109	0.011
$\Delta_6 \text{ ulc}_t$	0.249	0.038					0.638	0.036	0.244	0.063
$\Delta_6 \text{ ulc}_{t-6}$			0.148	0.028			0.371	0.039		
$\Delta_6 \text{ neer}_t$	-0.136	0.007			-0.109	0.016	-0.143	0.010	-0.118	0.014
$\Delta_6 \text{ neer}_{t-6}$	-0.240	0.005	-0.177	0.004	-0.139	0.010	-0.204	0.008	-0.269	0.011
$\Delta_6 \text{ neer}_{t-12}$	-0.150	0.004	-0.256	0.006	-0.107	0.009	-0.191	0.005	-0.160	0.008
$\Delta_6 \text{ neer}_{t-18}$	-0.024	0.005			-0.108	0.009	-0.063	0.006	-0.047	0.010
$\Delta_6 \text{ maize}_t$	0.011	0.004							0.077	0.007
$\Delta_6 \text{ maize}_{t-6}$	0.066	0.003					0.043	0.004	0.102	0.006
$\Delta_6 \text{ maize}_{t-12}$	0.103	0.004					0.042	0.007	0.186	0.007
$\Delta_6 \text{ maize}_{t-18}$	0.105	0.006					0.082	0.010	0.137	0.011
$(IPD - XPD)_{t-6}^{\text{white maize}}$	0.018	0.001								
$(IPD - XPD)_{t-6}^{\text{white maize}}$										
$(IPD - XPD)_{t-6}^{\text{yellow maize}}$			0.035	0.002			0.012	0.001		
$(IPD - XPD)_{t-6}^{\text{yellow maize}}$									0.016	0.002
Constant	0.012	0.001	0.024	0.001	0.030	0.001	0.009	0.001	0.003	0.002
Share	5.34		6.41		0.71		2.33		0.82	
N obs.	171,359		231,158		42,185		120,394		34,336	
Month dummies	No		No		No		No		No	
Foreign price			Brazilian beef		Norwegian Fish		New Zealand butter		New Zealand butter	

(continued)

Table 4. (Continued)

	(6) Fruit		(7) Vegetables		(8) Sugar [†]		(9) Coffee, tea and cocoa		(10) Other	
	Coeff.	Std error	Coeff.	Std error	Coeff.	Std error	Coeff.	Std error	Coeff.	Std error
$\Delta_6 \text{ foreign price}_t$	0.071	0.007					0.014	0.004		
$\Delta_6 \text{ foreign price}_{t-6}$					0.018	0.017			0.361	0.036
$\Delta_6 \text{ ulc}_t$					0.375	0.047	0.292	0.048		
$\Delta_6 \text{ neer}_t$										
$\Delta_6 \text{ neer}_{t-6}$	-0.214	0.029	-0.320	0.020	-0.061	0.012	-0.066	0.010	-0.069	0.006
$\Delta_6 \text{ neer}_{t-12}$	-0.067	0.013	-0.078	0.009	-0.129	0.006	-0.127	0.008	-0.030	0.005
$\Delta_6 \text{ neer}_{t-18}$	-0.160	0.016	-0.240	0.011	-0.072	0.006	-0.116	0.007	-0.041	0.006
$\Delta_6 \text{ neer}_t$	-0.141	0.016			-0.071	0.007	-0.068	0.006		
$\Delta_6 \text{ maize}_t$										
$\Delta_6 \text{ maize}_{t-6}$									0.070	0.004
$\Delta_6 \text{ maize}_{t-12}$									0.081	0.008
$\Delta_6 \text{ maize}_{t-18}$									0.021	0.001
$(IPD - XPD)_t^{\text{whitemaize}}$										
$(IPD - XPD)_t^{\text{whitemaize}}$										
$(IPD - XPD)_t^{\text{yellowmaize}}$										
$(IPD - XPD)_t^{\text{yellowmaize}}$										
Constant					0.016	0.001	0.012	0.001	0.018	0.001
Share	1.15		2.41		0.83		1.20		3.86	
N obs.	126,301		158,711		32,169		50,661		250,238	
Month dummies	Yes		Yes		No		No		No	
Foreign price	Latin American bananas				EU sugar		Brazilian coffee			

Notes: [†]The sugar sub-component is reported in the table without the currency invoicing term. However, the currency invoicing term is significant when included and this is discussed in the text. Note that lower case variables are in logs, see Table 1.

Table 5. Summary of pass-through by CPI food sub-components

	Cereal	Meat	Fish	Milk, cheese, eggs	Fats and oils	Fruit	Vegetables	Sugar [†]	Coffee, tea, cocoa	Other	Overall (weighted)
Months											
6	-0.136	0.000	-0.109	-0.143	-0.118	-0.214	-0.320	-0.061	-0.066	0.000	-0.095
12	-0.376	-0.177	-0.249	-0.347	-0.387	-0.280	-0.398	-0.190	-0.192	-0.069	-0.255
18	-0.526	-0.433	-0.355	-0.538	-0.548	-0.440	-0.638	-0.262	-0.309	-0.099	-0.421
24	-0.550	-0.433	-0.464	-0.601	-0.595	-0.581	-0.638	-0.333	-0.376	-0.140	-0.455
Weight	5.340	6.407	0.709	2.330	0.816	1.148	2.408	0.827	1.202	3.858	25.046
Relative weight	0.213	0.256	0.028	0.093	0.033	0.046	0.096	0.033	0.048	0.154	1.00

Notes: [†]The sugar sub-component is reported in the table without the currency invoicing term. However, the currency invoicing term is significant when included and this is discussed in the text.

groups together miscellaneous goods and services. These include stationery, watches, membership and professional fees, funeral costs, finance and bank charges, insurance and meals consumed outside of the house. The estimates indicate large and rapid pass-through of 16.7 per cent after six months, almost 50 per cent after one year, 76.6 per cent after 18 months and 80 per cent after two years. The individual product level estimations suggest that it is products such as stationery products and services such as food consumed outside of home and bank charges that are driving these. Bank charges include interest rates which tend to rise when the exchange rate depreciates. Imported goods such as personal computers and cellular telephones are among the products with the highest weightings in the recreation component.¹⁶ As such, it is not surprising that pass-through rates are fairly rapid, at 13.2 per cent after six months and 31.8 per cent after a year. After two years, 40 per cent of the exchange rate change has passed through to prices. White goods, many imported, such as fridge/freezers, washing-machines and kettles, as well as lounge and dining room suites, some imported, are included in the 'furniture' component.¹⁷ Estimates for furniture indicate that ERPT is 7.4 per cent after six months, 22.9 per cent after a year, 30.1 per cent after 18 months and 31.5 per cent after two years.

Much of the housing component of CPI is interpolated from less frequently observed rent data rather than collected on a monthly basis. We lack these data, and the results presented here are based on products such as holidays and types of fuel such as paraffin (kerosene), widely used for cooking, heating and lighting among lower income groups in SA. The presence of a relatively large pass-through effect in the subset we model of the housing component – 9 per cent after six months, 17 per cent after a year and 22 per cent after 18 months – could be driven by the effect of exchange rate changes on products such as paraffin. The housing operations component of the CPI contains products such as soaps, detergents, polishes and fertilisers. As such we use the chemicals and allied products component of the US PPI to proxy for foreign prices. This component of the CPI also contains services, including laundrette and dry cleaning services, which may not be affected by foreign prices. The estimations indicate a positive and significant relationship between foreign and domestic price changes, and between unit labour costs and local price changes. Pass-through for this component is relatively high at 11.6 per cent after six months, 28.9 per cent after one year and 35.8 per cent after 18 months.

The final CPI component in the group with relatively high pass-through rates is also the highest weighted, the food component. Pass-through is estimated to reach 24.5 per cent after 18 months (Table 3).¹⁸ However, as noted above, our preferred estimates for the food component employ a further disaggregation of food into its ten sub-components, discussed further below.

Rigobon (2007), for micro-consumer prices, and the Aron, Farrell, et al. (2014) study of import prices both find pass-through in SA falls after 2003. Even if the adoption of inflation targeting from 2000 had reduced pass-through, this effect might have been overwhelmed by a currency invoicing switch. If so, pass-through should have fallen again as confidence in currency stability gradually returned. For most goods, when taking into account the interaction between the currency invoicing dummy and the six-month change in the log exchange rate, the estimated differences from the Table 3 are slight and overall ERPT falls by only one percentage point.¹⁹ Thus, we find some evidence in support, but with the sample beginning in June 2002, there is little scope to discriminate between ERPT pre- and post-2003.

4.2. Pass-Through in the Food Component and its Sub-Components

In this section we allow for heterogeneous factors specific to each food group. Results for the 10 sub-components of food where the choice of foreign price proxy and specifications differ by sub-component are presented in Table 4.

Five food sub-components have *high pass-through rates*. For four of these – vegetables, milk, cheese and eggs, fats and oils, and fruit – ERPT is close to 60 per cent or more after two years. For cereals, ERPT is around 55 per cent. Exchange rate changes feed through rapidly in the fruit and vegetables sub-components, after six months measuring 21.4 per cent for fruit prices and 32 per cent

for vegetable prices. The remarkably high degree of long-term ERPT for fruit and vegetables is perhaps because of export parity pricing, given that SA is a large net exporter.²⁰

Relatively high pass-through rates are found for four remaining categories – meat, fish, sugar and tea, coffee and cocoa – and *low pass-through rates* for the residual ‘other food’ sub-component. For meat, fish and sugar, ERPT is approximately 45 per cent after two years. For sugar alone amongst the food components,²¹ there is evidence of a significant drop in 2003–2005 to around 33 per cent when the currency invoicing interaction effect is included. An EU sugar price index has a small insignificant effect, though domestic unit labour costs are significant. For tea, coffee and cocoa, ERPT is estimated at 38 per cent after two years. Unit labour costs are significant and there is a tiny foreign price effect from Brazilian coffee. Unit labour costs are also significant for ‘other food’ but the ERPT is estimated at only 14 per cent after two years.²²

The results also indicate the importance of controlling for import and export parity pricing. In cereals, meat, milk, cheese and eggs, and fats and oils, import and export parity pricing dummies for maize might be expected to be relevant. For cereals and the ‘other food’ sub-components, the (*IPD* – *XPD*) dummy defined for white maize is significant, and there is some pass-through from foreign maize prices. The (*IPD* – *XPD*) dummy for yellow maize enters significantly in the meat and milk, cheese and eggs sub-components. For fats and oils (which include butter and corn oil, where some maize-price dependence can be expected), and for meat, the dummy is significant at a lag of six months. The international price of beef proves to be a better proxy for international prices than the international maize price; but for fats and oils and for milk, cheese and eggs, lagged international maize prices also feed through significantly.

4.3. Summary

The results suggest that pass-through rates are heterogeneous by CPI component. Overall pass-through into the almost 63 per cent of the CPI basket for which there are data indicates that approximately 6 per cent of an exchange rate change reaches consumers after six months, increasing to 18 per cent after one year, 26 per cent after 18 months and 30 per cent after two years. The stabilisation after 18 months suggests that the impact of exchange rate changes on consumer prices does not extend much past this time frame. It is likely that pass-through to the total CPI will be lower, since the items excluded from this study may be less affected by the exchange rate. Nevertheless, it appears that the CPI pass-through estimates from this article are near the upper end of the 12–33 per cent range found in previous studies for the *aggregate* CPI in SA (survey in Aron, Creamer, Muellbauer, & Rankin, 2013).

These results have used the ERPT for the food component that was calculated from the disaggregated results shown in Table 4. Aggregating the results in Table 4, using the weights of each food sub-component, overall ERPT for the food component of CPI is estimated at 25.5 per cent after one year and 45.5 per cent after two years. This contrasts with a lower figure of 25 per cent for specifications restricted to use the same variables for each food item (Tables 2 and 3).²³ Allowing for heterogeneous factors specific to each food group thus has a notable effect on the estimate of ERPT. Table 5 summarises the time profile of ERPT for each sub-component and for overall food. ERPT after a year varies between 6.9 and 39.8 per cent, and after two years between 14 and 63.8 per cent.

5. Conclusions

This article has examined ERPT to consumer prices in South Africa using a micro-data set with over one thousand product groups (and over 2.5 million price observations) dating from December 2001 to December 2007 and covering close to 63 per cent by index weight of the prices in the consumer price index (CPI). The micro-data reveal substantial differences in the frequency of price changes amongst different types of goods; for example, higher for food than for clothing and footwear. There are also substantial variations over time; for instance, the prices of alcohol and tobacco are far more likely to be adjusted after announcements of tax rate changes in annual budgets in February. At the micro-level

most prices do not change at a monthly frequency, and the change in the log of prices over six months was taken as the dependent variable. As a compromise between parsimony and flexibility, changes in the log nominal exchange rate were also measured at 6 month intervals, and lags at 0, 6, 12, and 18 months considered. Controls for changes in domestic unit labour costs and relevant foreign prices were also introduced and retained where relevant. Note that as in much of the single equation ERPT literature, the exchange rate is treated as exogenous (see survey of Aron, MacDonald & Muellbauer (2014) for a discussion of the likely implication that ERPT is then over-estimated).

The estimates were based on OLS regressions at the level of each of 1,006 products to estimate the effects of current and previous exchange rate changes on each set of price changes. Non-food products were divided into 10 groups and with the same set of regressors within groups, but potentially different between groups. Food was sub-divided into 10 sub-groups and the same procedure applied. Differences between types of goods in the total pass-through after two years and in the immediacy of pass-through were considerable; for example, far higher for food than for medical care and health expenses or for clothing and footwear. Weighting the estimates by index weights, pass-through after two years for the CPI components covered by the study was estimated at 30 per cent, near the upper end of earlier studies on aggregate CPI data for SA. After six months, pass-through is about 6 per cent, 18 per cent after 12 months and 26 per cent after 18 months.

As noted, these estimates for overall pass-through use food pass-through estimates based on a disaggregation of food into subgroups, with heterogeneous specifications for each. One innovation was to study the effects of import and export parity pricing for maize, which is an important ingredient in cereals and an input into the production of meat, milk, cheese and eggs, and fats and oils. Quite high degrees of ERPT were found for food components, over 40 per cent after two years for all groups except coffee, tea and cocoa and a heterogeneous 'other' group. For food as a whole, pass-through is estimated at 46 per cent after two years. Interestingly enough, when heterogeneity between different food groups is ignored and a common set of variables used for each food item, the estimate of overall food pass-through drops to 25 per cent and overall pass-through for the CPI basket covered falls from 30 per cent to 21 per cent. However, for a crude specification, using the same set of regressors and including a single aggregate measure of foreign prices for all 1,006 products, overall ERPT is estimated at 34 per cent, but somewhat less when sign priors are imposed at the level of each of the 11 broad product groups.

Food is both quite heterogeneous and has a large CPI weight so that the disaggregation is productive. This finding suggests that in future work some of the other broad groups with significant weights, particularly transport goods, should be decomposed into sub-components. The use of micro-data has thrown much new light on both the heterogeneity and overall magnitude of ERPT in SA.

Although there is evidence from Rigobon (2007) and Aron, Farrell, et al. (2014) that pass-through in SA declined from about 2003, with the first observation in June 2002, there is little information in this micro-sample to detect a shift beginning in 2003. Future research for a longer micro-sample should return to this question given its interest for policy-makers and for international research on the apparent decline in exchange rate pass-through in recent years.

Notes

1. Aron, Creamer, et al. (2013) surveys the literature. Of the handful of studies that directly explore pass-through to the sub-components of the CPI, Belaish (2003) examines four CPI components for Brazil; Leung (2003) examines sub-components of Canada's CPI; Soffer (2006) investigates 31 sub-components of Israel's CPI; and Rigobon (2007) examines approximately 5,000 items underlying the monthly CPI in SA. Parsley (2012) examines 158 annual consumer prices for SA compiled by the Economist Intelligence Unit (EIU).
2. Rigobon (2007) assumes equal weights for South Africa's consumer prices; so does Parsley (2012), for the set of goods prices and the set of services prices from the EIU.
3. In South Africa, the exchange rate is defined as foreign currency relative to domestic currency, and increases with appreciation.
4. Systems methods, potentially available in longer samples than the one considered in this article, allow the exchange rate and domestic costs to be endogenous, and hence introduce a role for feedback effects. The resulting measures for pass-through from the two methods will be different.

5. We have also experimented with other specifications that include error correction terms. Given the short time-span of our data, there does not seem to be enough long-run information to estimate these well. Inclusion of these terms does not significantly alter the results, however.
6. An obvious extension is to allow for fixed effects. A fixed effects estimator would allow the constant to vary by product and store (i and k) or product, unit and store (i , j and k). Owing to the time-consuming nature of the estimation process, a full set of results has not been produced controlling for these. Exploratory regressions in some CPI components suggest that the results do not differ fundamentally from those reported here.
7. These are the underlying weights, based on the 2000 Income and Expenditure Survey, which were used to construct the CPI basket from January 2002. In 2009, a new CPI basket was introduced based on weights from the 2005–2006 Survey.
8. Various capture codes are used in collecting the data; we excluded capture codes reflecting out of stock goods and incomparable goods, due to changes in quality.
9. Given that the study is based on six-month price changes, prices collected quarterly, annually or at other non-monthly intervals have been excluded. A comparable approach is adopted in other micro-data studies (see Alvarez and Hernando, 2006).
10. These are the weights in the CPI for South Africa as a whole, as opposed to the weights for ‘Metropolitan areas’ and ‘Metropolitan and other urban areas’ as published by Statistics South Africa.
11. Housing costs were excluded due the fact that certain housing sub-sector price information – including the rents of housing, flats and townhouses – is based on a frequently updated price index rather than on actual pricing conduct. Hence, there is a tendency for small but frequent changes in price. This is as a result of a practice by the statistical authorities during the period under review, but subsequently discontinued, that any observed price change over a quarter was distributed over the three months of the following quarter.
12. For the clothing and footwear component, we impose a coefficient of zero on contemporaneous changes in the exchange rate, since the point estimate was positive. Lags of the exchange rate generally have negative signs, but the standard errors are relatively large.
13. The beverages and tobacco component specification includes the change in US PPI for processed foods and feeds as a foreign price control. For beverages and tobacco we impose a coefficient of zero on the current exchange rate term whose point-estimate is positive.
14. We impose a coefficient of zero on contemporaneous changes in the exchange rate.
15. For the transport component we include the current and six-month lagged Brent oil price change to proxy foreign prices.
16. The specification for recreation includes a US price index for computer parts and accessories, since computers form part of this CPI component. However, the aggregated standard error on this is relatively large.
17. Estimations for the furniture sub-component include South African unit labour costs.
18. For the food component in Table 3, foreign prices are proxied with lags in US maize prices up to 12 months, and the ($IPD - XPD$) dummy for white maize and unit labour costs are included.
19. Results are available on request from the authors.
20. The only foreign price used for fruit was that of bananas, however.
21. As noted above, however, the sample length is not sufficient for robust estimates.
22. This component contains sauces, condiments and baby food, likely to be mainly domestically produced.
23. The overall ERPT of 21 per cent shown in the penultimate column of Table 4 corresponds to these less preferred estimates.

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