What Price-Level Data Tells Us About Consumer Price Rigidity in Zimbabwe: Evidence From New Data

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Abstract

This paper documents the price setting behaviour, and the change in this behaviour, amongst retail firms after the introduction of the new currency system in Zimbabwe. We use sample data which covers 291 products to investigate whether prices became more flexible (rigid) and to track the adjustment process as Zimbabwe moved further away from the date the new currency system was introduced. We find evidence that prices became more flexible with time although this change is relatively small compared to the variation in the frequency of price changes between months. Compared to Lesotho and Sierra Leone, prices in Zimbabwe are stickier with more than 75 percent of products in the dataset not changing prices from the previous period. Over half of all absolute price changes are greater than 5 percent indicating that when price changes do occur, they are relatively large. Overall, the findings of the paper fit with the 'stylised facts' emerging about the micro aspects of price adjustment.

JEL Classification: E30, E31, D40, D21

Keywords: Pricing conduct, multicurrency, pricing heterogeneity, price rigidity

1 Introduction

Sometimes countries adopt new currencies which are not their own as a medium of exchange[1]. The reasons for this vary but many countries pick established currencies often as a response to a macroeconomic crisis. Zimbabwe is an example of this; in January 2009 it adopted a new currency after experiencing a

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[1]The most prominent example is when more than12 European countries adopted the euro, by creating a single market and eliminating all differences in the units of account

decade of hyperinflation and economic crisis. The change in currency may have positive effects for inflation – for example Zimbabwean inflation dropped to -3.4 percent by March 2009 after the change, but there are other challenges that come with it. The most obvious is a loss of monetary policy control. A less obvious one has to do with the stickiness of prices. In most cases the adopted currency is 'strong' in value but less fine in terms of denominations (the face value of the currency). The IMF (2010) argued that Zimbabwe's new multicurrency system came with a number of challenges for prices as the shortage of change posed difficulties for retailers. In addition to this, the 'coarseness' of the new currency denominations means that prices are likely to be more sticky as retailers have limited scope to change prices as a response to smallish economic shocks, especially for lower priced products. This matters because it introduces another source of rigidity into the economy and may have distributional effects if it impacts certain groups of consumers more than others (for example the poor who may disproportionally buy goods with low face-values). This type of challenge has been overlooked in the literature.

One way to investigate this price stickiness and its implications to the economy is to examine the pricing and price setting behaviour of firms using product level data used in the computation of the country's consumer price index. The study of pricing and price setting behaviour of firms at a disaggregated level is an important part of economic theory and is the starting point of modern-founded macro models. Baudry (2007) argues that the response of output, inflation and employment to an economic shock is highly dependent on the flexibility of prices. A number of theories on price stickiness have been developed (see Taylor, 1980 and Calvo, 1983), but their assessment on flexibility of prices has been limited due to lack of information, particularly disaggregated data at the consumer price level. Historically, most micro-studies which used disaggregated data concentrated on specific products or markets (see Cechetti, 1986 on magazine prices, Lach and Tsiddon, 1992 on food product prices).

Recently, there has been a renewed interest in the study of pricing and price setting behaviour of firms at a disaggregated level largely driven by the increasing availability of rich micro price data sets (Klenow & Malin 2010). The body of evidence based on this type of data has grown over the past decade and has allowed researchers to re-evaluate theoretical pricing models and to assess the role of price stickiness in generating persistent responses of output to monetary shocks (Elberg 2014a). Studies of micro price data sets used to compute the CPI have been used in a number of countries to study price dynamics at a micro level, including the United States (Bils & Klenow 2004), (Klenow & Malin 2010); Spain (Álvarez & Hernando 2006); Italy (Fabiani, Gattulli, Sabbatini, 2006); France (Baudry, Bihan, et al. 2007); South Africa (Creamer et al. 2012); Sierra Leone (Kovanen 2006); and Lesotho (Nchake et al. 2014b).

The common finding in these studies is that there is large heterogeneity in the pricing and price setting behaviour, which is often contradictory to the macro-economic theory of price setting. Very little of this type of work has been done for low income countries with segmented markets particularly in

Africa[2]. To our knowledge, our study is the first to investigate the pricing and price setting behaviour for low income countries that adopt a new currency as a medium of exchange in Africa. The primary focus of this study is the unique dataset of monthly product prices obtained from the National Incomes and Prices Commission in Zimbabwe.

In this study, we address 'stylised facts' of price setting for Zimbabwe and compare them to Lesotho and Sierra Leone. Firstly, we investigate whether prices become more flexible or rigid in Zimbabwe after introduction of the multicurrency system and compare it to Lesotho and Sierra Leone. We posit prices to be rigid as compared to Lesotho and Sierra Leone-both countries are classified as low income countries by the World Bank Indicators. Secondly, we investigate the magnitude of price changes and explore how prices adjusted to the multicurrency system over time. We also expect price changes to be bigger on average as compared to Lesotho and Sierra Leone due to the lack of change and problems associated with denominations in the Zimbabwean context. In addition, we would expect some adjustment process as we move further away from the date when the multicurrency system was adopted. We show that, prices are sticky at lower denominations, with retailers on average changing their prices after every 3.9 months. Moreover, we also show that more than 75 percent of products do not change prices from the previous period. When prices do change, they are big on average although small price changes are also common.

2 Background and Context of Study

In January 2009 Zimbabwe adopted a multicurrency system dominated by the US after a period of hyperinflation and severe economic crisis. Although official statistics, last released by the Zimbabwe National Statistics Agency (Zimstat), indicated that month-on-month inflation reached 231 million percent by July 2008, the International Monetary Fund estimated the inflation rate to be 489 billion percent as of September 2008 (IMF Country Report 2009). In an attempt to restore the credibility of the financial system, the government of Zimbabwe introduced a multicurrency system, with prices of domestic products quoted in US dollars, although South African Rand, Botswana Pula, British Pound and the Euro were also accepted as a medium of exchange. However, when transacting, these other parallel currencies were directly converted to US dollars at point of sale machines.

Following this, month-on-month inflation declined sharply, to -3.4 percent by March 2009, and prices of commodities began to stabilise (Hanke & Kwok 2009, p.362). Domestic pricing was mitigated by lower prices, particularly from South Africa (Piffaretti 2011). Even though the multicurrency system was introduced in January 2009, this process did not happen overnight. Prior to the policy change, most firms had already started transacting in US dollars as far back as

[2]Product market price based studies in Africa have been done only for South Africa (see Creamer, Farrell and Rankin, 2012) and Lesotho (see Nchake, Edwards and Rankin, 2014) and Sierra Leone (see Kovanen, 2006).

2007. By December 2008 more than 1000 shops were licenced by the government to trade in foreign currency. Other traders who were not licenced began to sell their products in foreign currency illegally, without licences. The situation became unbearable for those who traded in Zimbabwe dollars since they had to constantly go to the parallel market to convert their money into foreign currency. The Zimbabwe dollar began to be rejected by the public as the medium of exchange (Hanke & Kwok 2009, p.354) and this led to de facto dollarisation. The government was left with only one option: to adopt the US dollar as the medium of exchange. In January 2009, the government released a government gazette, giving legal tender to the use of the US dollar as medium of exchange, hence completing dollarisation.

The introduction of the US dollar as the medium of exchange brought its own challenges, particularly with denominating currency since the lowest denomination then was one dollar (USD1), such that products of lower denomination such as sweets were used as change. This introduced some form of price stickiness, which plays an important role in macro-economic theory.

Internationally little attention has been devoted to the price dynamics at a micro level after a country gives away its seignorage and adopts a foreign currency as a medium of exchange. Although Pesantes (2005) analysed how Ecuador adjusted after it dollarised in 1999 using CPI data, this study differs in that it provides a more detailed analysis of price setting behaviour of firms after the adoption of a new currency. In addition, the dynamics and circumstances leading to the implementation of dollarization in Ecuador are quite different to the Zimbabwean perspective.

Our paper is structured as follows: Section 3 outlines the literature review with section 4 dwelling on the methodology and data. Section 5 analyses the pricing stylized facts and Zimbabwe, comparing them to South Africa, Lesotho and Sierra Leone and section 6 concludes.

3 Literature Review

3.1 Introduction

Theoretical models of pricing and pricing behaviour can be used to explain nominal rigidities and price stickiness. Two types of models are dominant in the literature: time dependant and state dependant pricing models. The following section describes these two groups of models, highlighting their notable differences and discuss their relevance in the context of developing countries. In addition, related empirical evidence on price setting behaviour is analysed.

3.2 Theoretical evidence of price setting

3.2.1 Time dependant pricing models

Time dependant pricing models argue that the timing of individual price changes are exogenous to the firm. The firm only determines the size of adjustment.

Taylor (1980) and Calvo (1983) are well known proponents of time dependant pricing models. In these models a firm sets its price every nth period (Taylor 1980) or randomly (Calvo 1983), with a constant hazard function since price are kept fixed for certain period of time.

In the model of Taylor (1980), firms set prices of goods knowing exactly how long the price will last before they decide to change the price. Prices are kept unchanged for a fixed period of time, and all firms in the industry know when to change their prices. The main weakness of this pricing model is that it ignores the concept of heterogeneity of different firms and cannot be applied to extreme changes in economic conditions. This type of model is more applicable to regulated prices (such as social service delivery, mostly in the education and health sector) in developing countries.

Like Taylor (1980), Calvo (1983) uses staggered contracts, but in contrast, the model assumes that there is a constant probability that firms can set a new price, however, they do not know how long the price spell will last. Firms' prices have random durations, such that the number of periods the price is fixed may not be predicted precisely. The firm faces a probability distribution over possible price spell durations and, unlike in the Taylor model where all completed price spells have the same length, there will be at any time a distribution of completed price spell lengths. The major weakness of the Calvo pricing model is that it cannot respond to extreme changes in economic conditions such as high inflationary environments because of its assumption of constant price changes.

Empirical evidence (see Golosov & Lucas, 2007) suggests that the assumption of constant price changes in time dependant pricing models is false. They argue that the assumption of constant repricing cannot fit the fact that repricing is more frequent in high inflationary environments. Time dependant pricing models assume that the frequency of price changes is exogenously given and that a shock that raises the desired prices does not affect the duration of price spells, but raises the magnitude of price increases to (Calvo, 1983). These models ignore the fact that there is heterogeneity among different firms and that firms react differently to shocks that affect the economy. This means that firms are not allowed to change their price even if the costs of not changing that price exceed the benefits.

3.2.2 State dependant pricing models

In state dependant pricing models, the decision to change prices is endogenous. This implies that the decision is based on changes in the market and not related to the passage of time. Firms only change their prices when they experience a shock. This means that prices are changed when the benefit of changing a price exceeds the menu cost[3] of changing the price. Firms face different shocks and therefore different costs of changing prices, implying that the hazard function will be increasing. At the start of each period, there is a separate distribution of firms which changed their prices at different periods in the past. If there

[3] Menu costs are those costs incurred by firms when they change prices.

happens to be a shock in the economy, the benefit of changing prices would be higher for those firms who last changed their prices further back in time, since these firms would have accumulated shocks from the last period they changed prices.

The most prominent model of this type is by Dotsey *et al.* (1999), who develop a dynamic stochastic general equilibrium model of state dependant pricing. In this model, an economy is characterised by monopolistic competition where all firms have power to set prices, with common technology and common factor markets, implying that marginal costs are the same between firms. The model assumes that the fixed costs of changing prices are random across firms and drawn from a continuous distribution, such that equilibrium involves some but not all firms opting to adjust. Fixed adjustments costs of individual firms are assumed to be independent over time. Therefore, all firms face stochastic price adjustments costs which are independently and identically distributed across firms and across time. Firms evaluating their prices weigh the expected benefit of adjusting their prices against the price adjustment costs realised in the current period. This implies that in equilibrium, not all firms will change their prices, but the decision to change prices will depend on the benefit of changing the price and the current value of the costs of changing that price.

Dotsey et al. (1999) find that the fraction of firms changing prices responds to monetary shocks; a positive monetary shock induces more firms to change their prices whilst a negative monetary shock induces fewer firms to change prices. This form of state dependant pricing means that the endogenous bunching of prices speeds up the price adjustment process and dampens short run effects on real output. In addition, in state dependant pricing models, the frequency of price changes varies with the average inflation rate and the business cycle.

A more recent model on state dependent pricing models is by Golosov and Lucas (2003) who develop a model of a monetary economy in which individual firms are subject to idiosyncratic productivity shocks as well as general inflation. In this model, firms only change their prices when they incur a real menu cost. The study finds that the average size of the change in the individual prices that are adjusted is much larger than the expected inflation between adjustments. This model is different to the one by Dotsey et al (1999) in that it includes idiosyncratic shocks in addition to general inflation. The study finds that idiosyncratic shocks (shocks that affect productivity) are responsible for most of the price changes. In Dotsey et al. (1999), idiosyncratic shocks affect individual firm's menu cost, and this influences firms that will re-price at a given time. In contrast, in the Golosov and Lucas (2003) model idiosyncratic shock affects productivity, and affects all firms who re-price.

In conclusion, state dependant pricing models predict that economic agents base their behaviour on economic shocks and that the timing of price changes is endogenous. This means the average size of price changes is much larger than the expected inflation between adjustments (Golosov and Lucas, 2007). These types of models suggest that two main factors matter for the degree of nominal rigidities: idiosyncratic shocks, and the existence of menu costs.

3.3 Empirical evidence of price setting

Empirical research using micro level price data has grown rapidly in recent years mostly due to the availability of disaggregated data which is used in the computation of CPI. For example, Bils and Klenow (2004) and Klenow and Kryvstov (2008) analysed pricing behaviour using disaggregated data for the United States. Evidence for several European countries is also available such as Alvarez and Hernando (2006), Aucremanne and Dhyne (2004), and Baudry et al (2007). Recent studies for developing countries include Kovanen (2006) for Sierra Leone, Creamer *et al* (2008) for South Africa and Nchake *et al* (2014) for Lesotho. These studies have provided new insights on price setting behaviour of firms and there are a number of common findings across these studies.

These studies generally find that there is substantial heterogeneity both within and across different product categories. For example, Klenow and Malin (2010), who examined the role of price setting in business cycles using both CPI and PPI data for the United States, find that the frequency of price changes differs widely across goods, with more cyclical goods exhibiting greater price flexibility. Klenow & Kryvtsov (1997) show that there is heterogeneity between regular and posted prices while studies by Álvarez & Hernando (2006); Aucremanne et al (2004); Baudry et al.(2007); Creamer et al. (2012) and Nchake et al. (2014) report that there is significant heterogeneity across different product categories.

In addition, empirical literature finds that price changes are relatively infrequent. For developing countries, prices tend to be more flexible compared to developed countries. Creamer *et al* (2012) find that individual prices change more frequently than once per year in South Africa. Using CPI micro data, the average price duration for South Africa is 5.0 months. Developed countries tend to have lower frequency of price changes (see Álvarez & Hernando (2006); Aucremanne et al (2004); Baudry et al.(2007); Bils and Klenow (2004) compared to developing countries (see Nchake, Edwards and Rankin (2014); Kovanen, (2006); Gouvea (2007)).

In addition, most studies which have used micro price datasets find that on average price changes are relatively large, although many small price changes occur. Creamer *et al* (2012) show that South African micro price data reveal relatively large magnitudes of price changes. This is also the case in other developing countries (Gouvea, 2007, and Nchake *et al* 2014b), and for developed countries (Klenow & Kryvtsov, 2008, and Nakamura & Steinsson, 2008 for the United States).

In the United States the variance in monthly inflation is explained by fluctuations in the average size of price changes rather than the frequency of price changes in each month. This means that that pricing behaviour in the US is consistent with the assumptions of time dependant pricing model (Klenow & Kryvtsov 2008). A similar study for Lesotho by Nchake et al. (2014b) find consistent results.

A number of studies have examined the price setting behaviour of European firms (Álvarez & Hernando, 2006 for Portugal; Aucremanne et al, 2004 for

Belgium; and Baudry et al., 2007 for France). A common finding from these studies is that they find relatively lower frequencies of price changes and longer price duration spells. In addition, there is marked heterogeneity across product categories and that prices do not change more often but do so by a large amount. Overall, there is also evidence of both time dependant and state dependant pricing models across these studies.

Recently, there has been a growing number of similar studies for a number of African countries: (see Nchake, Edwards and Rankin (2014) for Lesotho, Kovanen, (2006) for Sierra Leone, Edwards and Rankin (2012) for African cities, and Creamer et al (2012) for South Africa). These use product level data to investigate the price setting behaviour of retailers. Nchake (2014) examined the price setting behaviour of firms in Lesotho using disaggregated data used in the computation of the country's CPI. Furthermore, Creamer and Rankin (2008) and Kovanen (2006) analysed price setting behaviour in South Africa and Sierra Leone respectively using product level data. Results from both studies reveals that there is heterogeneity in the price setting behaviour of firms at a disaggregated level across countries, hence the need to conduct country specific studies. This paper adds to this growing literature on African countries by investigating the short term effects of the multicurrency system on the dynamics of price at a micro level.

There is relatively small literature which analyses price setting behaviour for countries who adopt a new currency as a medium of exchange. Pesantes (2005) studied price dynamics before and after dollarization for Ecuador. The paper examined real exchange rates in relative and absolute terms and also the Consumer Price Index (CPI) before and after the adoption of the US dollar and finds that micro-prices are stationary as a panel with half-lives of about twelve months. The study finds that, after start of dollarization, price levels became more integrated for eleven Ecuadorian cities.

The only other study we are aware of which uses micro price data to examine price adjustment and currency change is Cavallo et al. (2014). The paper examines Latvia, a country which dropped its pegged exchange rate and joined the euro zone, and uses high frequency good level data prices of thousands of differentiated goods sold by Zara, the world's largest clothing retailer. This data is scraped from the website but although it covers many differentiated products, it is only for clothing and footwear. The study finds that prices converged rapidly between Latvia and the Euro countries following Latvia's entry into the euro.

Lastly, literature on price adjustment after high inflationary periods is limited. Angeloni et al (2006) examined the price setting behaviour and inflation persistence before and after the introduction of the euro in 1999 for six euro area countries. The paper argues that the motivation behind joining the euro area for most countries was that of monetary stability, and also moving away from high inflation and exchange rate instability. The study finds no evidence that euro changeover in 1999 brought any change in price setting and inflation persistence. Similar results are found by Hoffman (2006) who examined patterns of price setting behaviour at the retail level in Germany for the period

1998 to 2003 under low rates of inflation.

This paper adds on to the growing literature on micro price data sets for low income countries in Africa, albeit in different economic environments. In particular, there is little evidence for countries that adopt a new currency as a medium of exchange and this paper intends to fill in this research gap. In addition the nature of the data and the nature of the shock prior to the change in currency for Zimbabwe are quite different to studies which were done in Latvia and Ecuador.

4 Methodology and Data

4.1 Data description

The study uses unique data constructed from primary sources of weekly product prices at the retail outlet level. The data is unpublished and was obtained directly from the National Incomes and Pricing Commission (NIPC) in Zimbabwe. The raw data consists of 291 products spanning across 21 supermarkets in the Harare Metropolitan province for the period January 2012 to February 2015, with 196,199 price records (Table 1). NIPC collects prices for approximately 30 percent of the products in the entire CPI basket. Each individual price record has information on the date; retail outlet; product brand and unit. Some of the supermarkets are part of two big retail chains in Zimbabwe. The set of retailers included in this data is largely representative of the Zimbabwean supermarket sector as a whole since supermarkets are highly concentrated in Harare.

Table 1 shows a summary of the disaggregated data by major product groupings. There are 291 products in the dataset, with food products constituting 75 percent of all the products. In terms of price records, food products constitutes 65 percent of the total price records. Bread and Cereals constitutes the greatest proportion (19.59 percent) of all the products in the dataset, despite having only 31,272 price records (compared to 34,125 price records by other appliances, articles and products of personal care), followed by oils and fats with 12.03 percent (14,604 price records).Other appliances, articles and products of personal care are overrepresented in the sample relative to their share of total product items. Oils and fats are underrepresented (14,604 price quotes) relative to the number of product items (35) in the dataset. Bread and cereals has a greater proportion of CPI weights (34.02 percent) followed by meat (17.40 percent) with stationery having the least proportion of CPI weights (1.04 percent).

4.2 Specific Data Issues and weighting

Raw data is collected by the NIPC on a weekly basis and comes in excel files. Since there are some missing weeks in the data, data is converted into monthly price data with the middle of the month[4] price as the reference price for that

[4]In this case, the middle of the month is that price between the 12^{th} and the 18^{th} of each month.

particular month. In case of a missing price during the middle of the month, the closest price to the range (middle of the month) is used as the reference price for that particular month. Products with less than 100 observations are dropped from the final dataset since they provide little variation and might be potentially problematic when calculating the monthly frequencies.

To compute the aggregate measure of the frequency and size of price changes, we use CPI weights from Zimbabwe National Statistics. Since the NIPC data does not constitute all the products in the CPI basket, it is necessary to reweight. The procedure to calculate aggregate statistics is to set the weight for each individual observation equal to the weight of the CPI category and then divide it by the number of observations in that category. For each product line and category, it is necessary to calculate a new CPI weight. The new CPI reweights are then multiplied by each product line and summed up to obtain the aggregate frequency and size of price changes.

4.3 Methodological Framework

4.3.1 Frequency of Price Changes

Generally, there are two ways to analyse the periodicity- the frequency of price changes approach and the duration approach. This paper uses the frequency of price changes approach based on the type of data available for this study. The frequency of price changes is an indirect method of estimating the duration of price spells[5]. Álvarez & Hernando (2006) define the frequency of price changes as the percentage of none zero price change observations over the total number of observations. An advantage of using the frequency of price changes approach is that it uses all the statistical information available and is less affected by selection bias (Álvarez & Hernando 2006). In addition, Baudry (2007) argues that the frequency of price changes does not require a long time series of data as the measure is less sensitive to specific events. For example, a certain month can be ignored if it is characterized by an exceptional event (according to Baudry, 2007, one can ignore a specific month characterized by say, an increase in value added tax). This applies to the NIPC dataset used for this paper, as there are two months where data was not collected at all.

Furthermore, Baudry (2007) argues that, assuming homogeneity and stationarity in the data set, the inverse of frequency of price changes converges to the mean duration. The mean duration can be used to estimate the average duration of price spells, that is, it gives the precise monthly interval for which prices change. Under stationarity and homogeneity assumptions, the frequency of price changes gives an indirect estimate of the duration of price spells.

Following Creamer *et al* (2012), the frequency of price changes is defined as the percentage of all non-zero price changes over the total number of observation. To calculate the frequency of price changes, the paper specifies an indicator

[5] The duration of price spells is calculated as the inverse of the frequency of price changes.

variable which takes the following form:

$$I_{ijk,t} = \left\{ \begin{array}{c} 1 \; if \;\; p_{ijk,t} \neq p_{ijk,t-1} \\ 0 \; if \;\; p_{ijk,t} = p_{ijk,t-1} \end{array} \right\}$$

Where $p_{ijk,t}$ is the log price of product k in store i and time t. The indicator variable is then used to calculate the frequency of price changes. More specifically, the frequency of price changes to be estimated will be as follows:

$$Freq_{ijk} = \left(\frac{1}{T_{ijk}} \right) \sum_{t=2}^{T_{ijk}} I_{ijk,t}$$

Where T_{ijk} is the total monthly observations of the price $p_{ijk,t}$. The study assumes that $I_{ijk,t} = 1 \; if \; p_{ijk,t} \neq p_{ijk,t-1}$ and 0 if $p_{ijk,t} = p_{ijk,t-1}$. After calculating the product specific measure of frequency, the average frequency is then calculated across outlets, with the weighted average frequency finally computed across a sample of products using recalculated weights based on the Zimbabwe National Statistics.

4.3.2 Measurement of the direction of price change

The measure of price increases and decreases is calculated in the following ways:

$$\begin{aligned} I^{+}_{ijk,t} &= \left\{ \begin{array}{c} 1 \; if \;\; p_{ik,t} > p_{ik,t-1} \\ 0 \; otherwise \end{array} \right\} \\ I^{-}_{ijk,t} &= \left\{ \begin{array}{c} 1 \; if \;\; p_{ik,t} < p_{ik,t-1} \\ 0 \; otherwise \end{array} \right\} \end{aligned}$$

This indicator variable is then used to calculate the average frequency of price increases and decreases within and across product categories.

4.3.3 Size of price changes

The size of price changes captures the intensive margin whereas the frequency of price changes captures the extensive margin. In this paper the size of price changes at the store/product level is calculated as the month on month log differences in prices such that $p_{ikt} \neq p_{ikt-1}$. For each price line, the average of the absolute values for each are taken for each of the log price differences over the period. The average monthly magnitude of price changes following Creamer *et al* (2012) is calculated as follows:

$$M = \frac{\sum_{i=1}^{N} (\ln p_{it} - \ln p_{it-1})}{N}$$

Where $\ln p_{it} - \ln p_{it-1} > 0$ (for the magnitude of price increases) and $\ln p_{it} - \ln p_{it-1} < 0$ (for the magnitude of price decreases). p is the magnitude of the price of a specific item, and N is the number of observations where price magnitude increase (as price changes of 0 are not included in the calculation of average price change magnitudes).

5 Pricing Stylised Facts and Zimbabwe

5.1 Data Analysis: Distribution and Clustering of Prices

Table 2 shows summary statistics of prices in the NIPC dataset by products.

The highest variation is in super refined mealie-meal, with a standard deviation of 3.37, minimum price of $5.00 and a maximum price of $17.15, followed by roller meal and margarine with standard deviation of 2.79 and 2.71 respectively. An explanation for this variation is that these products are sold in different quantities (say mealie-meal ranges from 1kg to 20kg). The lowest variation is in white bread and sour milk with a standard deviation of 0.06.

Prices are clustered around one dollar, with products priced at one dollar appearing most in the dataset (Figure 1). The price distribution is skewed to the right, showing that prices are concentrated on lower denominations.

5.2 Frequency of price changes

We use the frequency of price changes to investigate whether prices became more flexible or rigid after the introduction of the multicurrency system. The frequency of price changes is an indirect measure of the average duration of price spells. Assuming stationarity and homogeneity of the data, the inverse of the frequency of price changes indirectly estimates the average mean duration of price spells.

Figure 2 plots the frequency of price changes and the inflation rate. The varying frequency of price changes co-moves together with the month on month inflation. The data shows varying frequency of price changes with the highest change occurring in May 2012 (42.41 percent) and the lowest frequency of price changes of 7.7 percent occurring September 2012.

Over the period from January 2012 to February 2015, the average monthly frequency of price changes is 23.6 percent (unweighted). This means that each month, an average of 23.6 percent of prices changes across all product categories with an implied duration of 4.24 months (Table 3). After reweighting the average monthly frequency of price changes increases to 25.32 percent with an implied monthly duration of 3.91 months.

Zimbabwe's weighted average frequency of price changes (25.32 percent) is close to that of the United States (24.8 percent) but significantly lower than for Lesotho (37 percent) and Sierra Leone (51 percent). We use the inverse of the frequency of price changes to investigate the duration of price spells to answer our main question. This means that on average, retailers change their prices every 3.91 months compared to Lesotho (2.7months) and Sierra Leone (2.0 months). Of the African countries for which figures exist, South Africa has the lowest frequency of price changes (17 percent)[6]. Compared to developed countries, particularly the Euro area, Zimbabwe has a significantly higher frequency of price changes as evidenced by the results for Spain (15 percent),

[6]Note that South Africa is not classified as a low income country, but under the Upper Middle Income Countries according to the World Bank.

France (18.9 percent), Belgium (17 percent) and Euro area (15 percent) (Table 4).

Although it seems that the frequency of price changes in Zimbabwe is towards the middle of the distribution of countries, these results need to be interpreted with caution since samples, periods and methodologies do differ across countries.

5.3 Heterogeneity in the frequency of price changes

The data shows that there is significant heterogeneity in the frequency of price changes across different product categories, with prices of perishable products, mainly vegetables, changing more frequently than prices of other products in the dataset (Table 5). This is a common finding across countries (see Nchake *et al* (2014b); Creamer *et al* (2012); Klenow & Malin, 2010).

Vegetables exhibit the highest frequency of prices changes, with 35 percent of vegetable prices changing each month, followed by meat with 33 percent of prices changing each month (Table 5). Klenow and Malin (2010) find similar results and argue that prices of perishable products are more unstable and change more frequently due to the storage costs. This causes prices to fluctuate since retailers prefer to pass these costs to consumers more quickly to avoid selling below marginal cost. In addition, the supply of perishable foods is more likely to be affected by variable weather patterns ((Nchake et al., 2014b). Stationery recorded the lowest frequency of price changes throughout the whole period, with 12 percent stationery changing each month. High frequencies for perishable (food) products are also found in (Nchake et al., 2014b) for Lesotho and (Creamer et al., 2012) for South Africa.

5.4 Frequency of price increases and decreases

The aggregate frequency of price changes is the summation of the frequency of price increases and the frequency of price decreases. The disaggregation of the frequency of price changes is important, particularly when they display offsetting movements in response the aggregate shocks in the economy (Nchake et al., 2014). Table 5 shows the weighted and unweighted average frequency of price increases and price decreases across major product categories. The frequency of price increases and price decreases are similar across all product categories.

There is significant heterogeneity in the frequency of price increases and decreases across product categories. Using CPI reweights, vegetables exhibited the highest frequency of price decreases of 19 percent followed by meat with a frequency of price decreases of 17 percent. The unweighted data shows that household maintenance had the highest frequency of price increases and decreases. Table 4 shows that household maintenance has the second highest total number of price records (29,310) after Bread & Cereals (31,272). Stationery recorded the lowest frequency of price decreases of 8 percent, reflecting sticky prices. The highest frequency of price increases can be found in beer (15 percent) with other food products recording the lowest frequency of price increases of 8

percent. It can also be seen that products with the highest frequency of price decreases also displayed the highest frequency of price increases (see vegetables and meat).

5.5 Size or magnitude of price changes

We investigate the magnitude of price changes and explore overtime how prices adjusted to the multicurrency system. The size of price changes captures the intensive margin of inflation while the frequency of price changes captures the extensive margin (how often price changes). The general finding which is common in literature is that price changes are infrequent, with more than 50 percent of prices not changing from one period to another. Figure 3 shows the distribution of the magnitude of price changes for Zimbabwe.

Most products do not change prices - 77.79 percent of products do not change prices from the previous period (Figure 3). Although price changes are rare, when prices do change, they are big on average as shown by the fat tails. In absolute terms 15.28 percent of the price changes are bigger than 5 percent, although smaller price changes also occur. Figure 4 shows the distribution of price changes after taking into account only non-zero price changes. Over half (68.75 percent) of all absolute price changes are greater than 5 percent indicating that when price changes do occur, they are relatively large.

Klenow and Kryvtsov (2008) find that absolute price changes for the US are large, averaging 10 percent. The existence of large price changes and small price changes might also be rationalised by a wide range of menu costs across items and time as in the Dotsey, King and Woolman model of state dependant pricing behaviour (Klenow & Kryvtsov 2008). In the model, the small and large price changes are reflective of small and large menu costs respectively. The large absolute price changes are also reflective of idiosyncratic shocks unique to a particular firm (marginal costs, desired mark-ups) which vary from firm to firm.

There is also substantial heterogeneity in the magnitude of price changes across different product categories. Table 6 decomposes the size of price changes by product category, size of price increases and the size of price decreases. The weighted average size of price increases is 6.85 percent while the weighted average size of price decreases is -7.25 percent. The largest magnitude of price changes can be found in vegetables, which tend to increase by 20.6 percent and decrease by 19.3 percent. The smallest magnitude of price changes can be found in oils and fats which tend to increase by increase by 5 percent and decrease by 6 percent

Like for other countries the magnitude of price decreases is generally lower than the magnitude of increases in Zimbabwe. This is generally argued to show downward nominal price rigidity. Baudry (2007) shows that, for France, the size of price decreases are more frequent in the economy with 40 percent of observed prices as decreases, suggesting the absence of downward nominal price rigidity. However, although the size of price decreases are more frequent than price increases, prices nearly fall as often as they increase across all product categories. Klenow and Kryvtsov (2008) show that, for the US, both large and

small price changes are common as both price increases and price decreases The weighted size of price changes across all product categories is -0.61 percent, which tallies with the prevailing inflation rates in Zimbabwe.

5.6 Effects of time trend on the frequency of price changes

A key question we are interested in is how the pricing behaviour of Zimbabwean retailers has changed over time as the economy becomes more used to the multi-currency regime. To do this, we regress the variable of interest against a time trend and monthly dummies. The estimated specification is:

$$fr_{it} = \alpha_{it} + \beta_1 trend_t + \beta_2 trend_t^2 + \varepsilon_{it} + \sum_{i=1}^{12} \gamma_i month_i$$

Where fr_{it} is the weighted frequency of price changes, $trend_t$ captures the time trend and $month_i$ are monthly dummies from January to December.

Figure 5 plots frequency of price changes with monthly dummies. The frequency of price changes is high at the beginning of the year, in February, before they start falling down to reach their lowest in May. There is a sharp jump in July, and they are also positive (relative to January) towards the end of the year.

The coefficient estimates on the time trend show that the frequency of price changes increases at a decreasing rate. Figure 6 shows the frequency of price changes with time trend. The frequency of price changes peaks in October 2013, 22 months after the start of our sample. The change in frequencies with time is relatively small compared to the monthly changes – the difference in the frequency of price changes between the start of the period and the peak is less than the average monthly difference in July (relative to January). Thus, although the estimates suggest that there is a trend (which might be associated with adjustment to the multi-currency regime), this is relatively small.

5.7 The frequency and size of price changes: Time series evidence

The relationship between the frequency and size of price changes with inflation is of paramount importance particularly in analysing theoretical models in pricing behaviour. If price movements reflect market forces, then knowing the relationship between price changes and inflation may have implications on business cycles and the transmission into monetary policy (Kackmeister 2005). Klenow & Kryvtsov (2008), Baudry (2007), Creamer *et al* (2012) and Nchake *et al* (2014) analyse the relationship between the frequency and size of price changes from a time series perspective.

With staggered contracts in time dependant pricing models, the variation in inflation is explained by the size of price changes, and the frequency of price changes is assumed to be constant overtime. This assumption seems plausible for the US since the average size of price adjustment accounted for 95 percent

of the variance of inflation (Klenow & Kryvtsov, 2008). Nchake et al (2014), also finds a close association between the size of price changes and inflation for Lesotho, with the frequency of price changes less closely associated with inflation. However, in contrast, Creamer *et al* (2012) finds a strong relationship between the frequency of price changes and inflation for South Africa.

Figure 5 shows how the frequency and size of price changes with month-on-month inflation. Month on month inflation, calculated for the products only in the dataset, seems to co-move together with both the frequency and size of price changes. In addition, the frequency of price increases and decreases also displays a strong relationship with CPI month-on-month inflation. Creamer *et al* (2008) also find a strong relationship between the frequency of price changes and CPI inflation for South Africa. However, Klenow and Malin (2010), find a close association between inflation and the size of price changes and that the frequency of price changes is weakly correlated with inflation.

To analyse the relationship more closely, we smooth out the data by calculating four month moving averages. We choose four month moving averages since the duration of price spells is 3.9 months. Nchake *et al* (2014) used a similar moving averages bandwidth for Lesotho. Fig 6 plots the moving averages for the CPI (month-on-month inflation), frequency of price changes, and the size of price changes.

Figure 8 shows that changes in the size of price changes are more volatile and more closely correlated with the inflation rate than the frequency of price changes. These results are similar to Klenow and Kryvtsov (2008) for the US, and Nchake et al (2014) for Lesotho, and suggest that movements in inflation are driven more by the variations in the size of price changes.

The relationship between the frequency of price changes and inflation may be weak because of offsetting movements between the frequency of price increases and decreases (Gagnon, 2009). Figure 7 plots the four month moving averages between inflation, frequency of price increases and the frequency of price decreases.

There is strong co-movement between the frequency of price increases and inflation but a weaker relationship between the frequency of price decreases and inflation. Due to offsetting movements (prices increasing as much as they are decreasing), the frequency of price changes therefore exhibits a weaker relationship with the inflation rate. This corresponds to what Nchake *et al* (2014b) reports for Lesotho.

Regression results suggest that both the frequencies and magnitudes are correlated with CPI but that the magnitude of price changes has a stronger relationship. Both positive and negative frequencies and magnitudes are related to the CPI. The frequency of price increases has a stronger relationship CPI changes compared to the frequency of price decreases. For magnitudes the positive and negative changes have similar (but opposite signed) relationships with CPI.

Klenow and Kryvtsov (2008) show that the coefficient of variation for the average size of price changes is much higher for the US, confirming that the variance in inflation is explained by the size of price changes. Nchake *et al* (2014),

confirms this stylised fact for Lesotho, a developing country like Zimbabwe. This is also confirmed in Figure 7, where the size of price changes strongly co-moves with inflation with the frequency of price changes relatively more stable. However, Creamer et al (2012) finds a close association between the frequency of price changes and inflation for South Africa.

The variance of inflation can be decomposed into the frequency of price increases and decreases, and size of increases and decreases. Klenow and Kryvtsov (2008) decompose the inflation into frequency and size of price changes in the following way:

$$fr_{ijkt} \stackrel{\circ}{=} \sum w_{ijkt} I_{ijkt} \stackrel{\circ}{=} \sum\sum w_{ijkt} I^{+}_{ijkt} + \sum\sum w_{ijkt} I^{-}_{ijkt}$$

Where I_{ijkt} is the frequency of price increases indicator that is 1 if $p_{ijkt} > p_{ijkt-1}$ or 0 otherwise. Similarly I^{-}_{ijkt} is the frequency of price decreases that is 1 if $p_{ijkt} < p_{ijkt-1}$

or 0 otherwise. Likewise, the weighted average size of price increases and decreases will be as follows:

$$dp = \frac{fr^{+}}{fr_t} \cdot \frac{\sum_i \sum_t w_{it} I^{+}_{it} (p_{ijkt} - p_{ijkt-1})}{\sum_i \sum_t w_{it} I^{+}_{it}} - \frac{fr^{-}}{fr_t} \cdot \frac{\sum_i \sum_t w_{it} I^{-}_{it} |p_{ijkt} - p_{ijkt-1}|}{\sum_i \sum_t w_{it} I^{-}_{it}}$$

Where the first part of the right hand side is the size of price increases and the second part is size of price decreases. Taking both equations, it can be noted that inflation is the sum of terms involving price increases and decreases. To summarize, the specification of inflation will be as follows:

$$\pi_t = fr^{+}.dp^{+} - fr^{-}.dp^{-}$$

Table 6 shows that frequency of price increases are common (12.83) compared to the frequency of price decreases (12.49). The frequency of price increases is highly correlated with inflation (0.71). The size of price increases and decreases are also modestly correlated with inflation (0.38 and -0.30, respectively). We also run separate regressions of the, frequency of price increases and frequency of price decreases together with the size of price increases and decreases on inflation. A one percentage point increases in inflation is associated with a 0.08(-0.04) percentage point change in the frequency of price increase (decreases). Likewise a one percentage pointy increase in inflation is associated with 0.17(-0.18) percentage point in change in size of price increases (decreases). The coefficients are statistically significant at 10 percent, however, with the size of price increases and decreases more closely tied with inflation that the frequency of price increases and decreases.

5.8 The duration of price changes and hazard functions

Micro-price data allows for further investigation into the duration of price spells and how the probability of price changes differs over the price spell. A price spell is an episode with a fixed price whilst the price spell duration is just

the time between two price changes. The shape of the hazard function shows the probability of changing the price conditional of the time the firm survived since the last price change. The hazard of a price change is merely defined as the conditional probability that a price will change given the time it has survived since the last price change[7]. If prices are more likely to be changed the longer they have remain unchanged, then it represents an upward sloping hazard function. Constant hazard functions arise if firms have a fixed probability of changing prices (as in Calvo, 1983).

At an aggregated level, the shape of the hazard function across the Zimbabwean sample is downward sloping for the first 20 months, and then eventually rises again (Figure 8).

Hazard functions by product category are shown in Figure 11 and Figure 12. These hazard functions are initially downward sloping for food products, but rise after about 20 months. The pattern for non-food products is similar to food. This is in contrast to Nchake *et al* (2014), who finds upward sloping hazard functions for Lesotho, and Creamer *et al* (2012) for South Africa. The fact that the probability of price changes differs with the length of the spells provides evidence for state dependant pricing models.

5.9 Evidence of heterogeneous price dynamics: Variance decompositions

The data allows us to decompose the frequency of price changes into: variation within a given store, variation across stores for a given product and lastly the idiosyncratic shock for a particular product and store. To estimate this, this paper uses a variance components model using the nested random effects model[8]. The model specification is as follows:

$$f_{i,k} = \beta + \varphi_i + \varphi_k + \varepsilon_{ik}$$

Where $f_{i,k}$ is the frequency of price changes for a unique product k sold in store i; β is a constant term and φ_i is the fraction of variation common to a particular store; φ_k is the variation which is common across stores for a given product; and ε_{ik} is an idiosyncratic shock to a given store and product and is supposed to pick up the remaining variation in the frequency of price changes. The random components ($\varphi_i; \varphi_k$ and ε_{ik}) are assumed to be identically and independently normally distributed with zero mean and variance. The model is estimated using maximum likelihood[9]. Table 8 reports this decomposition estimated separately for the years 2012, 2013 and 2014.

The first column shows the fraction of variation which is common to a particular store for all products (φ_i), with the second column showing fraction of

[7] According to Nchake (2014), "a hazard rate $h(\tau)$ is expressed as the probability that a price (p_t) will change after τ periods conditional on it having remained constant in the previous $\tau - 1$ periods, that is $h(\tau) = Pr\{p_{t-\tau} \neq p_{t+\tau-1} | p_{t+\tau-1} = p_{t+\tau-2} = ... = p_t$"

[8] The nested random effects model assumes that products are nested within stores.

[9] Nakamura .....()..... ()()()..(2011) used the same specification using the US CPI level data.

variation which is common to all stores selling a particular product (φ_k) and the last column gives the residual variation which is common to a particular product and store (ε_{ik}). Across all years the fraction of variation which is common to all stores selling a particular product accounts for most of the total variation of the frequency of price changes. Store and store by product variation account for almost a similar amount of variation.

These results are similar to Nakamura (2011) who reports the largest variation being from stores selling a particular product in the US. However, Elberg (2014b) finds that variation that is common to all stores selling a particular barcode accounted for only 25 percent of the variation in the frequencies of posted price adjustments in Chile However Elberg (2014) did include the proportion of variation attributable to common movements across retail chains.

Table 9 further decomposes the variance by product category. This confirms the aggregate results – product level variation is the largest source of price variance The results across product categories are similar, although within store variation in the meat category is substantially higher than for other product categories.

6 Conclusion

In January 2009 Zimbabwe adopted a multicurrency system after a period of hyperinflation. This paper presents new evidence of price setting behaviour for a period after this change and compares these results to similar studies on other countries (see Nchake et al, 2014; Creamer et al, 2012; Klenow & Kryvtsov, 2008; Nakamura & Steinsson, 2008). The results fit with the 'sylised facts' emerging about the micro aspects of price adjustment (Klenow and Malin, 2010).

We find evidence that prices are stickier in Zimbabwe than other similar countries, with retailers on average changing their prices every 3.9 months compared to Lesotho (2.7 months) and Sierra Leone (2.0 months.) There is significant heterogeneity in the frequency of price changes across different product categories, with prices of perishable products changing more frequently than prices of other products in the dataset. This results fits well with international literature, where there is substantial heterogeneity in price setting behaviour across products and outlets (see Nchake et al 2014; Creamer et al 2012; Klenow & Kryvtsov, 2008; Nakamura and Steinson, 2008; Klenow and Malin, 2010).

We find that more than 77.79 percent of the products in the dataset do not change prices between months. However, for those that do change the magnitude of the change is relatively large. Over half (68.75 percent) of all absolute price changes are greater than 5 percent. One potential explanation for this, which we examine in another paper, is that for lower prices (for example US$ 1) there are relatively few points to which prices can change given the lack of smaller currency denominations.

There is evidence of some adjustment process as Zimbabwe moved further away from the day the multicurrency system was introduced. We find that there is a non-linear time-trend in the frequency of price changes – the frequency of

price changes initially increase but then fall after 23 months (October 2013). However the magnitude of this change is small relative to the monthly variation in the frequency of price changes.

Furthermore, the paper also analyses the dynamics of price changes overtime. We find that the variance in inflation is driven by the size of price changes rather than the frequency of price changes. Using four months moving averages to plot inflation and frequency and size of price changes, there is evidence that variance in inflation is strongly correlated with the size of price changes rather than the frequency of price changes, which corresponds also with international literature (see Klenow & Kryvtsov, 2008; Nakamura & Steinsson, 2008).

We decompose the frequency of price changes into variation within a given store, variation across stores for a given product and lastly the idiosyncratic shock for a particular product and store. Interestingly, across all years, the fraction of variation which is common to all stores selling a particular product accounts for most of the total variation of the frequency of price changes. Store and store by product variation account for similar amounts of variation. Overall, price setting behaviour in Zimbabwe fits with the stylised facts identified by Klenow and Malin (2010).

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Table 1: Price records by major groups

Product class	Price quotes		Product items		Zimstat CPI Weights	CPI Re-weights
	Number	Percent	Number	Percent	Percent	Percent
Food						
Bread and Cereals	31 272	15.94	57	19.59	10.29	34.02
Meat	11 422	5.82	24	8.25	5.26	17.40
Milk, Cheese and Eggs	14 643	7.46	24	8.25	1.86	6.15
Oil and Fats	14 604	7.44	35	12.03	2.30	7.60
Vegetables	16 299	8.31	27	9.28	1.88	6.21
Sugar, jam, honey, chocolate and confectionery	4 896	2.50	15	5.15	2.48	8.20
Other food products	10 835	5.52	8	2.75	0.39	1.29
Coffee, tea and cocoa	8 335	4.25	7	2.41	0.22	0.73
Mineral waters, soft drinks, fruit and vegetable juices	12 880	6.56	19	6.53	0.72	2.38
Beer	2 038	1.04	1	0.34	0.72	2.37
Non-food products						
Household Maintenance	29 310	14.94	34	11.68	2.60	8.60
Stationery	5 540	2.82	6	2.06	0.32	1.04
Other appliances, articles and products for personal care	34 125	17.39	34	11.68	1.21	4.00
Total	**196 199**	**100**	**291**	**100**	**30.24**	**100**

Table 2: Summary Statistics

Product	Mean price ($)	Standard deviation	Number of observations	Min	Max	Median
White Bread	0.98	0.06	1212	0.60	1.10	1.00
Flour	2.89	1.24	1791	1.69	6.45	2.25
Super Refined Meal	9.18	3.37	614	5.00	17.15	7.65
Roller Meal	6.62	2.79	1013	2.40	14.00	6.16
Cereals	3.74	1.13	1586	0.95	10.89	3.48
Rice	2.71	2.18	1787	0.85	19.40	2.20
Beef	7.73	2.15	1511	4.30	13.50	6.95
Chicken	6.16	1.82	880	2.17	9.00	6.89
Pork	5.25	0.79	513	3.30	8.50	5.25
Sour Milk	0.75	0.06	660	0.50	0.99	0.75
Fresh Milk	0.82	0.14	585	0.65	1.50	0.79
Sterilised Milk	0.92	0.05	327	0.75	1.00	0.90
Powdered milk	4.16	1.38	1815	1.00	8.80	4.20
Eggs	5.55	0.41	363	4.40	6.90	5.65
Peanut Butter	1.83	0.21	585	1.30	2.69	1.88
Cooking Oil	3.42	0.98	1437	1.40	5.52	3.80
Margarine	3.39	2.71	1687	0.70	11.80	2.65
Cabbage	0.92	0.18	267	0.49	1.45	0.95
Lettuce	0.85	0.15	101	0.50	1.20	0.90
Onions	1.49	0.43	249	0.69	3.60	1.45
Tomatoes	1.30	0.39	269	0.60	2.45	1.26
Baked Beans	1.30	0.39	1119	0.65	2.60	1.20
Peas	2.05	0.68	347	0.79	3.30	2.15
Chips	1.80	0.50	1034	0.20	2.73	1.99
Tomato Sauce	1.88	0.94	633	0.85	5.50	1.40
White Sugar	2.17	0.22	291	1.80	2.70	2.20
Brown Sugar	2.03	0.20	303	1.65	2.40	2.00
Jam	2.32	0.66	642	0.90	4.65	2.10
Salt	0.66	0.23	1624	0.25	1.20	0.52
Soups	0.48	0.08	1143	0.29	0.75	0.49
Tea	2.86	0.96	2142	1.02	5.20	2.60
Mineral Water	0.55	0.23	739	0.30	2.55	0.50
Soft Drinks	0.76	0.29	997	0.40	1.70	0.80
Fruit Squash	2.87	0.33	1548	1.70	3.80	2.90
Beer	1.23	0.42	515	0.65	2.20	1.10
Washing Soaps	1.59	0.24	1062	0.99	2.10	1.59
Washing Powder	2.84	1.56	2353	0.70	9.65	2.30
Detergents	1.68	0.79	1976	0.43	4.25	1.70
Matches	0.57	0.14	431	0.25	1.00	0.55
Candles	1.87	0.25	561	1.00	2.30	1.90
Shoe Polish	1.46	0.56	911	0.70	2.80	1.20
Floor Polish	4.71	2.54	1138	1.30	10.20	3.65
Exercise Books	0.54	0.40	1152	0.10	2.65	0.45
Pen	0.21	0.15	266	0.12	1.98	0.20
Bathing Soap	0.95	0.25	2118	0.46	1.80	0.95
Toilet paper	1.13	0.41	440	0.26	2.20	1.20
Skin cream	2.72	0.88	1494	1.00	5.85	2.50
Petroleum Jelly	1.53	0.66	1974	0.65	3.95	1.37
Toothpaste	1.05	0.28	950	0.45	1.80	1.05
Sanitary pads	1.32	0.44	866	0.70	2.99	1.10

Table 3: Average frequency of price changes across all products

	Aggregate	Increases	Decreases
Mean Frequency of price changes (Unweighted)	0.24	0.114	0.123
Mean frequency of price changes (Weighted)	0.25	0.128	0.125

Table 4: Comparison of the frequency of price changes across countries

	Frequency of price changes (%)	Mean Implied Duration
Zimbabwe (2012-2015)	25.3	3.9
Lesotho (2002-2009)	37.1	2.7
South Africa (2002-2007)	17.1	5.8
Sierra Leone (1998-2003)	51	2.0
United States (1998-2003)	24.8	4.0
Spain (1993-2001)	15	6.7
France (1994-2003)	18.9	5.3

Table 5: Average frequency of price changes by product categories

Product category	Weighted			Unweighted		
	Frequency of price changes	Frequency of price increases	Frequency of price decreases	Frequency of price changes	Frequency of price increases	Frequency of price decreases
Food						
Bread and Cereals	0.227	0.117	0.109	0.256	0.123	0.133
Meat	0.328	0.160	0.168	0.292	0.138	0.154
Milk, Cheese and Eggs	0.234	0.129	0.105	0.222	0.114	0.108
Oils and fats	0.271	0.131	0.141	0.233	0.114	0.120
Vegetables	0.349	0.159	0.190	0.247	0.115	0.132
Sugar, jam, honey, and confectionery	0.215	0.099	0.116	0.164	0.074	0.090
Other food products	0.161	0.085	0.076	0.188	0.096	0.092
Coffee, tea and cocoa	0.204	0.098	0.105	0.204	0.098	0.105
Mineral Waters, soft drinks, fruit juices	0.199	0.087	0.111	0.181	0.081	0.100
Beer	0.289	0.151	0.138	0.289	0.151	0.138
Non Food Products						
Household maintenance	0.247	0.127	0.120	0.276	0.134	0.142
Stationery	0.122	0.044	0.078	0.157	0.068	0.090
Personal Care	0.236	0.113	0.123	0.234	0.112	0.122

Table 6: Average size of price increases and decreases, conditional on a price change, by product category

Product category	Weighted			Unweighted		
	Size of price changes	Size of price increases	Size of price decreases	Size of price changes	Size of price increases	Size of price decreases
Food						
Bread and Cereals	-0.005	0.068	-0.071	-0.001	0.076	-0.081
Meat	-0.006	0.102	-0.112	-0.002	0.102	-0.106
Milk, Cheese and Eggs	0.002	0.083	-0.090	-0.001	0.090	-0.103
Oils and fats	-0.005	0.055	-0.060	-0.001	0.079	-0.080
Vegetables	-0.011	0.206	-0.193	-0.002	0.190	-0.183
Sugar, jam, honey, and confectionery	-0.007	0.069	-0.071	-0.002	0.091	-0.097
Other food products	-0.001	0.119	-0.134	-0.001	0.134	-0.152
Coffee, tea and cocoa	0.005	0.161	-0.141	0.001	0.161	-0.141
Mineral Waters, soft drinks, fruit juices	-0.021	0.128	-0.122	-0.003	0.076	-0.091
Beer	0.002	0.149	-0.159	0.000	0.149	-0.159
Non Food Products						
Household maintenance	-0.009	0.089	-0.108	-0.003	0.115	-0.133
Stationery	-0.032	0.222	-0.163	-0.001	0.284	-0.223
Personal Care	-0.010	0.132	-0.139	-0.003	0.130	-0.143

Table 7: Time series moments for price changes

Variable	Mean	Std dev	Corr with cpi	Regression on cpi	
	%	%		Coef	Std. Err
Cpi	-0.03	0.79			
fre	25.32	9.93	0.3	0.024**	0.01
dp	-0.66	2.28	0.8	0.276***	0.04
fr+	12.83	6.62	0.71	0.085 ***	0.01
fr-	12.49	5.51	-0.31	-0.04**	0.02
dp+	6.85	1.66	0.38	0.174***	0.01
dp-	-7.25	1.42	-0.3	-0.176***	0.02

*Note: *** significant at 5 percent **significant at 10 percent*
Data covers the period January 2012 to February 2015 obtained from the National Incomes and Pricing Commission. The entries are means, standard deviations and correlations across time of the monthly values of each variable relative to inflation. The last two columns are OLS regressions and standard errors of each variable individually on inflation, with the monthly variables across time weighted using 2013 CPI weights obtained from Zimstats.
Cpi = Inflation
fre = frequency of price changes
dp = size of price changes
fr+ = frequency of price increases
fr- = frequency of price decreases
dp+ size of price increases
dp- size of price decreases

Table 8: Variance decomposition of the frequency of price changes

	Store	Product	Store-Product
2012	16.51	60.53	22.96
2013	23.44	55.34	21.22
2014	24.80	54.29	20.92

Table 9: Variance decomposition by product category

	Store	Product	Store-Product
Bread & Cereals	19.38	58.52	22.11
Meat	35.74	45.76	18.50
Milk, Chees & Eggs	26.76	52.91	20.33
Oils and Fats	19.85	58.35	21.80
Vegetables	21.37	57.10	21.53
Household Maintenance	19.65	58.14	22.20

Figure 1: Distribution and Clustering of prices

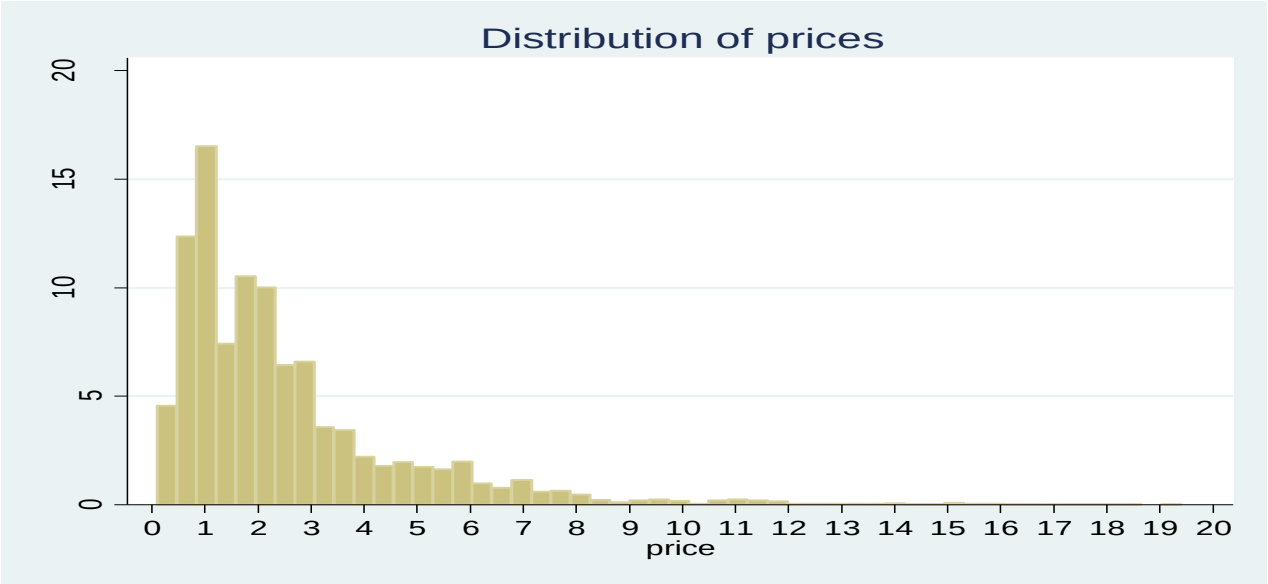
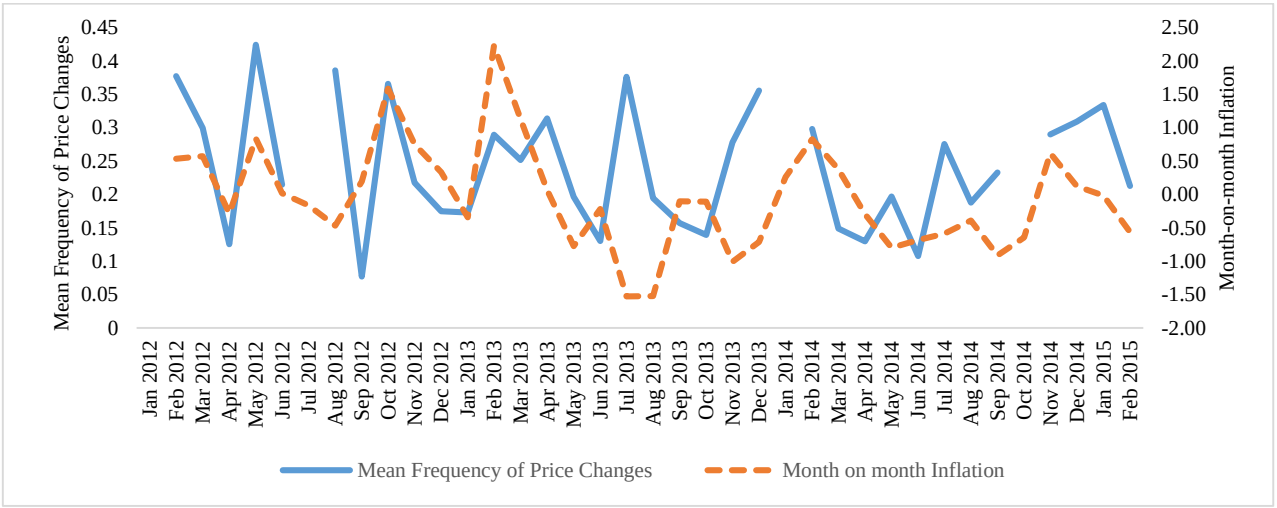


Figure 2: Frequency of price changes per month and month-on-month inflation



Note: The month on month inflation rate was calculated for the products only in the dataset using the magnitude of price changes and Consumer Price Index reweights.

Figure 3: Histogram of magnitude of price changes

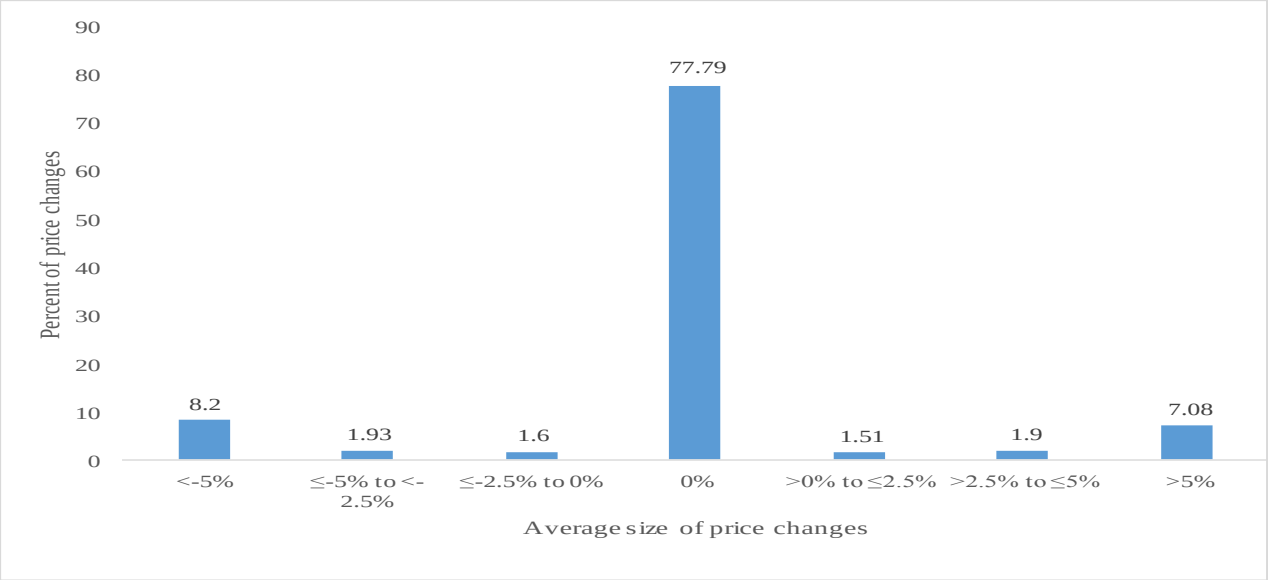


Figure 4: Distribution of average size of price changes

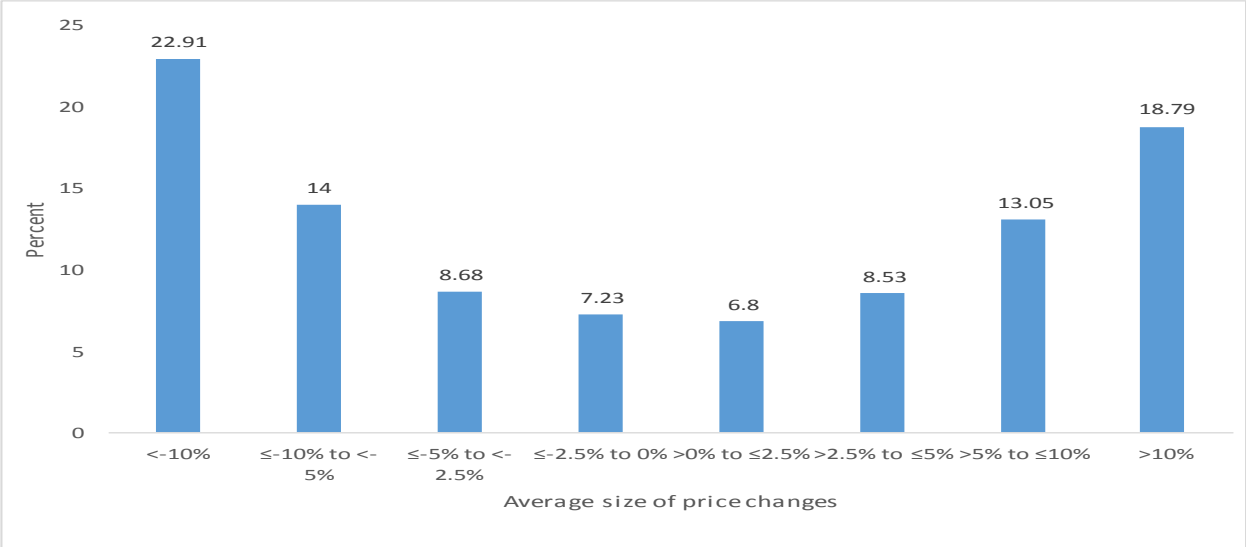


Figure 5: Frequency of price changes with monthly dummies

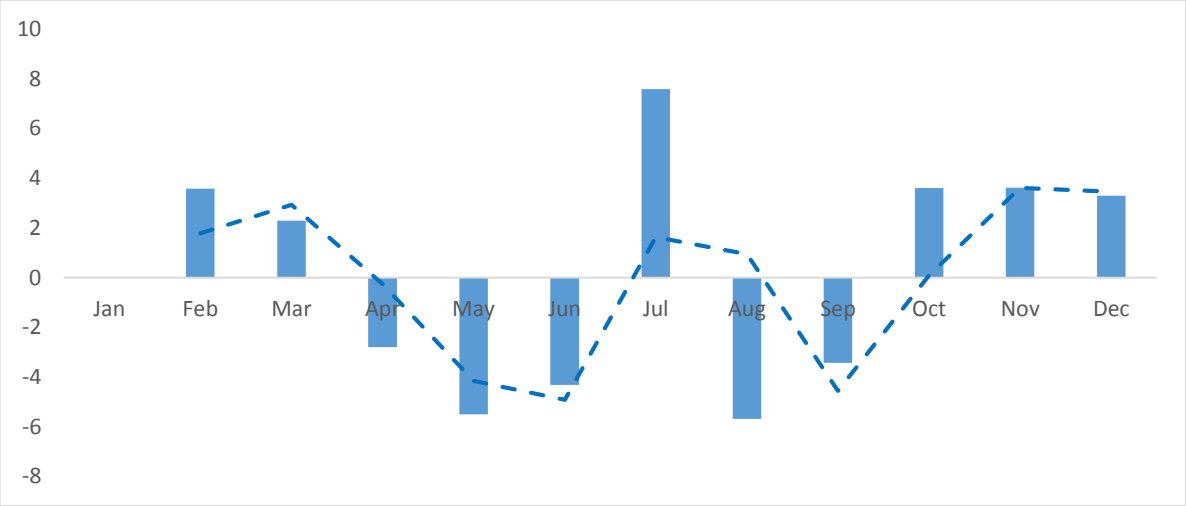


Figure 6: Frequency of price changes and time

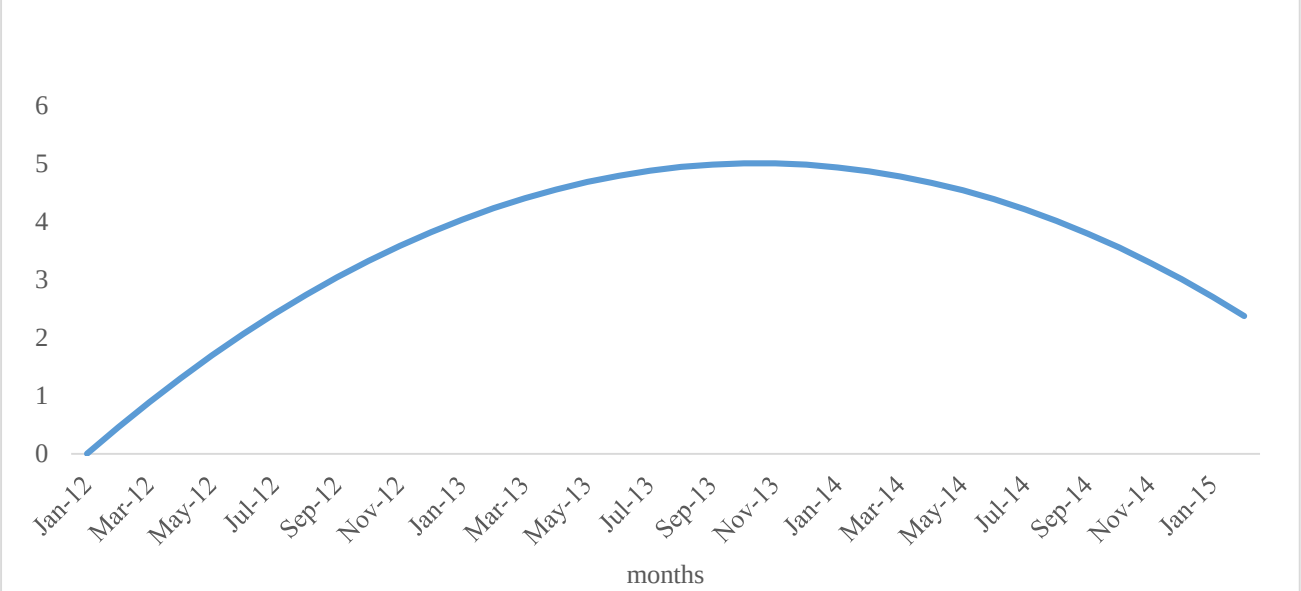
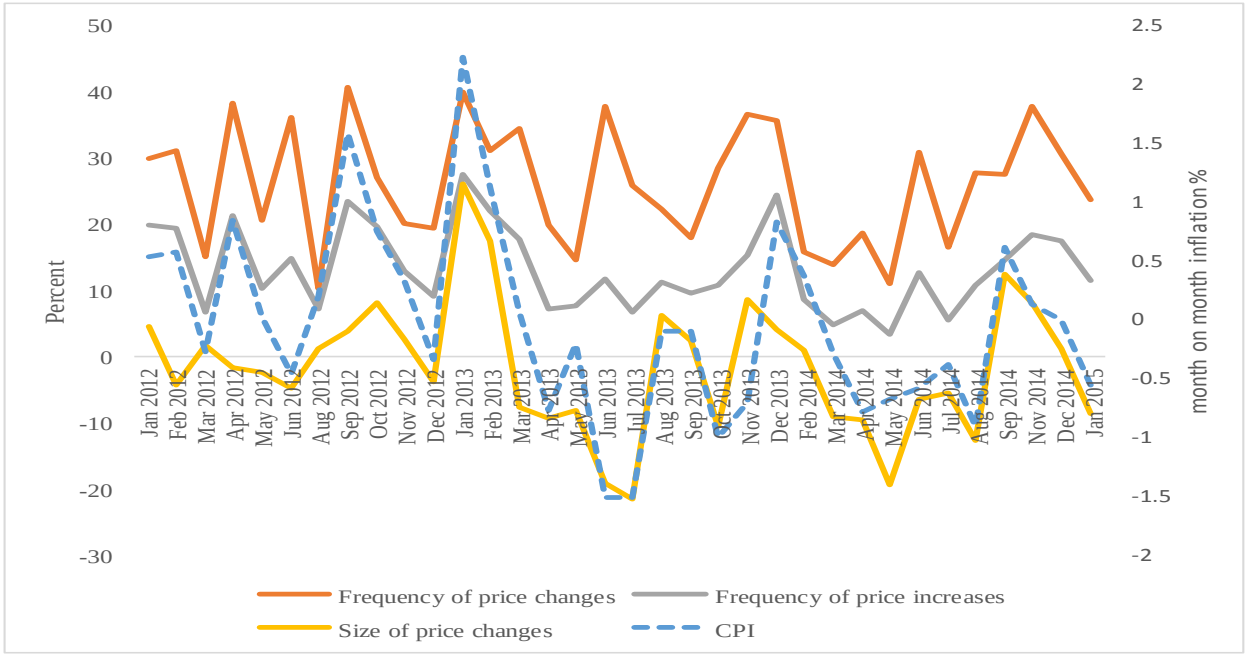


Figure 7: Frequency and size of price changes with month on month inflation (weighted)



Note: The month-on-month inflation is restricted to only products in the sample

Figure 8: Four month moving averages for CPI, frequency and size of price changes

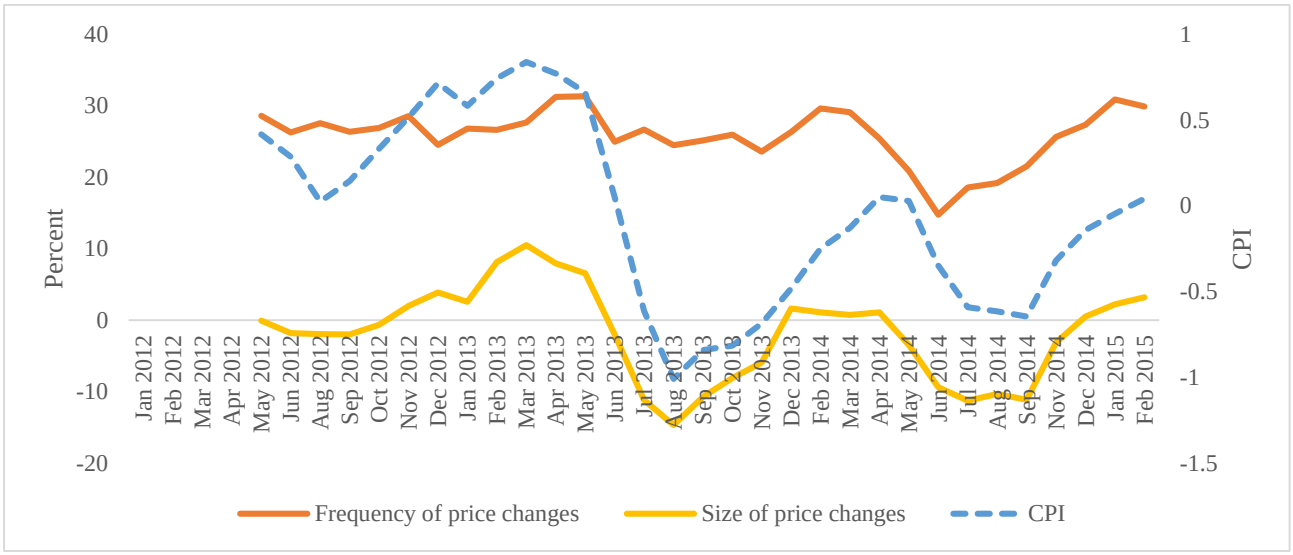


Figure 9: Four month moving averages of inflation, frequency of price increases and frequency of price decreases

Figure 10: Hazard function

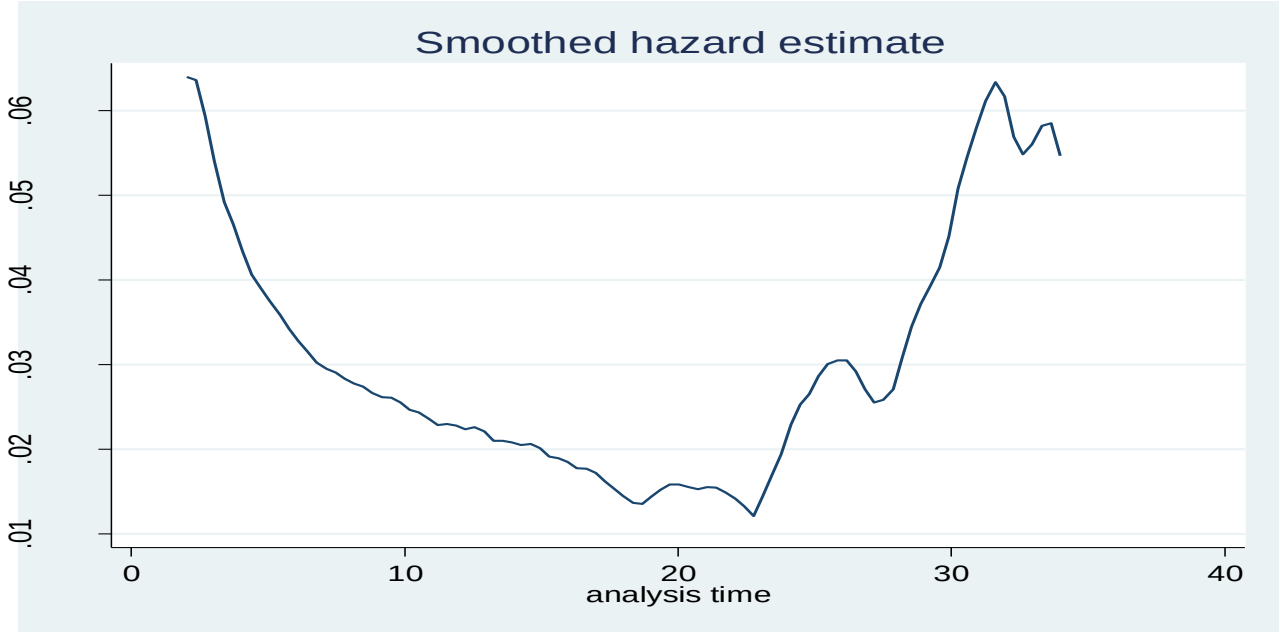


Figure 11: Hazard functions for food products

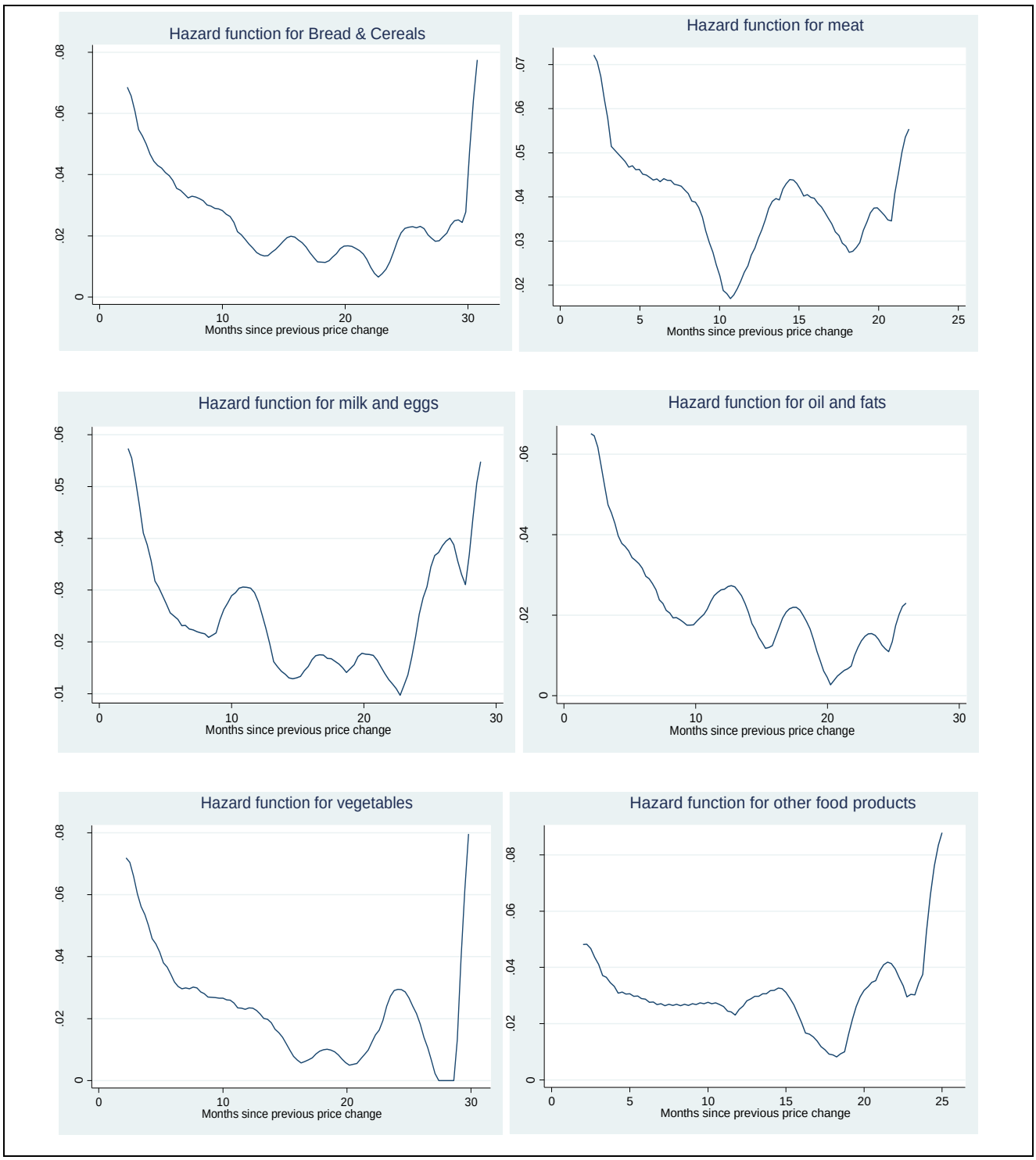


Figure 12: Hazard functions for non-food products