Import Tariff Pass through Effect and the Spatial Distribution of Domestic Consumer Goods Prices: Zimbabwe (2009-2014)

By

Everisto Mugocha

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School of Economics and Business Sciences

University of the Witwatersrand

Supervisor: Professor Miracle Benhura

Abstract

The study of import tariffs pass through has been observed to be crucial for policy making, for instance this may inflate some goods' prices with a negative effect on individual welfare. However, extant literature on the import tariffs pass through effect has largely ignored the possibility of spatial dependence between domestic goods prices which may brew imprecise estimates. Hence, this study proposes an extension of the traditional empirical model for estimating the import tariff pass through effect by introducing controls for the domestic spatial dependence of prices. The estimates relied on a panel dataset of consumer goods for Zimbabwe, which has both the individual spatial effect and the time spatial effects. Spatial Durbin model (SDM), Spatial AutoRegressive model (SAR), Spatial Error model (SEM), Spatial Autoregressive with Spatially Autocorrelated Errors model (SARAR) and the Generalised Spatial Random effect model (GSPRE) all agree that there is positive spatial dependence of domestic goods' prices in Zimbabwe over the period 2009 to 2014. When compared to our modified model, the traditional import tariffs pass through model was found to highly overestimate the import tariffs pass through effect. The study found that a positive and significant portion of import tariffs is being passed on to domestic goods prices in Zimbabwe, and also that provinces are disproportionately affected by import tariffs. Thus there is need for policy to be cautious of the import tariffs increase in relation to national inflation, and poverty targets.

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1.0 Introduction

The way in which import tariffs interact with domestic goods price hinges on the pass through effect. Import tariffs pass through to domestic goods prices incorporate how changes in import tariffs are transmitted to domestic price. Understanding the import tariff pass through to domestic goods price is important as it affects other real economic variables like inflation, industrialisation, economic growth and household welfare (Ahn and Park, 2014). Studies of import tariffs pass through to domestic goods prices are of paramount importance to researchers, policy analyst and policy makers as the findings help to establish the magnitude and the speed of the effect of an import tariffs change on other economic variables.

In assessing the import tariff or exchange pass through effect to domestic good prices, Zubair et al., (2013), Clarida and Gali (1994) used time series and macroeconomics data in a Vector Autoregression (VAR). Shambaugh, (2008), Faust and Rogers, (2003) engaged the pass through equation model, impulse response and the variance decomposition to determine the speed and magnitude of changes in the import tariffs on domestic prices. Their findings range from complete[1], moderate, incomplete[2] to low and fairly slow pass through. Traditional studies on the import tariffs pass through fail to establish the effects of spatial price distribution on the import tariffs pass through. Thus they do not incorporate the link between spatial distribution of the domestic prices and the pass through effects, (Campa and Goldberg, 2002; Ahn and Park, 2014; Calvo and Reinhart, 2002; Goldberg and Campa, 2010). The spatial distribution of domestic prices affect the resulting effect of import tariffs pass through on domestic goods prices. The failure to control for the nature of domestic spatial price distribution when commenting on the import tariff pass through is of great concern. Chances are that researchers might think that it is the import tariff pass through which is high yet it might be the nature of the domestic spatial price distribution.

[1] A complete pass through implies that, for example a 10 percent increase in import tariffs will also result in a 10 percent increase in domestic prices. That is, all the changes in import tariffs are completely passed on to domestic goods prices.

[2] Incomplete import tariffs pass through means that a change in import tariff will result in a small effect on domestic goods prices.

The spatial distribution of domestic goods prices can be random[3] or spatially depended[4]. The influence can be positive or negative which can also be called positive or negative spatial dependence. Positive spatial correlation means that prices in one district positively affects prices in other districts. Increasing price in one district will affect other surrounding districts. When the spatial distribution of prices is random, then there is no price relation across districts. Increasing price in one district will likely result in zero effect on prices of the surrounding districts.

In cases where domestic prices are spatially randomly distributed, then a change in import tariffs is likely to affect districts price randomly without a second round effect due to the fact that prices in different districts are not spatially correlated (Beag and Singla, 2014). If the districts prices are spatially correlated then an import tariff change will have second and third round effects, (Sekhar, 2012).

What we learn is that the nature of spatial distribution of domestic prices is important when assessing import tariffs pass through effects. Not controlling for spatial price distribution when estimating the import tariffs pass through is likely to bias the estimates. Traditional studies on import tariffs pass through do not control for spatial price distribution, (Zubair et al., 2013; Clarida and Gali, 1994; Shambaugh, 2008; Faust and Rogers, 2003). Thus there is gap in literature of import tariffs pass through.

On one hand there is growing literature which model space through spatial econometrics modelling. On the other side there are also studies on the import tariff pass through to domestic goods price. There is limited literature which combines these two aspects together. The few studies which combine spatial econometrics and pass through are more focused on agriculture products and they use granger causality and pairwise cointergration to determine spatial distribution of prices between different markets, (Jayasuriya et al, 2007; Beag and Singla, 2014; Deodhar et al, 2007; Ghosh, 2011). Studies on spatial econometrics by Salehyan and Gleditsch (2006) and Salehyam (2008) only determine the existence or non-existence of the spatial dependence. They fail to carry the analysis further by looking at the connection between spatial

[3] means that prices in one district are not affected or influenced by prices in another districts, (LeSage and Pace, 2005)

[4] Means that prices in one district are influenced by prices in another districts, (Sen and Smith, 1995).

distribution effects and pass through of import tariffs at different provinces or regions in a country.

Shambaugh (2008), Faust and Rogers (2003) among others, used macro level data to investigate the import tariffs pass through. They did not consider to investigate the spatial effects of the import tariffs variations. A few studies on pass through which use micro-data fail to provide evidence for the spatial dependence before analysing the pass through effects, (Varela et al., 2012). This literature gap brings out the need for studies which merge spatial econometrics and pass through in order to fully explore the effects and distribution of the import tariffs changes. In that respect this study seeks to combine these two methodologies as it contributes to the existing body of knowledge.

A review of trade studies deficiency on import tariffs pass through studies focusing on Zimbabwe, (Hayakawa and Ito, 2015; Mugano et al., 2013). The recent hyperinflation, adoption of multiple currency and the use of a fiscal cash budget make it interesting to undertake an import tariff pass through study on Zimbabwe, (Zimbabwe Economic Policy and Research Unit, 2012; Reserve Bank of Zimbabwe, 2014; Confederation of Zimbabwe Industry, 2013). A country not using its own currency has limited power to influence its exchange rates. Such a country takes the exchange rate as given and thus has limited policy influence as it can only adjust the import tariff rates to affect the flow of trade. Literature shows a growing number of countries adopting other countries currency. These countries include Ecuador, Liberia, Zimbabwe and Guatemala (Minda, 2005). With the growing pressure towards currency unions such countries will soon be on the increase.

Mugano et al., (2013) focused on Zimbabwe but the study looked only at the impact of most favoured nation tariffs rate on Zimbabwe. The study did not include other import tariffs types hence exclude trade between Zimbabwe and the rest of the World. Zimbabwe does trade with the rest of the world thus trade policy in Zimbabwe should inculcate all the countries.

In light of the above research problems, the studies main objective is to combine spatial econometric and the pass-through literature in analysing the spatial distribution of prices in different districts of Zimbabwe. Prices survey data from the Zimbabwe statistical agency, import tariff rates from Zimbabwe revenue authority and Zimbabwe shape files are going to be used in the analysis. This study aims at contributing to knowledge through building an import tariffs pass through model which controls for spatial distribution of prices. The study will also contribute to existing literature as it uses micro-data for Zimbabwe to investigate the import tariff pass through to the domestic goods price over the period 2009 to 2014. It is also important to state the unique economic system that Zimbabwe went through during the period under study.

1.2 Background of the Zimbabwean Economy

In 2009 the Zimbabwean government adopted the multiple currency economic system. This economic system allowed the use of multiple currencies as legal tender in Zimbabwe (Government of Zimbabwe, 2009). At such a time, the Zimbabwean currency was dysfunctional following its rejection by Zimbabweans after the hyperinflation period of 2000-2008. Such an economic system meant that the Reserve Bank of Zimbabwe was not printing money and had no opportunity to use the exchange rate to influence economic variables. It should also be noted that during the same period, the Zimbabwean government adopted the cash budgeting system in managing national income and expenditure (Government of Zimbabwe, 2009). A cash budget system means that the country could not borrow either domestically or internationally to finance government expenditure. Thus, the government was depending on tax which included import tariffs to generate government revenue. These unique economic characteristics makes it interesting to research on how the issue of import tariff pass through affected the domestic prices.

Prior to the 2009- 2014 period, Zimbabwe had implemented multiple macroeconomic policies which had effects on the import tariffs and the domestic goods prices. After attaining independence in 1980, the Zimbabwean government implemented policies which were targeted towards empowering the poor and most vulnerable groups of the population, (Tereke, 2001). In doing that they promoted industrialisation through import substitution which meant rising import tariffs with the objective of protecting and promoting domestic industries. In the period 1994-1996 the Zimbabwean government embarked on the Economic Structural Adjustment Programs (ESAP) which was highly towards liberalisation of the economy, (Chitiga, 2004). ESAP meant that import tariffs and other trade restrictive measure were to be reduced as the country focused on export oriented growth strategies.

After abandoning ESAP, the country reversed the liberalisation strategies which included rising import tariffs as it went back to protect the domestic industries (Tekere, 2001). With the growing bilateral and multilateral trade agreements such as SADC, COMESA, the countries import tariffs had to be reduced as the country was aimed at facilitating trade with its regional counterparts. However, there was a problem of reducing import tariffs to promote regional trade at the expense of exposing domestic industries to external competition. The research is more interesting given the unique characteristics of the Zimbabwean economy during the period under study. Due to the multiple currency and the cash budgeting, the government needed to generate revenue through taxes like import tariffs. The findings of the study will therefore show the effects of import tariffs changes on the domestic prices and household welfare.

1.3 Spatial differences in Zimbabwe

Before determining the spatial distribution of prices and the spatial effects of import tariffs, it should be noted that the historical spatial settlement, rainfall patterns and agriculture regions already gives an indication of price difference across regions. Prior to the 1980 independence, the European White settlers relocated the black Zimbabweans to less fertile and semi-arid regions. Zimbabwe is generally divided into 5 Natural Farming Regions (NFR) as shown in table 1 below.

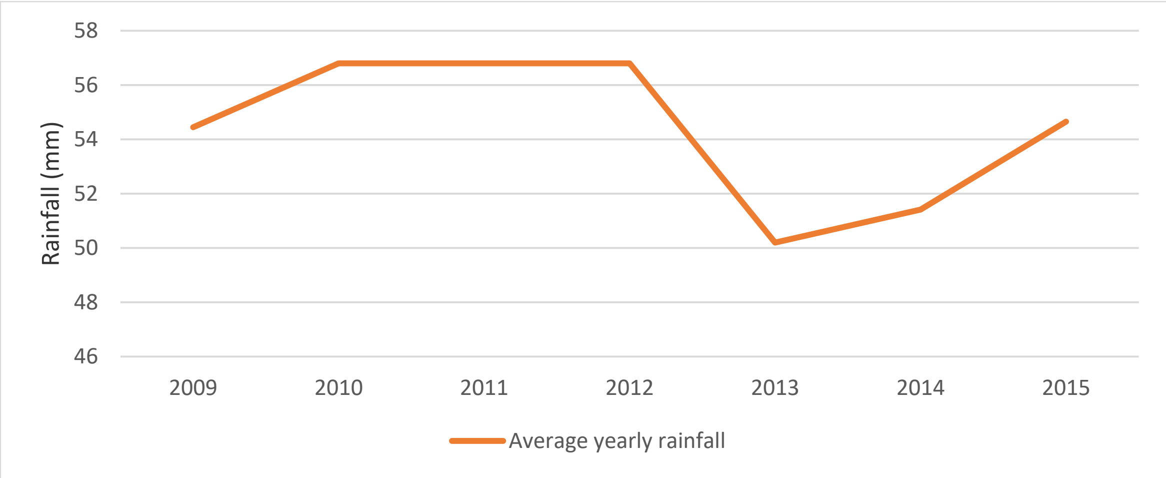
Table 1: Natural Farming Regions in Zimbabwe

Natural Farming Region	Province covered	Characteristics
1	Manicaland	1050mm or more rainfall per annum, relatively low temperature
2	Mashonaland East, Harare, Mashonaland Central	700-1050 mm rainfall per annum
3	Mashonaland West, Midland	500-700mm rainfall per annum, relatively high temperatures, subjective seasonal droughts
4	Matebeleland North, Matabeleland South	450-600mm rainfall per annum and subject to frequent seasonal droughts
5	Masvingo	less than 500mm rainfall per annum poorer soil

Source: Dube (2008)

White settlers forced the black Zimbabweans to move from NFR 1 and 2 into NFR 3, 4 and 5 which have high temperatures and receive lower rainfall (Dube, 2008). Provinces in NFR 1 and 2 also happened to have better roads and railway infrastructure and most agriculture industries are located in these provinces, (Dube et al., 2013). Though the 1980 independence tried to address this disparity, the effects are still being felt. This means that prices of agriculture products are expected to be higher in NFR 3, 4 and 5. However, this is subject to receiving of good rainfall and good national economic performance. Recently the country has not been receiving enough rainfall as shown in Figure 2 below. Over the period under study, the country received a yearly average maximum rainfall of 56.7 millimetres between 2010 and 2012, and a minimum yearly average rainfall of 50 millimetres in 2013. The economic performance of the country has also been subdued. This has resulted in the economy depending more on imported product. Thus benefiting more, regions which are located closer to major countries trading partners like South Africa, Botswana and Namibia. This situation would mean that prices are expected to be lower in Matebeleland North, Matebeleland South and Masvingo provinces.

Figure 1: Average Yearly Rainfall



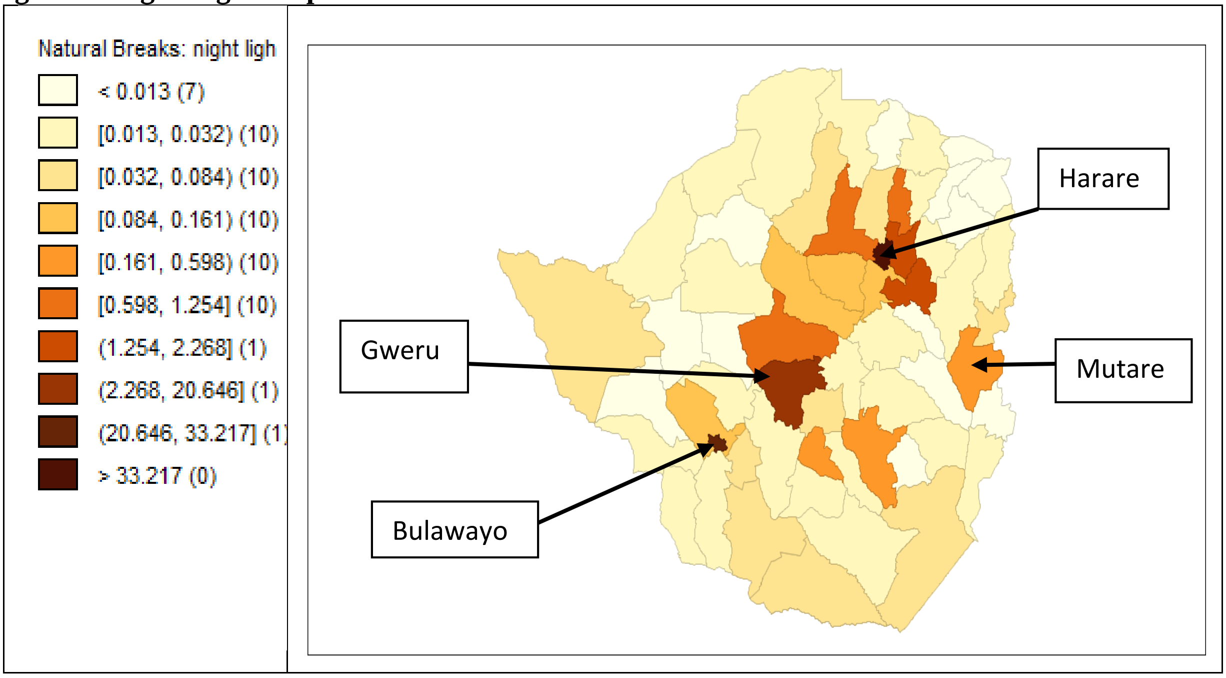
Source: World Bank Climate Data Portal (2018)

Another indicator which can also show the a-priori spatial difference of prices in Zimbabwe is the level of economic activities across different districts. Night light has been used as a proxy of measuring economic growth or the level of economic activities, (Ebener et al., 2005; Doll et al., 2009 and Xi et al., 2010). In Figure 2 below we present the spatial map of night light in Zimbabwe for the year 2012. The data used in the map was taken from QGIS Rasta files.

What we can observe from the figure below is that levels of economic activities highly varies across different districts in Zimbabwe. On the map below the darker the colour the more the night light intensity, which implies higher economic activity. We can notice that Harare and Bulawayo have the highest levels of economic activities followed by other districts like Mutare, Gweru, Zvishavane and Marondera among other districts. The distribution of the night light intensity highly represents economic activity as we also have industrial hubs or mining activities in the districts with high night light intensity. A district located closer to an industrial hub in highly likely to enjoy lower price of the goods produced with the industries close to that district. Following the price gravity model, price varies with distance (Goldberg and Campa, 2010). Therefore, districts far away from the industrial hub are bound to have higher prices.

Thus the map provides a-priory information of how prices in Zimbabwe are likely to be distributed.

Figure 2: Night Light Map of Zimbabwe for the Year 2012



Source: GeoDa

This section provides the motivation of the study. As discussed above, it is clear that there is a literature gap. The gap is on establishing the import tariff pass through to domestic goods prices for a country using a cash budget and a multiple currency economic system. In light of the above problems, the study seeks to investigate the spatial distribution of the domestic prices and then establish the import tariff pass through to domestic price across the districts and the products. In addressing the problems, the study will use data for Zimbabwe from 2009 to 2014. The rest of the study will be structured as follows; section 2 will elude on the theoretical and empirical literature review. Methodology and data description will be shown in section 3 and the findings of the study will then be presented and analysed in section 4.

2.0 Literature Review

The study combines the import tariffs pass through and the spatial econometrics literature. In that respect, this section will be broken down into two. The first part will give theoretical literature of the import tariffs pass through. Section 2.3 will develop the theoretical model which combine spatial econometrics and import tariffs pass through.

2.1 Theory of import tariffs pass through to domestic goods prices

The theoretical model of import tariffs pass through to domestic goods prices highly borrows from the law of one price which encompasses the works of Engel and Roger, (1996); Ceglowski, (2004) and Goldberg, (1996) among others. The law of one price state that in a well-functioning economy, the price of the similar goods should be the same in different places or regions subject to transport cost. If at one point the price of say bread is $1 in region A and $2 in region B then, traders would arbitrage and make more profit if they can buy bread from region A and sell it in region B. Overtime the prices in both markets will change as they respond to the forces of supply and demand such that the disparities will disappear as prices conform to the law of one price (Rogoff et al., 2001).

Evidence has shown some disparities in prices meeting the law of one price. Other studies have pointed to the movement towards the law of one price being currently slower compared to the situation in the fourteenth and thirteenth centuries, (Maurice and Rogoff, 2000; Alan, 2000). The main drivers of the failure of prices to conform to the law of one price have been cited as growing domestic nominal price rigidities, high nominal exchange rates volatilities, market segmentation, capital controls, coordinated financial regulation and coordination in trade policies.

Another evidence for the failure of the law of one price is the fact that goods have different attributes even when they are similar and also that consumers have imperfect information about prices in different places. The study acknowledges the growing evidence of the failure of the law of one price and accepts that prices are different across regions even after accounting for transport cost and exchange rate variation. Proceeding in that way we consider that the consumer basket comprises of imported and domestically produced goods. Betts and Devereux (2000) noted that imported goods prices are temporary rigid in markets blocks the transmission of import tariffs to domestic goods prices. Obstfeld and Rogoff, (2001) also pointed out that import tariffs pass through to domestic goods prices is influenced by whether prices are set in producer or local currency. Prices are relatively sticky downwards in the producer's currency. Thus the production and distribution channels affect the pass through mostly if intermediate inputs are imported. These models consider all the economic agent in an optimisation behaviour to explain the effects of the import tariffs on the domestic goods prices. Focusing on the price function and acknowledging that the price setting dynamics affect the import tariffs pass through and that average unit price of goods are a factor of domestic and imported goods prices, we assume a mark-up over marginal cost and a Cobb-Douglas production function. Thus, the average unit price of good 1 in location j, P_{1j} can be represented in the form (3.1);

$$P_{1j} = \mu_{1j}\left(P_{1j}^{D}\right)^{\gamma}\left(P_{1j}^{I}\right)^{1-\gamma} \ldots\ldots .3.1$$

Where $\gamma < 1$

μ_{1j} is the mark-up over marginal cost of product *1* in location *j*, *D* captures domestically produced goods, *I* captures imported goods and γ is the substitution effect between imported and domestically produced goods. The prices of imported goods P_{1}^{I} are made up of import tariffs and they are expressed as (3.2);

$$P_{1j}^{D} = P_{1}^{B}(1 + t_{1}) \ldots\ldots .3.2$$

Where *B* depicts prices of goods at the border before import tariffs are added, *t* is the import tariffs rate of product *1* at a given time. Transforming 3.1 into logarithms, substituting 3.2 and differentiating with respect to the log of tariffs we get;

$$\frac{\partial logP_{1j}}{\partial \log t_{1}} = (1-\gamma) \ldots \quad 3.3$$

Given that $\gamma < 1$, then $\frac{\partial logP_{1j}}{\partial \log t_{1}} > 0$ ……3.4

which means, there is a positive relationship between unit price of products *1* and import tariffs at location *j*. It should be noted that it is not always the case that the effect of import tariffs of product *1* is the same across all the locations, such that;

$$\frac{\partial logP_{1j}}{\partial logt_{1}} \neq \frac{\partial logP_{1k}}{\partial logt_{1}} \ldots\ldots\ldots 3.5$$

Where $j \neq k$. Regions which depend highly on imported goods should be seen reacting relatively more sensitive to import tariffs rate changes compared to other regions, (Moodley and Gordon, 2000). The same goes for regions close to industries which highly depend on imported materials. This shows the importance of including location in analysing regional price differences. Another issue that should also be noted is that the speed and magnitude of import tariffs effects on goods prices in different locations are bound to be non-uniform. Thus, showing the need of adding space in analysing import tariffs pass through to domestic goods prices.

The other extension to the law of one price is about the percentage of import tariffs that are passed through to goods prices. In most cases a 10 percentage increase in import tariffs will result in less than 10 percent increase in prices of domestic goods (Mudende, 2013). This scenario is called partial import tariff pass through. The extreme cases are when 100 percentage or 0 percentage of changes in import tariffs are passed-through to goods prices. The degree level of the pass through determines the power of import tariffs in influencing the substitution between domestic and imported goods.

2.2 Combining spatial econometrics and import tariff pass through

From equation 3.2 we know that the price P_{1j} of good 1 in district *j* is made up of the price at the border plus the import tariff component. Due to spatial correlation then we will add another component xP_{1k}. Where *x* represent the correlation between prices P_{1j} of good 1 in district *j* and price $P_{1k}$of good 1 in district *k*. This can be represented in the form

$$P_{1j} = P_1^B(1 + t_1) + xP_{1k} \text{.....................} 3.6$$

When there is spatial price randomness, meaning prices in one district are not correlated with prices in another district then $x = 0$ and we revert to equation 3.2. If there is price spatial dependence then $x \neq 0$ which means prices in one district are a factor of prices from other surrounding districts. What should be noted from 3.6 is that price P_{1k} is also affected by import tariffs *t* and it is also affected by prices from other districts such that P_{1k} can be expressed as;

$$P_{1k} = P_1^B(1 + t_1) + xP_{1l} \ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.7$$

If we substitute 3.7 into 3.6 we get

$$P_{1j} = P_1^B(1 + t) + xP_1^B(1 + t) + x^2P_1^B(1 + t) + x^3P_{1l} \ldots\ldots 3.8$$

It should also be noted that $P_{1l}$is also affected by import tariffs *t* and also affected by prices from other districts. Without loss of generality we can assume that we only have three districts which are districts *j, k* and *l*. Though in reality these districts can go even up to 100. If we differentiate 3.8 with respect to import tariff *t* we get,

$$\frac{\partial P_{1j}}{\partial t} = P_1^B + xP_1^B + x^2P_1^B + x^3\frac{\partial P_{1l}}{\partial t}\ldots\ldots 3.9$$

Equation 3.9 represents the change in price of P_{1j} caused by change in import tariffs t. When there is price spatial randomness then $x = 0$ and 3.9 will become

$$\frac{\partial P_{1j}}{\partial t} = P_1^B \quad \ldots 3.10$$

If we have positive spatial distribution of price that is price in one districts is (are) influenced by prices in the surrounded districts then, *x* will be positive and the effect of a change in tariffs will be as shown in 3.9. In cases where there is negative spatial price dependence then *x* will be negative such that 3.9 will become

$$\frac{\partial P_{1j}}{\partial t} = P_1^B - xP_1^B + x^2P_1^B - x^3\frac{\partial P_{1l}}{\partial t}\ldots .3.11$$

Equations 3.9 (positive spatial dependence), 3.10 (spatial randomness) and 3.11 (negative spatial dependence) shows that the effect of import tariffs changes highly depends on the nature of the spatial price distribution. This finding has implication on the import tariff pass through effects. In cases when there is positive spatial price dependence then, the effect of a small change on import tariff will be larger as there will be several rounds of effect or ripple effects which will escalate the effects. In cases when we have spatial randomness then a change in import tariffs will have a smaller effect on domestic goods prices. What we can conclude is that the effect of an import pass through highly depends on the nature of the spatial distribution of domestic goods prices.

2.3 Empirical literature review

This section reviews the empirical literature on import tariffs pass through to domestic goods prices. In motivating the objectives and contribution of the study, this section will first look at empirical literature on pass through in general and then compares it with studies of import tariffs pass through. The idea is to show a gap in literature of limited studies on import tariffs pass through. Secondly, the study will review the empirical literature of the import tariffs pass through. The main argument is to show limited studies which used disaggregated data at provincial or district level. Finally, literature on pass through will be reviewed in order to track the evolutions of the techniques that have been used over time.

The pass through effect measures the magnitude and the speed of how a certain variable or shock is passed on to other economic variables. However, there are fewer studies which specifically look at how import tariffs are passed through to domestic goods prices. Ahn and Park (2014); McCarthy (1999, 2000); (Taylor, 2000) under took studies to investigate exchange rate and the import tariffs pass through to domestic goods. These studies used Vector Autoregression in their estimation and also added the vector error correction. McCarthy (2000) used a different estimation technic called cholesky decomposition. Most of these studies focused on exchange rate pass through to domestic goods price (Blanchard and Quah, 1989; Betts and Devereux, 1996; Faust and Rogers, 2003; Shambaugh, 2008) among others. Table 2 below give a summary of studies on pass through and the estimation models they used.

The table gives more evidence about limited studies on import tariffs pass through to domestic prices. Although there are some studies which combine exchange rate and import tariffs pass through, there is need to separate these two effects for policy analysis purpose. The need to separate the effects of exchange rates and import tariffs on the domestic goods price becomes important mostly for those countries which are not using their own currency. Over the years we have seen a growing number of countries that have abandon their own currencies and adopted currencies of other countries.

Table 2: Summary Table of Pass through Studies

Authors	Model	Subject
Shambaugh, (2008)	variance decomposition impulse responses	Exchange rates and prices
Faust and Rogers, (2003)	VAR	Exchange rates
Blanchard and Quah, (1989)	VAR	Exchange rates
Clarida and Gali, (1994)	VAR decomposition impulse responses	Exchange rates
Campa and Goldberg, (2002)	VAR	Import tariffs- exchange rate pass through
Goldberg and Knetter, (1997)	Trends	Exchange rate pass through
Betts and Devereux, (1996)	General equilibrium model	Exchange rate pass through
Ahn and Park, (2014)	Vector error correction model	Import tariffs to prices
Woo, (1984)	VAR	Exchange rates and prices
Calvo and Reinhart, (2002)	VAR	Exchange rates
Bergin and Feenstra, (1999)	theoretical	Exchange rate pass through
McCarthy, (2000); McCarthy (1999)	restrictive VAR, cholesky decomposition	Exchange rate and import prices

Choudhri and Hakura, (2002)	VAR	Exchange rate pass through
Parsley, (2007)	OLS, error correction model	Exchange rate , price pass through
Goldberg and Campa, (2010)	Sensitivity analysis	Exchange rate prices pass through
Parsley, (2010)	OLS, error correction model	Exchange rate , price pass through
Taylor, (2000)	Staggering model in VAR	Exchange rate pass through to prices across countries
Mudende, (2013)	OLS	Tariff reforms and Zambian domestic markets
Naqvi and Ruzvi, (2006)	Structural VAR, impulse responds, variance decomposition	Exchange rate pass through to prices for Ghana
Liu and Tsang, (2008)	Phillips curve model	Global commodity prices
Bacchetta and Wincoop, (2002)	theoretical	Import price and exchange rate pass through

Source: own computation.

These countries include Guatemala, Ecuador, Liberia, and Zimbabwe among others as shown in the Table 3 below. Such countries do not have policy power to influence exchange rates as they take exchange rate as given. These countries highly depend on import tariffs rates or trade policy to influence the flow of trade. With growing movement towards currency unions, countries of such nature will soon be on the increase. Thus, there is need to separate import tariffs and the exchange rate pass through to the domestic goods prices.

Table 3: Selected Countries which Dollarized their Economies

Country	Currency used	Year
Guatemala	Quetzal and the American dollar	Since 2001
Ecuador	US dollar	Since 2000
Liberia	Liberian dollar and American dollar	Since 1945
Monaco	Euro and French franc	Euro since 2002, French franc since 1865
Micronesia	US dollar	Since 1944
Andorra	French Franc, Euro and Spanish peseta	Euro since 2002, French franc and Spanish peseta since 1278

Source: (Minda, 2005)

Focusing on the few studies which explicitly looked at import tariffs pass through to domestic prices, we see that most of the studies used macro level data. Goldberg and Campa (2010); Parsley (2010); Choudhri and Hakura (2002) used exchange rate, import prices, output levels, nominal shocks and supply shocks at an aggregated level. One problem of using macro level data is that it does not show the dynamics of the import tariffs pass through to domestic goods prices at lower level like provincial level. These studies assume that different provinces within a country are affected identically by the changes in import tariffs. This assumption is highly debatable due to the growing literature which shows the failure of the law of one price, (Alan, 2000).

The law of one price state that in a well-functioning economy when price of identical goods are different across locations, economic agents will arbitrage based on the price difference across locations. Overtime the arbitraging will affect the forces of supply and demand which will result in the goods having the same price in different locations. Maurice and Rogoff, (2000) pointed to the growing evidence of the failure of the law of one price. The major drivers leading to the growing literature on the failure of the law of one price include; rising nominal price rigidity, high volatility of exchange rates and product differentiation among others. Provinces closer to the borders are highly expected to respond differently to changes in import tariffs. Provinces located in industrial hubs of industries which highly depend on imported inputs should not be expected to react the same way to import tariffs changes when compared to other provinces of different characteristics. This gives an indication that different provinces within one country can be affected differently by the variations in the import tariffs rates. Thus, there is need to expand the literature of import tariffs pass through by including disaggregated level data at both location and product level.

If we consider disaggregation at product level, countries have multiple import tariff product lines which are different from each other. Import tariffs on food products are different from import tariffs on vehicles and machines. Due to this difference, countries may choose to increase import tariffs of a certain group of products while reducing import tariffs of the other group of products according to their domestic protection policy. In that same respect, prices of different goods can also vary differently overtime. The price of certain products might increase relative to another group of products. Given all these possible product variations it is important to disaggregate the analysis at product level.

Table 2 shows bias towards the use of the Vector Autoregression (VAR). Most of the studies use impulse respond functions, variance decomposition, cholesky decomposition and error correction model. A few use Ordinary least regression estimation. Choudhri and Hakura (2002) used VAR and impulse respond functions to investigate the exchange rate pass through in different products. The study used consumer prices, producer prices, export and import prices, terms of trade and exchange rates at aggregated level. The paper profound the importance of including stick prices, sticky wages, distributional cost, local and producer pricing shocks in

VAR to explain the exchange rate pass through. A number of studies also used the same technique and these include Rudebusch (1998), Clarida and Gali (1994), Blanchard and Quah (1989), Campa and Goldberg (2002).

Studies above have been criticized based on their failure to separate economic shocks and variable shocks. In a VAR and impulse response functions it is not easy to tell when variables are shocking each other or when they are all responding to common economic shocks like business cycles. Faust and Rogers (2003) pointed to the need of identifying common economic shocks first before running the impulse response functions. Shambaugh (2008) noted the importance of identifying economic shocks like supply shocks, nominal shocks and demand shocks before allowing variables to shock each other. Bacchetta and Wincoop (1999) pointed to the inclusion of lagged variable in dealing with common shocks in the data. Sachs (1985), Woo (1984) discussed the issue of common shocks and endogeneity problem. They included dummy variables in checking for robustness in their model and controlled for omitted variables but also failed to account for common shocks in the data.

Goldfajn and Werland, (2000) and Calvo and Reinhart (2000) controlled for pricing sticky shocks but ignored controlling for other shocks to exchange rates. McCarthy (2000) separated the shocks at different stages of the distribution chains using short run restricted VAR. The problem in doing this is that only short run relationships will be identified. Gagnon and Ihrig (2000) and Taylor (2000) found that the best way to account for the common shocks is by controlling those which are known from the data and use a staggering model with a micro founded model to explain the remaining shock which are not easily seen in the data. This point to the importance of using micro data and controlling for specific location difference in the data.

Given the fact that this study focuses on interregional trade, there is a need to also review studies on trade which use spatial econometrics modelling. The first point to be noted is that there are limited studies under trade which acknowledge space (Krishna and Mitra, 1998; Ceglowski, 2004; Parsley and Wei, 2007; Aker, 2010; Topolova, 2010). When investigating the distribution of prices across regions, these studies take location in absolute terms. Most of these studies use the gravity model to determine the price distribution across regions. In most of their modelling, the above studies incorporate regional differences through the use of dummies in a classical linear regression model, but fail to acknowledge the spatial dependence and the spatial heterogeneity (Adam, 1995; Rogolf, 1996; Greenway et al., 1997; Moodley and Grdon, 2000; Asplund and Friberg, 2001; Nicita, 2009; Foad, 2010).

A small group of studies under trade largely focus on space in spatial econometric modelling (Oosterhaven and Hewing, 1993; Sen and Smith, 1995; Hewing and Okuyahama, 2001; LeSaga and pace, 2005) among others. These studies emphasise on spatial dependence and spatial heterogeneity across regions. Their main argument is that everything is related to everything else but closer things are more related than distant things. This means in as much as a variable is explained by another variable, it should also be noted that variable y in location i is also influenced by variable y in location j. In that respect traditional literature which does not incorporate space when using variables with a location component, are highly affected by the problems of spatial dependence and spatial heterogeneity. Not accounting for the above problems when they are present will thus bias the estimations.

In this section we reviewed the literature on spatial econometrics and pass through effects. The section showed the literature gaps which need to be addressed. In the spatial econometrics literature, we found out that there are limited studies on trade which use spatial modelling In the pass through literature, we found limited studies which use micro data at disaggregated level of both location and product. Most importantly we have limited studies which combine spatial economics and pass through effects. The literature showed limited studies which use data from a country using a multiple currency and the cash budgeting fiscal system.

3.0 Methodology

As highlighted in previous sections, this study is combining two methodologies. The first is spatial econometric model and the second one being the pass through model. In that respect this section will present how the two models will be combined.

3.1 Determining the spatial distribution of prices.

The starting point is to determine the spatial distribution of domestic prices. In section 2.3 we discovered that the distribution of the prices influence the import tariffs pass through. To determine the distribution of prices the study intends to use spatial maps, Moran's I and spatial dependence regression estimations. The Moran's I test statistic use the z-score and it test the null-hypothesis of spatial dependence against the alternative of independent. If the p-value of the test is less than 0.05, then we will fail to reject the null hypothesis and conclude that there is spatial dependence.

Under spatial maps, the study is going to utilise Zimbabwe's shape files from ArcGIS. The shape files have 82 districts and 10 provinces. The latitudes and longitude of all the 82 districts are provided. The GeoDa software program will be used in drawing the spatial maps. District pricing data will be merge with the latitude and longitudes coordinates in GeoDa. The Zimbabwean Statistical Agency provided the study with district monthly average prices of food products, alcohol and non-alcohol beverages, clothes, shoes, furniture's, household textiles vehicle fluids and fuels. The visual display of the maps will be used to determine the price distribution.

In addition to the spatial maps and the Moran's I test the study will run spatial regression models. The study is using a panel data of goods prices over 6 years and covering 60 districts. The use of panel dataset introduces two dimensions of spatial relation. The first spatial relation is between district, where districts prices might be positive, negative spatially dependent or randomly distributed. The second dimension of spatial dependence is across time, where prices in one year might be spatially dependent with price in the next year. Spatial regression model which should be used thus need to account for the fixed time difference, fixed individual difference and the random effects in the relation. The study intent to run a multiple of spatial regression model then test to identify the most appropriate model given our dataset. The models to be estimated are:

1. Spatial Autoregressive Model (SAR) which will be specified as;

$$P_{1t} = \alpha + \rho W P_{1t} + \beta_2 x_{1t} + \mu_{1t} \ldots\ldots\ldots\ldots 3.12$$

Where P_{1t} is price of good 1 at time t, α is a regression parameter to be estimated in the fixed-effect variant, ρ and β_2 are coefficient to be estimated. W is a spatial weighted matrix constructed from the latitude and longitude coordinate. The spatial weighted matrix takes into consideration the distance between regions. Doing this correct for spatial heterogeneity in the data. The spatial weighted matrix mathematically describes the spatial dependence structure in a matrix. The spatial weighed matrix is of dimension N by N, where N is the amount of nodes in a network given by the latitudes and longitudes. The spatial weighted matrix is of the form;

$$W = \begin{bmatrix} 0 & w_{1,2} & w_{1,3}\cdots & w_{1,n} \\ w_{2,1} & 0 & w_{2,3}\cdots & w_{2,n} \\ . & & & \\ . & & & \\ w_{n,1} & w_{n,2} & w_{n,3}\cdots & 0 \end{bmatrix} \ldots\ldots\ldots\ldots\ldots\ldots 3.13$$

W is the spatial matrix which quantifies the spatial relation that exist between region j and k. The diagonals of the spatial weighted matrix are zero as they quantify the spatial relation between a region and itself. The rows are standardised such that they sum up to 1 (Kelejian and Prucha, 1998). x_{1t} is regression equation 3.12 include other controls while μ_{1t} is a white noise error term. The coefficient ρ will be used state the nature of the price distribution. A statistically significant and positive ρ means there is positive spatial dependence while a negative ρ shows a negative spatial dependence in prices. If the coefficient ρ is not statistically significant the result implies rondom price distribution.

2. Spatial Durbin model (SDM) which is a generalised SAR model and include spatially weighted independent variables as explanatory variable. The model is specified as;

$$P_{1t} = \alpha + \rho W P_{1t} + \beta_2 x_{1t} + \emptyset W x_{it} + \mu_{1t} \ldots\ldots 3.14$$

Where the component $\emptyset W x_{it}$ include the weighted lag of all the other controls (x_{1t}), the other variables are as explained in equation 3.13.

3. Spatial Autoregressive model with spatially Autocorrelated errors (SAC). This model combines the SAR with a spatial autoregressive error. The model will be specified as

$$P_{1t} = \alpha + \rho W P_{1t} + \beta_2 x_{1t} + V_t \ldots\ldots 3.15$$

Where $V_t = \lambda W V_t + \mu_{1t} \ldots\ldots\ldots 3.16$

4. Spatial Error Model (SEM)The model can be treated as a special case of both the SAC or SDM. This model focuses on spatial auto-correlation in the error term which will be specified as:

$$P_{1t} = \alpha + \beta_2 x_{1t} + \mu_{1t} \text{.......3.17}$$

Where $\mu_{1t} = \lambda W v_t + \varepsilon_{1t}$....... 3.18

5. Generalised Spatial random-effect model, which will be represented as;

$$P_{1t} = \alpha + \beta_2 x_{1t} + \mu_{1t} \text{......3.19}$$

Where $\mu_{1t} = \lambda W v_t + \varepsilon_{1t}$ ...3.20

and $\alpha = \theta W \alpha + \eta$.......3.21

The generalised spatial model assume pane effects α are spatially correlated, α and ε_{1t} are assumed to be independently normally distributed errors so that the model is necessarily a random effects model.

The LR test, AIC and BIC test values will be used to choose the most appropriate model which fit the dataset better. All the three test (Moran's I test, spatial maps and spatial regression) for price distribution are expected to be consistent.

3.2 Merging Spatial econometrics and import tariffs pass through

The next step of the methodology is to merge the spatial econometrics model and the pass through models together. The merging is however subject to the spatial distribution findings. The strategy is to compare the traditional pass through model and the new model which controls for spatial distribution. The popular specification model in literature used to investigate the import tariff pass through is specified as equation 3.22, (Liu and Tsang, 2008; Marazzi et al., 2005; Mumtaz and Wang, 2006; and Zubair et al., 2013).

$$\Delta log P_{1t} = \beta_0 + \beta_1 \Delta logtar_{1t} + \beta_2 logmon_t + \beta_3 \Delta logexc_t + \beta_4 \Delta x_t + \beta_5 y_t + \epsilon_{1t} \text{.. 3.22}$$

Where $\Delta log P_{1t}$ is change in the log of domestic goods prices of good *1* in at time *t*, β_0 is a constant, $\Delta logtar_{1t}$ is change in log of import tariffs of good *1* at time *t* (policy consistent factor), mon_t is money supply at time *t* (policy consistent factor), exc_t is exchange rate of US dollars to South African rand. Though Zimbabwe had no exchange rate during the period 2009-2014 most economic variables like inflation rate, poverty datum line are highly correlated with the US dollar and South Africa rand exchange rates (Zimbabwe Economic Policy Analysis and Research Unit, 2012). X are other regional specific explanatory variables, it also includes variables which can be differenced like district temperature and rainfall. Y include regional specific dummies like dummies for districts in the rural or urban areas, year dummies, month dummies among other districts specific variables. The key variable is $\Delta logtar_{1t}$ with its coefficient β_1. β_1 will carry the magnitude percentage of how changes in import tariffs are passed on to domestic goods prices across different goods, regions and time.

In spatial dependency regression estimation, the study will adopt a spatial autoregressive model or spatial lag model, Anselin (1988). Based on section 2.4 this study intends to merge spatial econometrics and the import pass through effect. Is that regard a spatial weighted matric component will be added to equation 3.22. Such modification will produce equation 3.23. Equation 3.23 include the spatial weighted matrix and logarithm following the model (Long et al., 2016; Chen et al., 2017; Tsutsumia and Tamesuea, 2011 and Wheeler et al.,2013)

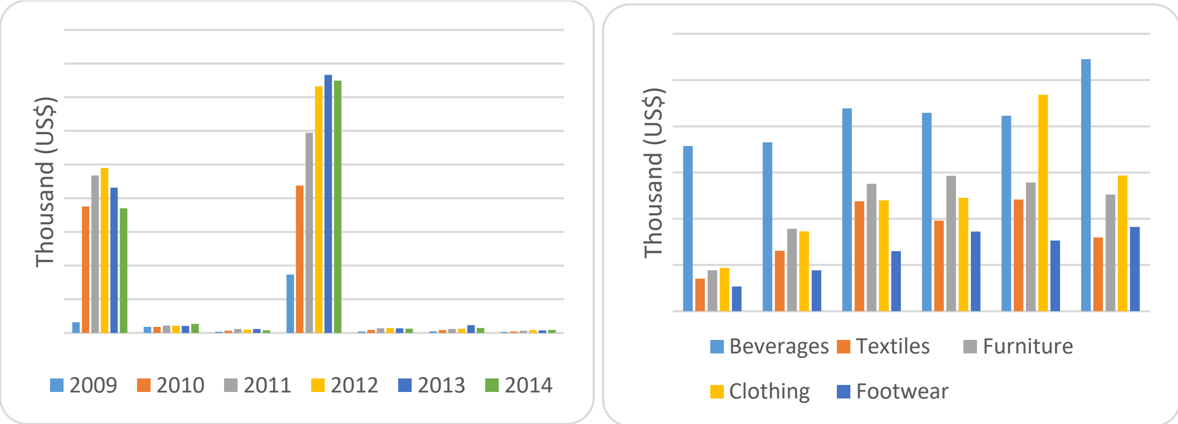
$$\Delta logP_{1t} = \beta_0 + \beta_1 \Delta logtar_{1t} + \beta_2 logmon_t + \beta_3 \Delta logexc_t + \beta_4 \Delta x_t + \beta_5 y_t + \beta_4 W \Delta logP_{1t} + \epsilon_{1t} \quad 3.23$$

The difference between 3.22 and 3.23 is the addition of the spatial component $\beta_4 W \Delta logP_{1t}$ in equation 3.23. This component controls for the spatial distribution of prices as highlighted in section 2.3. Equation 3.23 is a spatial lagged model, the specific mode to be used will depend on the most appropriate spatial model following the analysis in section 3.1 above.

3.3 Tradable goods

The distinction between tradable and non-tradable goods is very important mostly when product prices are collected. Non-tradable goods are products which cannot be traded internationally or across country. Such goods include services where the producers and consumers of the product in question are all located in the same country. Some examples of non-tradable goods are electricity, water supply, public service, local transport, hotel accommodation among others. A tradable good can end-up being a non-tradable due to extreme levels of domestic protection. An extreme level of protection can officially prohibit importation of a certain product such that the producers and consumers of that product will only be found within the country. The product prices which are being used in this study are all tradable as can be seen in Table 5.

Figure 3: Volume of Imports by Products



Source: Own computation using (WITS database)

Futher analysis of the imports by Zimbabwe proves that the products we have are tradable goods. Figure 3 above shows the Zimbabwe's imports by product groups. The figure to the left include food and fuels while the one to the right exclude the two product groups. Over the period under study Zimbabwe was significantly importing all the products. However, we see food (36 percent) and fuels (57.7 percent) occupying the highest share of Zimbabwe's imports. This is highly attributed to poor harvest and increased demand of fuel during the period under study. The study continues to treat all the goods as tradeble given the above analysis.

Table 4: Summary Statistics of the Data to be used

Variable	Observations	Mean	Std. Dev.	Min	Max
Month	4320	6.47	3.46	1	12
Location	4320	0.4	0.49	0	1
Food	4320	4.26	1.06	3.09	7.51
Non-alcohol beverages	4320	2.24	1.05	0.86	5.19
Alcohol beverages	4320	2.57	0.54	1.76	3.86
Clothes	4320	5.75	2.39	2.14	12.15
Footwear	4320	6.97	3.51	1.45	14.99
Fuels	4320	17.4	12.65	1.25	46.24
Household textiles	4320	6.61	2.66	2.39	13.23
Vehicle fluids	4320	6.27	3.09	1.75	13.8
Furniture's	4320	338.89	50.45	132.57	457.45
All goods	4320	29.45	4.89	13.88	40.98
Imports Tariffs	4320	28.68	12.37	2.98	44.57

Money supply	4320	2867.61	1236.82	297.63	4457.26
Exchange rates	4320	8.58	1.38	6.72	11.46

Source: Stata output (5904 observations is made up of 60 district for 12 months over 6 years)

The dataset to be used is from monthly the consumer goods prices surveys produce by Zimbabwe National Statistics Agency (ZIMSTAT), covering 60 districts for the period 2009-2014, Consumer goods prices at district level, as shown in Table 5.

Section 4: Presentation of results

4.0 Spatial distribution of prices.

Before diving deep into spatial distribution of price we the study first looks at the price differences in across the 60 districts. Table 5 below show the mean price of the goods for the first 8 districts. The table show high price difference in the district contradicting the low of one price theory.

Table 5: Average price for the first 8 districts

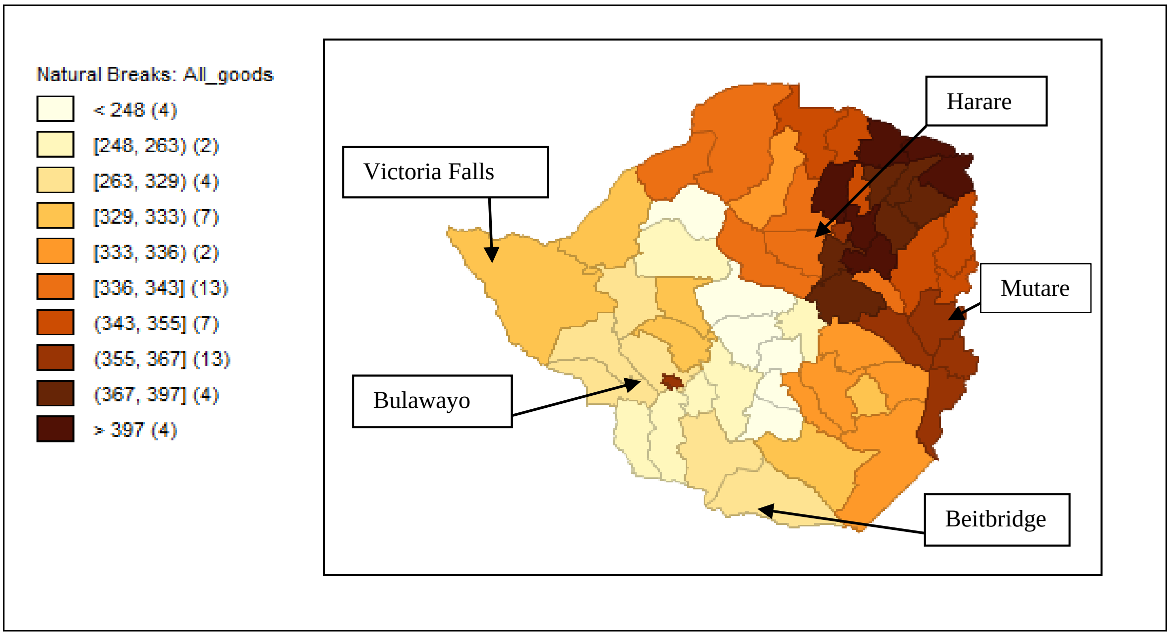
	Bulawayo	Harare	Chimanimani	Chipinge	Makoni	Mutare	Mutasa	Nyanga
Food	146.5	201.6	194.3	182.3	187.2	164.6	187.3	194.3
Non-Alcohol Beverage	159.8	292.6	281.8	298.5	300.6	300.8	291.1	279.3
Alcohol Beverage	125.8	155.8	164.8	185.2	178.3	173.2	167.8	157.5
Cloth	122.1	219.8	221.6	233.3	224.8	222.8	221.1	209.2
Footwear	159.6	249.3	250.5	269.5	264.3	261.6	256.1	240.8
Fuel	146.1	146.5	146.2	153.8	151.1	151.6	146.6	141.6
Textiles	129.3	212.6	219.3	227.8	219.3	218.1	214.6	204.3
Vehicle Fluids	97.2	209.5	214.5	163.3	158.8	157.5	208.3	254.6
Furniture	115.3	93.8	99.2	111.5	105.6	99.8	99.6	89.3

Source: Own compilation using Stata.

As has been mentioned in previous sections, this study exploit two methodologies which are; the spatial econometrics and the pass through models. The first step is to determine the spatial distribution of prices before determining the import tariff pass through effect. In this section, the study will present the results on spatial distribution of prices first and then determine the import tariffs pass through effect at the end.

Using data described in section 3 and averaging the prices for the 6 years in GeoDa the study constructs spatial map for the 82 districts. The spatial map is presented in Figure 4.

Figure 4: Spatial Map of Price Distribution in Zimbabwe for the period 2009-2014



Source: GeoDa spatial map

In the spatial map, the darker the colour the higher is the average goods prices. The map shows that prices are relatively lower in districts to the western and south western sides of Zimbabwe. Prices are relatively high in districts to the northern east parts of Zimbabwe. To the eastern side of the country there is Mashonaland central, Mashonaland east and Manicaland provinces. The cities in these provinces are Harare, Bindura, Marondera, and Mutare. These cities are closer to the Mozambican border but they are far away from the Beitbridge border and it seems as if they are not benefiting much from that. The eastern side of the country is rich in agriculture and the region is also an industrial hub with industries located in Harare and Mutare, (CZI, 2014). However, these characteristics seem not helping in keeping prices lower.

In the western and southern west parts of Zimbabwe there is Matebeleland North, Matebeleland South and Masvingo provinces. The cities in these provinces are Beitbridge, Masvingo and Victoria Falls. These provinces do not receive good rainfall, (Dube, 2008). They have dry and less fertile land for agriculture but people there are enjoying relatively lower prices. Table 6 shows the natural farming regions and their characteristics. Provinces to the western and southern western parts of Zimbabwe belong to natural farming region 3 to 4, which are not favourable for agriculture.

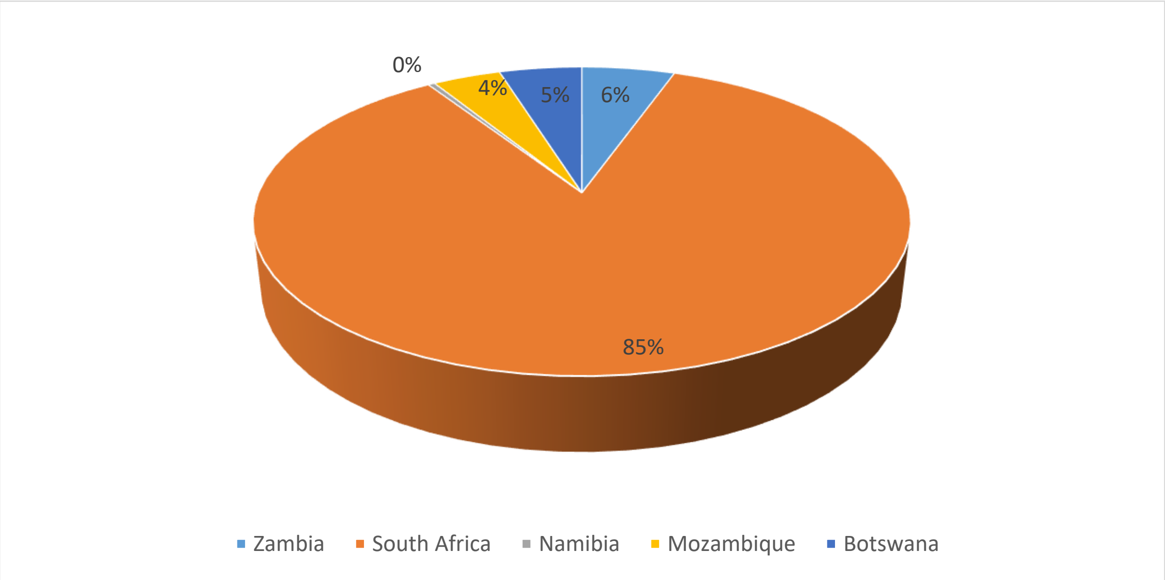
Table 6: Regional Rainfall Characteristics

Natural Farming Region	Province covered	Characteristics
1	Manicaland	1050mm or more rainfall per annum, relatively low temperature
2	Mashonaland East, Harare, Mashonaland Central	700-1050 mm rainfall per annum
3	Mashonaland West, Midland	500-700mm rainfall per annum, relatively high temperatures, subjective seasonal droughts
4	Matebeleland North, Matabeleland South	450-600mm rainfall per annum and subject to frequent seasonal droughts
5	Masvingo	less than 500mm rainfall per annum poorer soil

Source: Dube (2008)

Most industries in the western and southern western parts of Zimbabwe relocated to the capital city (Harare) following the economic crisis between 2000 and 2008 (Dube et al., 2013). These provinces are also relatively closer to the major country borders which are Beitbridge border post, Plumtree border post, Pandamatenga border post, Kazungula and Chirundu border post. These borders are between Zimbabwe and South African as well as Botswana. Figure 5 below shows the share of goods imported from the five countries surrounding Zimbabwe which are Botswana, Mozambique, Namibia, South Africa and Zambia for the period 2009 to 2014. The pie chart shows that Zimbabwe imported much from South Africa (85 percent) and Botswana (6 percent). This helps to explain why these provinces located to the western and southern western parts of Zimbabwe are have relatively lower prices.

Figure 5: Share of Imports among 5 Countries surrounding Zimbabwe



Source: own computation.

The study groups the products prices into ten groups shown in Table 7. Looking at the same map but at product level, one can see some variations in the distribution of prices (Figure 6).

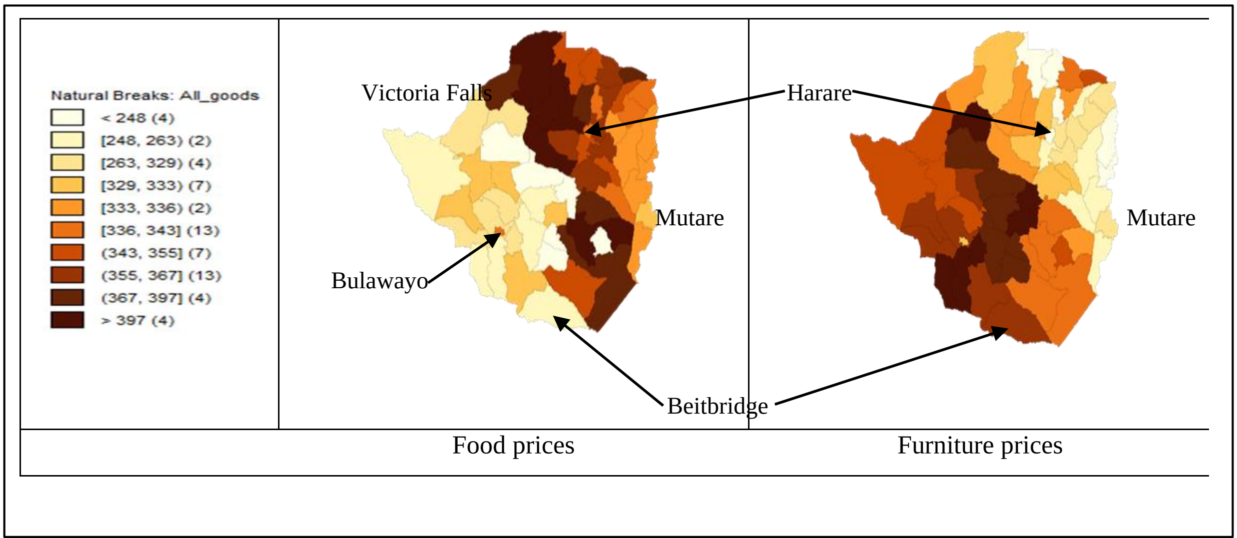
Table 7: Product Groups

Product Groups	Number of Products
Food	18
Non-Alcohol beverage	7
Alcohol beverages	9
Clothes	50
Footwear	6
Fuels	9
Household textiles	7
Vehicle fluids	3
Furniture	8
others	2

Source: own computation.

If the spatial maps of food and furniture product groups are compared, one can see some distributional changes. The eastern side of Zimbabwe has relatively high food and low furniture price compared to the western. Figure 6 below shows the comparison of the spatial distribution of food and furniture prices. One can conclude that the spatial distribution of food prices is similar to the spatial distribution shown in Figure 4. The spatial distribution of furniture prices is however different from that of food. This shows that spatial price distribution can be different across products. The spatial distribution of furniture seems highly influenced by strong furniture industries in the eastern side of Zimbabwe.

Figure 6: Comparison of Food and Furniture Prices for the period 2009-2014

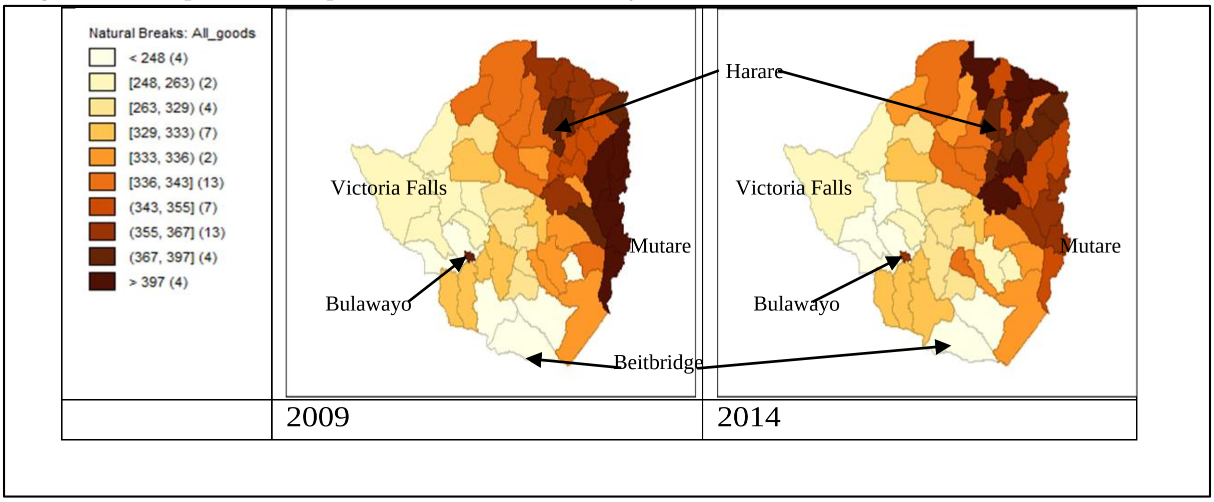


Source: GeoDa spatial map

The eastern highlands of Zimbabwe are characterised by multiple tree plantations and furniture industries which makes it the furniture industrial hub (Dube et al., 2013). Further analysis also shows that Manicaland province was the least affected by the 2000-2003 land reform as it had a low land take up rate of 42 percent compared to the national average of 66 percent (Utete, 2003). Given the long life cycle of tree plantation compared to maize and other small grains, at a time when the average rainfall pattern was erratic, it makes sense for the furniture industry to continue striving while other agriculture food products were repeatedly being imported from neighbouring countries. These are some of the reasons to why furniture prices were lower in the eastern parts of Zimbabwe. More maps at product level are shown in the appendix A2. However, the major lesson from these maps is that spatial distribution of prices are different across products though some products show some similarities.

A closer analysis of the yearly maps also shows that the spatial distribution of the products prices varies across years. Figure 7 shows the spatial price distribution maps of 2009 and 2014. Though there are some similarities, we can also observe some distributional differences. A good example is that of Manicaland province which experienced higher prices in 2009 compared to 2014. This change in distribution is attributed to the influx of second hand clothes being imported from Mozambique, (Confederation of Zimbabwe Industry, 2013). This is the case given that the Nyamapanda border post and Manica border post between Zimbabwe and Mozambique are all located in Manicaland province. However, districts to the western parts of the country continued to experience relatively low prices in both 2009 and 2014. This might be driven by continued importation of products from South Africa and Botswana over the period under study, (African Development Bank, 2013).

Figure 7: Comparison of Spatial Distribution across years



Source: GeoDa spatial map

Considering our objective of determining whether there is spatial dependence or spatial randomness, what one can conclude from the maps is that districts with low (high) prices are surrounded also by districts with low (high) prices. This gives an indication of the existence of spatial prices dependence across districts in Zimbabwe. Cressie and Chan (1981) highlighted that maps can be misleading in determining the spatial dependence or randomness. We can continue the analysis through estimating the Moran's I test. The Moran's I test statistically and significantly determines the present or absent of spatial dependence in the given data set. The Moran's I test statistic, test the null hypothesis that the variables are randomly distributed against the alternative hypothesis in which the variables are dependent on each other. If the p-value is not statistically significant then we fail to reject the null hypothesis.

Using the same data, the Moran's I test statistic is presented in Table 8 below. In the table we compare the Moran's I test statistics of the 10 product groups against the variable named, *price random*. Using the price in the sample, the study generates a randomly distributed price variable named *prices random*. All the products prices are significant at 1 percent significant level except for the *price random* variable which is randomly generated. We thus, fail to accept the null hypothesis of randomness in the prices and conclude that the prices are spatially depended.

Table 8: Moran's I Statistic Test

Variables	I	z	p-value
All goods	0.023	2.458	0.007***
Prices random	-0.031	-0.854	0.197
Food	0.078	5.832	0.000***
Non-Alcohol beverage	0.115	8.183	0.000***
Alcohol beverages	0.151	10.362	0.000***
Clothes	0.200	13.360	0.000***
Footwear	0.135	9.333	0.000***
Fuels	0.186	12.394	0.000***
Household textiles	0.229	15.256	0.000***
Vehicle fluids	0.264	17.250	0.000***
Furniture	0.052	4.318	0.000***

Source: Stata output Standard errors in parentheses: *** $p<0.01$, ** $p<0.05$, * $p<0.1$

This means that districts in Zimbabwe with high (low) prices are also surrounded by district with high (low) prices. In other words, changing prices in one district will affect prices in all the surrounding districts. This means that prices of good *y* in district *i* depend on the price of good *y* in all the surrounding districts.

The Moran's I test statistic is however influenced by the distance between the districts. According to the Moran's I test statistic, a district which is 50 kilometres away and another one which is 500 kilometres away are all treated the same as if they are in the neighbourhood. This concept slightly contradicts the Tobler (1970) first law of geography which says that, everything is related to everything else but closer things are more related than distant things. Thus, we would expect a statistic which controls for the distance between neighbouring regions. In that respect, Anselin (1988) developed a better method which estimates the spatial dependence after controlling the distance between districts through the construction of the spatial weight matrix and the spatial lagged variables. Running a spatial regression will provide more information with regard to spatial dependence or spatial randomness.

Before comparing the traditional pass through regression to the spatial pass through model, we need to allow the data to tell us which spatial model is more appropriate from the 5 model specified in section 3.1. Table 9 shows the three most appropriate spatial model according to our dataset, the rest of the table is in appendix A3. The lower the AIC and BIC the better the model. The greater LM value, the better is the model. The SDM, SAR and the SEM models which controls for both the individual and the time effect are highly preferred against the other models. If we focus on the LM value only then the SAR model will be the most appropriate model. In addition to the three models being the most appropriate, rho and lambda values show the presence of positive spatial dependence of price. This result is consistent with the outcome of Table 8.

Table 9: Appropriate spatial model

Variables	SDM both	SAR both	SEM both
rho-spatial dep	0.556***	0.609***	
LM	4.805***	5.630***	5.557***
lambda-spatial dep			0.643***
AIC	1708,49	1725,74	1725,89
BIC	1895,02	1822,89	1822,95
Observations	360	360	360
R-squared	0.465	0.532	0.424
Districts	60	60	60

Source: Own computation using STATA, (the regressions Control for import tariffs, location (rural and urban), exchange rate, money supply, industrial hubs, distance to the borders, provincial dummies, rainfall), (*** p<0.01, ** p<0.05, * p<0.1)

4.1 Comparison between the traditional and spatial import tariffs models

Following the results in Table 9, the study processed to estimate and compare equation 3.22 and 3.23. Table 10 shows the regression results of the traditional import tariffs pass through model compared to three model which controls for the spatial distribution of price. In all the regression the depended variable is average price levels. The most important variable is the coefficient of import tariffs. The coefficient shows the magnitude of import tariffs which are being passed on to prices. The coefficient for import tariffs is positive and statistical significant in all the models. The magnitude of the coefficient (0.129) of import tariffs in the traditional model is greater compared to that of the SDM (0.030), SAR (0.015), and SEM (0.006). This finding confirms the discussion in section 2.3, consequently the spatial distribution of domestic prices affect the import tariffs pass through. Thus not controlling for spatial distribution highly bias the import tariffs pass through effect.

Table 10: Comparison between the traditional and spatial import tariffs models

Variables	Traditional	SDM	SAR	SEM
Import tariffs	0.129*	0.030***	0.015**	0.006***
location	2.130***	2.956**	1.116*	1.112**
Exchange rates	0.098	-0.778	-0.112	0.056
Money supply	0.002***	-0.002	-0.002	-0.001
Distance to Harare	0.028	0.205**	0.048**	0.034
Distance to Bulawayo	-0.015**	0.037*	-0.006	-0.003
Distance to Beitbridge	0.019*	0.133*	0.073***	0.053**
Distance to Mutare	0.015	-0.439**	0.010	0.003
Bulawayo prov dum	0.849	-5.336	2.597	1.170
Harare province dum	-4.585*	-70.71***	2.122	-1.989
Manicaland prov dum	-5.914***	37.29*	-5.520	-6.415
Mashonaland central prov dum	-0.237	13.10	-14.62***	-13.00***
Mashonaland east prov dum	-0.824	21.87	-11.50***	-11.06***
Mashonaland west prov dum	-0.294	7.184	-5.755*	-5.322*
Masvingo prov dum	-2.911*	-13.11	-3.453	-3.531
Matabeleland south dum	-5.811***	-8.918	-1.823	-1.889
Midlands prov dum	-8.105***	21.18*	3.255	0.927
Distance to Chimanimani	-0.004	0.243*	-0.0007	0.003
Distance to Makoni	-0.014	-0.004	0.00	0.009
Distance to Mutasa	0.008	0.206**	-0.038	-0.043
Distance to Nyanga	-0.006	-0.014	0.026	0.024
Distance to Bindura	0.019	-0.133	-0.073***	-0.053**
Distance to centenary	0.014	-0.027	0.032**	0.027
Rainfall	-0,275	-0.023*	-0.0009**	-0.0002**
rho-spatial dep		0.556***	0.609***	
LM		4.805***	5.630***	5.557***
lambda-spatial dep				0.643***
AIC	1948,79	1708,49	1725,74	1725,59
BIC	2042,06	1895,02	1822,89	1822,75

R-squared	0.518	0.465	0.532	0.424

Source: Own computation using STATA, (significant level *** p<0.01, ** p<0.05, * p<0.1)

Rho and lambda values for the spatial models all agree for the present of a positive spatial price dependence in Zimbabwe over the period 2009-2014. These results are consistent with the analysis in Table 8 and 9. All the models in Table agrees that location and distance from beitbridge are importance variable in determining price variations. The location variable compares price in the rural and urban areas, results shows that there are high prices in the rural areas relative to urban areas. This outcome is largely driven by poor rainfall over the period 2009-2014, (World Bank Climate Data Portal 2018). Most rural households highly depend on agriculture activities, thus lack of enough rainfall will affect their livelihoods causing shortages and rising of prices.

The coefficient for distance from beitbridge is positive and significant in all the models. This means the further away the districts are from beitbridge the higher are the prices. This capture the border effect of the South Africa –Zimbabwe border. During the period 2009-2014 the industrial capacity for Zimbabwe was low, thus most of the goods were being imported and 85 percent of the imports were coming from South Africa (Figure 5).

Distance of the districts from Harare is only positive and significant under the DSM and SAR models. We also observe varying results across provinces depending on the model being used. Rainfall is negative and significant in all the spatial models, the more rainfall the district receives the lower are the prices. This result is greatly driven by the agriculture activities. We also have mixed results which vary depending on the model being used, we know with certainty that all the models agree in terms of the signs and significant of the coefficients on, import tariffs, location and distance from beitbridge.

In Table 10 the y-variable was the average prices of all the goods. We can continue the analysis repeating the regression in Table 10 but breaking the prices according to different products are shown in Table 11. The aim is to observe if the coefficients of import tariffs will remain positive and significant in all the models and also to notice if the import tariffs coefficient in the traditional model will remain greater than in the other spatial models (SDM, SAR and SEM).

Table 11: Robustness checking

	Panel A: Food Prices			
Variables	Traditional	SDM	SAR	SEM
Import tariffs	0.071**	0.013*	0.008**	0.011*

rho		0.484***	0.501***	
LM		0.224***	0.257***	0.250***
lambda				0.552***
R-squared	0.602	0.593	0.420	0.405
	Panel B: Cloth prices			
Import tariffs	0.016**	0.006***	0.007**	0.005**
rho		0.526***	0.561***	
LM		0.789***	0.847***	0.843***
lambda				0.574***
R-squared	0.726	0.464	0.429	0.561
	Panel C : Beverage prices			
Import tariffs	0.004**	0.0008**	0.002**	0.001***
rho		0.373***	0.429***	
LM		0.047***	0.051***	0.053***
lambda				0.440***
R-squared	0.647	0.443	0.514	0.501

Source: Own computation using STATA, (the regressions Control for import tariffs, location (rural and urban), exchange rate, money supply, industrial hubs, distance to the borders, provincial dummies, rainfall), (significant level *** p<0.01, ** p<0.05, * p<0.1)

Table 11 show positive and significant import tariffs coefficient in all the panels (Panel A-C). The coefficient of import tariffs in the traditional model remains greater than in the spatial model, though the level of significant changes in across the models. The results in Table 10 are thus consistent to the outcome displayed in Table 10.

4.2 Explanation of the import tariffs pass through bias

The driver of the wedge between the traditional pass through model and the model proposed in this study, the one which controls for spatial distribution of price, hinges on the inclusion or non-inclusion of the spatial lagged variables. Under the problem of the omission of an important variable, such a problem will bias the regression estimations. For the problem to be valid the omitted variable should be strongly correlated with both the dependent and some or one of the independent variable.

Table 12: Correlation matrix

	Prices	Tariffs	Money supply	Spatial weighted price	Rainfall	Distance to Beitbridge	Location
Prices	1.0000						
Tariffs	0.4438	1.0000					

Money supply	0.4013	0.8857	1.0000				
Spatial weighted price	0.8173	0.4912	0.4672	1.0000			
Rainfall	-0.1935	0.0018	0.0041	-0.3858	1.0000		
Distance to Beitbridge	0.2366	-0.0006	-0.0040	0.4563	-0.4430	1.0000	
Location	0.0325	0.0007	0.0041	0.0470	-0.2201	0.0475	1.0000

Source: Own computation using STATA

Table 12 shows a strong correlation between the spatial weighted price with price and other independent variables, for example a correlation coefficient of 0.49 with import tariffs. There is thus spatial dependence in the prices as identified in sections 4.1 and 4.1. The spatial interdependence across districts is the driver of a small import tariffs pass through in SDM, SAR and SEM models. The spatial interactions could highly be brought up by the spatial spill-over, policy space, inter-personal distance, social networks, arbitrariness of district boundaries which is then restricting a smooth pass through of import tariffs.

The hyperinflationary period of 2006-2008 created a strong interconnection of markets in Zimbabwe. Prices of goods would change more rapidly and retailers had to keep up with price changes as they fear failure to restock their shops. This interconnectedness can best be explained with the black market forex market. The black market forex markets in different cities were all connected to what was happening in the capital city- Harare. A change of the exchange rate in Harare would be timely communicated to other city as they tried to keep-up. This market chain arguably had also some time lags but it shows the strong connectedness of markets in Zimbabwe. The market connection might have been made easy due to telephone technology and also the relatively small size of the country which would reduce communication cost. The same forex market connectedness was also found in other goods mostly imported goods which are tangled to the foreign exchange market. The period after the adoption of the multiple currency was followed by the correction of a distortionary exchange rate which were created by the market. The general price level started to stabilise as inflation rate was dropping severely. The year on year inflation rate was recoded as -0.2 percent in 2014, (Zimbabwe Statistics Agency 2014). A negative inflation rate signifies a drop in prices. Such dropping prices were also timely communicated in all the market due to the strong market linkages which were created during the hyperinflationary period. An increase in import tariff in the present of decrease in generate price would definitely absorb the effect of import tariffs on final domestic goods prices. The above market dynamics can be used to explain the subdued import tariffs pass through once the market connectedness in controlled for in the form of a spatial weighted matrix.

The growth of the black market in Zimbabwe introduced some market competition were basic goods like cooking oil, sugar etc would be sold on the black market at a discounted price compared to the formal market. Such competition would also mute the final price effect of import tariffs.

In support of the limited import tariffs pass through is the correction of the exchange rated distortion in Zimbabwe during the period 2009-2014 due to the adoption of the multiple currency economic system. The adoption of a multiple currency and the complete dysfunctional of the Zimbabwean dollar meant a complete removal of the Zimbabwe dollar exchange rate and the distortion which might have been previously created by the system. Prior to the adoption of the multiple currency system in February 2009, 1USD was trading for 300 trillion Zimbabwe dollar, the Zimbabwean dollar had also gone through a series of re-denomination. The first one in 2006 where 3 zeros were removed, the second one in 2008 were 13 zeros were removed and the last on in 2009 were 1 billion Zimbabwe dollar were re-denominated to 1 Zimbabwe dollar (Reserve bank of Zimbabwe 2009). In addition, the Zimbabwean dollar had been devalued several times, Government of Zimbabwe (2009). The above evolution of the Zimbabwe currency might highly have attracted some exchange rate distortions. Correction of the exchange rate distortions can offset the effects of rising import tariffs, (Krueger, 1992). Including exchange rate in equation 3.2 will produce $P_{1j}^{D} = P_{1}^{B}e(1 + t_{1})$ where e is the exchange rate. A high and distorted exchange rate will inflate domestic prices while a correction of exchange rate distortion will absorb the rising import tariffs such that the final price will not capture the full price changes of import tariffs.

The period after the adoption of the multiple currency in Zimbabwe was followed by low inflation rate with the lowest inflation of -0.2 percent which was recorded in 2014, Confederation of Zimbabwe Industry (2014). Such significant drop in price might have also muted the distribution cost of imported products that include transport cost, and domestic tax which is likely to absorb the effects of increasing import tariffs thus muting the import tariffs pass through effect.

Apart from the exchange rate there also could be other factors that can slow down the import tariff pass through, McCulloch et al (2004) pointed to the extent of domestic competition, functioning of the market, infrastructure and domestic regulation. The policy of price control is popular in Zimbabwe, were the government controls the rising of prices through enforcing strong regulation against price increase. The other possible explanation of low import tariffs pass through is the changes in the world or border prices. Using equation 3.2 a drop in the border prices can greatly offset the effect of rising import tariffs, (Lutz and Singer, 1994).

4.3 Findings

1. A significant portion of import tariffs is being passed on to domestic goods prices
2. The traditional import tariffs pass through model overestimate the import tariffs pass through compared to the spatial import tariffs pass through model estimations.
3. There is a positive spatial distribution of domestic goods prices in Zimbabwe over the period 2009 to 2014.
4. Rainfall, temperature, and exchange rate are important variables in explain the import tariffs pass through effect.

4.4 Conclusion

The study managed to meet its objectives outlined in section one. The study investigate the import tariffs pass through effect. A new import tariffs model is proposed which controls for spatial distribution of prices when estimating the import tariffs pass through effect. The outcome of the new pass through model are compared to the traditional model of estimating the import tariffs pass through effect. The study observes that the traditional import tariffs pass through model highly overestimate the import tariffs pass through effect as it does not control for the spatial distribution of domestic goods prices. The find greatly highlights the need to control for the spatial distribution of domestic goods prices before estimation the import tariffs pass through effect. Thus the domestic spatial distribution of prices highly affect the import tariffs pass through effect.

The study also found a positive spatial price dependent among districts in Zimbabwe for the period 2009 to 2014. Spatial maps, the Moran's I, Spatial Durbin model (SDM), Spatial AutoRegressive model (SAR), Spatial Error model (SEM), Spatial Autoregressive with Spatially Autocorrelated Errors model (SARAR) and the Generalised Spatial Random effect model (GSPRE) all agree that there is positive spatial dependence of domestic goods' prices in Zimbabwe over the period 2009 to 2014.

The study also found that a positive and significant portion of import a tariffs is being passed on to domestic goods prices. Thus policy should be cautious of the import tariffs increase in relation to poverty reduction targets. Since high increase of import tariffs is associated with a significant increase of domestic goods prices.

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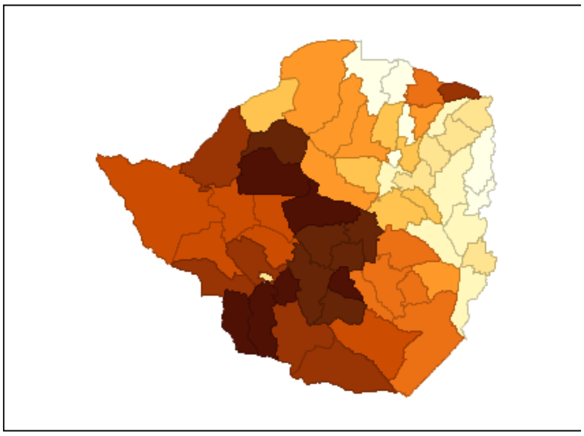
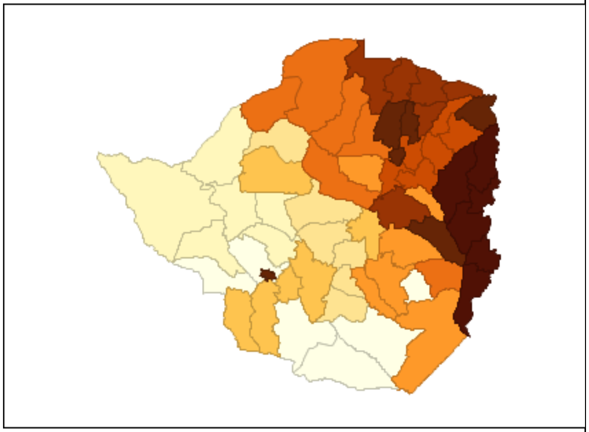
5.1 Appendix

Appendix: A1: Map of Zimbabwe

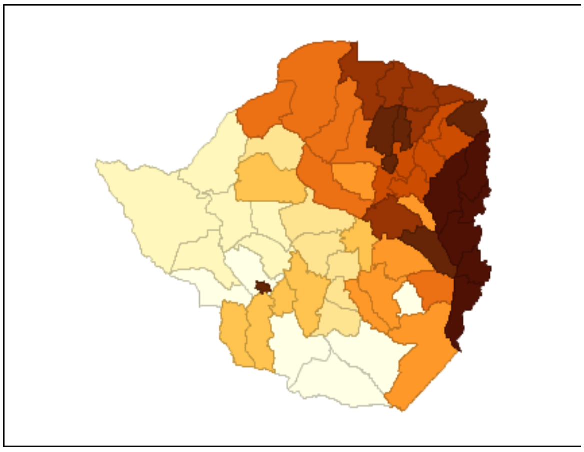
Appendix A2: Spatial maps of domestic prices in Zimbabwe (2009-2014)



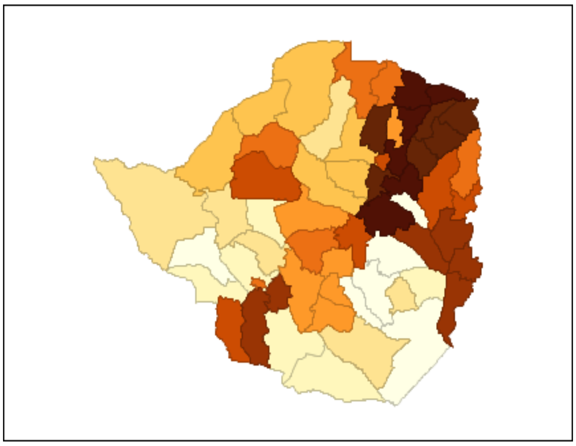
non-Alcohol beverage



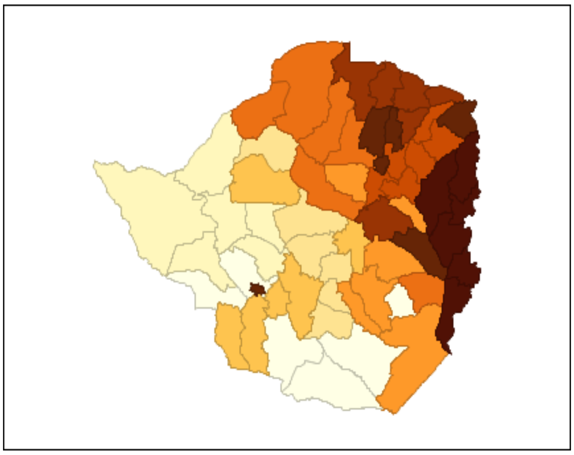
Clothes



Footwear



house hold textiles



Fuels

Appendix A3:

Variables	DSM_ind_fxd_effects	DSM_fxd_time_effects	DSM_re_effects	DSM_both_fxd_effects	DSM_without_effects	SAR_fxd_ind_effects	SAR_re_effects	SAR_fxd_time_effects	SAR_fxd_both_effects
LM	4.852***	7.322***	8.327***	**4.805*****	4.852***	5.719***	8.380***	8.634***	**5.630*****
AIC	1716,27	1856,52	1879,936	**1708,49**	1716,27	1736,41	1882,61	1865,12	**1725,74**
BIC	1902,79	2043,05	1988,75	**1895,02**	1902,79	1833,56	1987,54	1962,27	**1822,89**
Observations	360	360	360	360	360	360	360	360	360
R-squared	0.439	0.434	0.265	**0.465**	0.039	0.067	0.509	0.001	**0.532**

Ap