Heterogeneous impact of Interest Rates on Retail Firm Product Prices:

A product-level analysis using micro-data from Lesotho

Master of Commerce specializing in Applied Economics

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Minor dissertation presented for the approval of Senate in partial fulfilment of the requirements for the MCom specializing in Applied Economics in approved courses and a minor dissertation. I hereby declare that I have read and understood the regulations governing the submission of MCom specializing in Applied Economics dissertations, including those relating to length and plagiarism, as contained in the rules of this University, and that this minor dissertation conforms to those regulations.

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Abstract

Price-setting behaviour plays an important role in the transmission mechanism of monetary policy as pricing decisions of firms in the private sector determine how changes in the official rate affect prices. Several recent studies using micro price data have highlighted the importance of the variation in firm characteristics on pricing decisions. This study investigates whether firms adjust their prices in response to higher interest rates and whether this response differs for firms that have credit. We estimate multinomial logistic regression models using highly disaggregated panel data on monthly product prices of 131 retail outlets in Lesotho over the period 2002-2009. In general, our results suggest that firms are more likely to adjust their prices in response to an interest rate shock. Firms will either revise their prices upwards or downwards compared to keeping their prices constant. This ambiguity occurs when a firm's price is a function of price elasticity of demand and costs. A firm has to balance the need to pass on increased cost of the higher interest cost onto prices against the demand-side sensitivity to price increases. On the contrary, when comparing firms with credit to those without, our findings show that firms with credit are more likely to keep their prices constant than to revise them. Furthermore, the study finds asymmetric results in the direction of the price adjustments. Prices are more likely to increase or decrease in the presence of both a demand and a cost shock, whereas prices are more likely to remain constant in the presence of a cost shock only. No evidence was found that credit owing firms pass the higher cost of credit onto their prices, suggesting that firms with credit finance have access to cheaper financing options than firms without credit.

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1. INTRODUCTION

1.1 Background

Price setting behaviour is fundamental to the efficient functioning of the transmission mechanism. The way firms set their prices is critical as this affects how changes in monetary policy make their way through the economy and the effect these changes have on economic activity and inflation. Analysis of how prices are set by firms has grown in response to the growing availability of data on prices at a micro level (Amirault, Kwan, and Wilkinson, 2006; Greenslade and Parker, 2012; Nchake, Edwards, and Rankin, 2014). However the empirical work on how price setting behaviour is affected by changes in monetary policy is quite thin (Copaciu, Neagu, and Braun-Erdei, 2010). This study aims to fill this gap by investigating how prices adjust in response to changes in monetary policy via changes in interest rates.

According to monetary economic theory, monetary policy is the key tool for stabilizing inflation thus improving economic growth. Monetary policy, acting through various channels, has important macroeconomic and welfare implications. Studies have identified different channels of monetary policy transmission, broadly classified as 'price' and 'credit' transmission channels (Bernanke and Gertler, 1995; Cecchetti, 1995). The applicability of these channels varies across countries, largely due to differences in level of financial development, intensity of government regulation and structural conditions. Therefore, understanding the mechanism through which monetary policy is transmitted is essential in achieving the key objectives of the central bank and enhancing macroeconomic stability in the economy. This is particularly imperative for developing countries, where in general, lack of well-functioning financial markets limit the effectiveness of monetary policy actions. According to Ikhide and Uanguta (2010) financial markets in low-income countries tend to be less flexible to lending rates, thereby, limiting the effectiveness of monetary policy transmission mechanism.

The financial sector plays an important role in the transmission mechanism. Developed countries have complex financial markets that have evolved substantially

(Ikhide and Uanguta, 2010; Nchake *et al.,* 2014). As such, the literature on these countries focuses more on the credit channel of the transmission mechanism and in particular on the balance sheet side (Sander and Kleimeier, 2006). According to this channel, when a contractionary policy is implemented, this causes a variation in banks' credit supply following deterioration in borrowers' net worth and a decline in collateral values. This reduces borrowers' credit options, hampers demand for goods and services and eases pressure on prices, stabilizing or decreasing inflation. (Dedola and Lippi, 2005).

For developing countries whose financial markets are still in the early growth stages, more attention is placed on the bank lending channel compared to the balance sheet channel. Financial markets in developing countries are not as well developed, impose many restrictions and have thin and inefficient capital markets. In such environments, credit sources are constrained. This leaves banks as the principle sources of credit and creates a greater environment for asymmetric information as most borrowers fail to find perfect substitutes for bank loans (Mishra, Montiel, and Spilimbergo, 2010; Sacerdoti, 2005).

The bank lending channel relies on market frictions. Monetary tightening has a direct effect on firms that rely on bank finance to fund their investments and activities (Bank of England, 1999). Banks play a special role in the economy by accepting bank deposits that contribute to the broad monetary aggregates and also by issuing bank loans which have few substitutes. Because banks rely on reserve demand deposits as an important source of funds, a rise in interest rates affects banks' required reserve ratio, reducing the aggregate volume of bank reserves. This will result in banks imposing stricter credit conditions and decreasing their loan supply (Ireland, 2008). With such heavy reliance on bank credit, a reduction in bank loans reduces aggregate spending by economic agents.

Academic textbooks and theoretical models usually assume that all agents in an economy are impacted in the same way by monetary policy shocks. However, empirical evidence shows that different responses to monetary shocks exist according to regional, firm and product characteristics (Dedola and Lippi, 2005; Georgiadis, 2015; Georgopoulos and Hejazi, 2009; Yang *et al.*, 2010).

interest rates change, how a change in monetary policy via interest rates actually results in price changes is an area of research interest (Ikhide and Uanguta, 2010; Nchake *et al.,* 2014; Sander and Kleimeier, 2006). The relationship between interest rates and prices is usually explained by the monetary transmission. The demand side view states that higher interest rates dampen consumption and investment spending and this results in lower prices. The supply side view suggests that higher interest rates increase the cost of production, pushing up prices. However, on the supply side, if firm prices are contingent upon demand elasticity and cost, then higher interest rates may have an ambiguous effect on prices as higher costs and elasticity of demand facing a firm have opposing effects on prices. Many researchers have the traditional view that the demand side of the transmission mechanism is more dominant than the supply side, thus higher interest rates help to curb inflation. Some researchers oppose this view and propose that the supply side dominates the demand side so contractionary monetary policy aggravates inflation (Barth and Ramey, 2002; Seelig, 1974).

Thus, this study aimed to investigate the relationship between interest rates and firm prices in a developing country, and answer the following two-fold research question. *What effect do higher interest rates have on firm pricing behaviour and does this effect vary according to firms' credit structure?*

1.2 Research objectives

To answer the above research question, this study sought the following objectives:

i. To investigate what relationship exists between higher interest rates and retail prices.
ii. To determine whether the relationship between higher interest rates and prices differs for firms that have credit compared to firms that do not.

Interest in the heterogeneous impact of monetary policy in the economy has been on the rise in the literature. In addition, the relevance of different transmission channels has been found to vary due to regional, sectoral and firm attributes. Industrial composition, financial structure, output durability and firm size are the major factors determining responses to interest rate shocks. (Georgopoulos and Hejazi, 2009; Lewis and Poilly, 2012; Tena and Tremayne, 2009).

In addition to heterogeneity existing in different sectors of the economy, particularly when it comes to prices, firms are ultimately directly in control of setting their prices and the manner in which their prices behave play a crucial role in monetary policy and macroeconomic models. Factors that cause prices to change are cost shocks and changes in market conditions (competitors' prices and demand) (Amirault et al., 2006; Copaciu *et al.,* 2010; Park *et al.,* 2010).

Empirical evidence shows that prices do not respond in a uniform manner to different shocks. Price increases mainly respond to rises in input costs. Labour costs, raw material and intermediate good costs often hold top position when firms are asked to rank factors that cause an upward price adjustment. Demand increases and competitors' price are next in order of importance, followed by financial costs. For price decreases, market conditions are the main driving force. Weakening demand conditions and competitors' prices rank as the top two factors in a downward price revision (Amirault *et al.,* 2006; Copaciu *et al.,* 2010; Greenslade and Parker, 2012; Hoeberichts and Stockman, 2010; Klenow and Malin, 2010; Park *et al.,* 2010). Kwapil et al (2005) for example analysed 873 manufacturing firms to determine how their prices increased and decreased in response to cost and demand shocks. The authors documented that in the presence of a cost shock, price increases occur more and with a larger effect than decreases. They found the opposite to be true for a demand shock.

Although literature on price setting behaviour focuses predominantly on which cost and demand factors influence price adjustments and some studies have looked at the effect of an aggregate shock, (either a tax regime change or movements of the domestic exchange rate), not much research has been conducted on the effect of interest rates as an aggregate shock to the economy. Interest rates are particularly interesting as they have the potential to affect both the demand and the supply side of a firm. Since prices are influenced from both the demand and the cost side when

1.3 Organization of the dissertation

This study is presented in six chapters with this chapter being the first. The second chapter reviews the literature on price setting conduct by firms and the way decisions taken on monetary policy can affect the manner in which prices are determined by firms. The third chapter provides the methodology for the empirical work, starting with a brief description of the data. Subsequent sections present the methodological approach. The fourth chapter provides the data analysis. The fifth chapter discusses the key findings and chapter six concludes by tying together the key themes and provides points of departure for further research.

2. LITERATURE REVIEW

2.1 Price setting conduct of firms

Economic theory suggests that prices are important in determining an efficient allocation of resources in a market. Prices also function as a signal for shortages or surpluses of resources, which helps firms to respond to changes in market conditions. Thus, in a free market, prices are the driving force that determine whether markets clear or not and the two main factors that influence prices are demand and supply (Mohr and Fourie, 2004; Nicholson and Snyder, 2011).

These two market forces work well in a competitive market where there are no barriers to entry and no collusion between firms. The market clearing price is where the price at which a producer is willing to sell their product is equal to the price at which a consumer is willing to purchase the product (Mohr and Fourie, 2004). The general workings of supply and demand on market prices function as follows; changes in supply may either lead to a surplus or shortage of goods if demand stays constant. If there is a shortage, firms will increase the price of the goods, resulting in a new higher market clearing price. The opposite will result when an excess of goods are available and demand remains constant. On the other hand, if demand changes whilst supply remains constant, there will either be excess or not enough demand for a product. When consumers demand for a product is less than what the firm is supplying, the price of the product will decrease so firms can sell off the excess output and a new market clearing price will result (Nicholson and Snyder, 2011).

Price setting behaviour, that is, the manner in which firms decide what prices to charge for their products, is crucial on both a broad and narrow context in any economy. On an individual firm level, survival in a market is contingent upon the success of a firm's product or service. Embedded in this success is the correct price set for the product (Amirault, Kwan and Wilkinson, 2006). Since setting or changing prices to ensure they are optimal can be a very costly thing to do, firms tend not to continuously adjust their prices. Some firm prices are said to be sticky, because they respond slowly to changes in market conditions and many firms deliberately allow their

prices to adjust slowly in order to minimize the costs associated with price adjustments (Amirault et al., 2006; Greenslade and Parker, 2012; Nchake, 2013).

Furthermore, price setting behaviour is critical to the design of monetary policy and understanding the manner in which the transmission mechanism functions. The presence of some rigid prices is one of the factors allowing monetary policy to affect real activity in the economy in the short run (Greenslade and Parker, 2012; Nchake, 2013). When prices are rigid, the monetary policy committee has the ability to respond to some changes in the economy before firms have the chance to adjust their prices and so monetary policy changes can result in changes in output in the short run (Sahin-oz and Saracoglu, 2011). The manner in which prices are rigid, for example whether price adjustments to demand or cost shocks are symmetric, affects how economic shocks are transmitted through the economy. Consequently, the nature of price stickiness has implications for how effectively the monetary stances affect real activity (output and employment) and how well inflation responds to policy shocks (Amirault *et al.,* 2006).

Two theoretical models have been developed to explain these price rigidities, namely “time-dependent” and “state-dependent” models (Greenslade and Parker, 2012; Nchake *et al.,* 2014). In the time-dependent model, price adjustments take place depending on time intervals, (regular or random) and this interval is owing to the fact that price changes are generally costly to implement. The state-dependent model asserts that prices only adjust in response to changes in the economy. Price setting is not routinely done and prices will not change until a significant event (shock) takes place that warrants a change. As such, the type of shock (idiosyncratic versus common) coupled with other factors will determine which firms adjust their prices (Nchake, 2013). In essence, both theories propose that prices generally stay the same and their adjustments are contingent on either time intervals or shocks to market conditions in the economy.

2.1.1 How often do prices change?

Empirical research using price microdata has attracted considerable interest in analysing price setting behaviour in different countries. Research has been conducted in Canada (Amirault *et al.,* 2006), the UK (Greenslade and Parker, 2012), Australia (Park, Rayner and D'Arcy, 2010), Austria (Kwapil, Baumgartner and Scharler, 2005), the Netherlands (Hoeberichts and Stockman, 2010), South Africa (Creamer, Farrell and Rankin, 2012), Romania (Copaciu *et al.,* 2010), Turkey (Sahinoz and Saracoglu, 2011), and Lesotho (Nchake *et al.,* 2014), to name a few. Many studies on price setting behaviour use a firm level micro approach to investigate the extent of nominal price rigidities and their causes (Creamer *et al.,* 2012; Greenslade and Parker, 2012; Klenow and Malin, 2011; Nchake *et al.,* 2014).

Just how rigid are prices? This can be established by studying how often prices adjust. A frequency measure of the number of times prices change is a common measure used in studies that analyse price changes. The frequency of a price change has a wide distribution. On the one end of the distribution are firms that change their prices less than once a year. Most firms however, seem to change their prices at least once a year (Amirault *et al.,* 2006; Creamer *et al.,* 2012). Firms in North America appear to have more flexible prices, many changing their prices 4 or 5 times a year, whereas prices in Europe seem to be more rigid, changing roughly once in every 5 months (about 2.5 times a year). On the extreme right of the frequency distribution are prices that change more than once a week (Copaciu *et al.,* 2010; Greenslade and Parker, 2012).

Literature finds that pricing conduct varies by sector, firm, competitive structure and products (Creamer et al., 2012; Greenslade and Parker, 2012). For example, some studies have found that with regards to sectors, the trade (wholesale and retail) and construction sectors tend to have more flexible prices than manufacturing, tourism and business to business service sectors (Greenslade and Parker, 2012;Hoeberichts and Stockman, 2010). Moreover, the competitive environment a firm faces strongly influences its pricing decisions. A firm that faces stronger competition tends to have more flexible prices than one facing weaker competition. At the firm level, small firms change their prices less often than larger firms, with the least price changes occurring

in firms run by single-workers. This is mostly explained by the types of mark-ups used in different firms. Small firms mainly determine their prices using fixed mark-ups whereas large firms use variable mark-ups. Thus a greater degree of price flexibility is evident in large firms (Greenslade and Parker, 2012; Hoeberichts and Stockman, 2010; Nchake *et al.,* 2014).

The frequency of price changes also differs at the product level. At the product level where studies have found that prices for goods are more flexible than those for services. In particular, cyclical products such as perishable foods, fuel and airfares have a higher frequency of price changes (Copaciu *et al.,* 2010; Nchake *et al.,* 2014). Although most pricing theories and many studies suggest that prices are rigid, there has been some empirical evidence that over the past two decades, prices have become more flexible (Amirault *et al.,* 2006).

2.1.2 Price adjustments and their asymmetries

In competitive markets the trend often seen is that prices are more responsive to cost shocks than to demand shocks.

The microeconomic evidence on price setting conduct presented above suggests that the different sources of price variability cause heterogeneity in the manner in which firms set their prices and thus not all prices can be considered to be rigid, as is proposed by macroeconomic policy models. An important factor that contributes to the adjustment of prices is the ability of a firm to pass on shocks to its prices (Lee, 2002; RBB, 2014).

2.2 Relationship between price adjustments and shocks

Studies that measure the frequency of price changes or price reviews typically consider what factors lead to a price adjustment. There is a general consensus that cost shocks and changing market conditions (competitors' prices and demand) are the main factors that trigger price adjustments (Amirault *et al.,* 2006; Copaciu *et al.,* 2010;

Greenslade and Parker, 2012; Hoeberichts and Stockman, 2010; Park *et al.,* 2010). Price increases mainly respond to rises in input costs. When firms are asked to rank factors that cause an upward price adjustment, labour costs, raw material and intermediate good costs often hold top position. Rises in demand changes and competitors' price are next in order of importance, followed by financial costs. For price decreases, market conditions are the main driving force. Weakening demand conditions and competitors' prices rank in as the top two factors that result in a downward price revision. Below these factors are reductions in market share, lower raw materials and wage costs trailed by financial costs. Therefore supply and demand shocks are principal in adjusting prices and factors that influence an upward revision of prices are different from those that influence a downward revision of prices (Amirault *et al.,* 2006; Copaciu *et al.,* 2010; Greenslade and Parker, 2012; Hoeberichts and Stockman, 2010; Klenow and Malin, 2010; Park *et al.,* 2010).

Asymmetries also exist between the directions of price adjustments. Generally, price increases occur more frequently than price decreases. For a cost shock, Kwapil *et al* (2005) found that prices of most Austrian firms are more responsive to increased costs than they are to lower costs. Firms also respond more quickly to negative demand shocks than to positive demand shocks. Similar evidence has also been found in many firms in the euro area, the US and in some developing countries. Increased costs are more influential in driving prices upwards than decreased costs are in reducing prices. In contrast, weakening demand conditions have a stronger influence on downward price revisions than stronger demand conditions have on upward price revisions. Thus for a cost shock, prices are sticky downwards whereas for a demand shock, prices are sticky upwards (Copaciu et al., 2010; Hoeberichts and Stockman, 2010, Nchake *et al.,* 2014).

There is an abundance of empirical work on price adjustments, the causes of these changes and the depth of these investigations vary (Alvarez *et al.,* 2006; Amirault *et al.,* 2006; Bils and Chang, 1999; Buckle and Carlson, 2000; Dias, Marques, Martins and Santos Silva, 2015; Greenslade and Parker, 2010; Hoeberichts and Stockman; 2010; Klenow and Malin, 2010; Kwapil *et al.,* 2005; Moura and Rossi Junior, 2010; Loupois and Sevestre, 2013; Nchake *et al.,* 2014;Park et al., 2010; Rumler, Stiglbauer and Baumgartner, 2011; Sahinoz and Saracoglu, 2011). A review of the literature on adjustments of consumer and producer prices finds that the general

agreement on price adjustments is that their frequency is in response to a shock and the nature of the change depends on the type of shock (demand versus cost and idiosyncratic versus common) that a firm faces (Alvarez et al., 2006; Klenow and Malin, 2010).

Some research has identified which factors are most influential in changing prices by conducting firm surveys and asking owners to rank a list of factors in the order of importance of their role in affecting prices. Greenslade and Parker (2010) conducted such a study on 693 UK firms covering all industries. Roughly half of the firms ranked costs as the number one factor influencing price increases whereas demand and competitors' price were the leading factors for price decreases. A similar result was obtained from studies conducted in some European countries and North America where most of firms provided the same ranking order. However, these results were based on reports given by business owners extracted from fill in questionnaires which makes it difficult to verify the correctness of the information given (Amirault *et al.,* 2006; Hoeberichts and Stockman, 2010; Park *et al.,* 2010).

Other research has adopted a more refined approach by testing the significance of listed factors on price adjustments using empirical models. Moura and Rossi Junior (2010) conducted a probit analysis on consumer prices of 281 firms in Brazil. Having found that prices in Brazil are fairly rigid, changing roughly once every 10 months, they identified market conditions, in the name of competitiveness and demand elasticity and costs as significant factors resulting in the duration of price spell.

Rumler *et al* (2011) also conducted a probit analysis on consumer prices to investigate price rigidities and price spells in Austria but they used a panel data approach, following 639 product categories. They found an even longer price spell of greater than one year for Austrian firms, reflecting that prices did not change frequently. When prices did change however, the frequency of an increase was slightly higher than the frequency of a decrease and the duration played a significant role in explaining this.

In line with this research, some studies have modelled the effect of cost, demand and inflation shocks on price adjustments. Kwapil et al (2005) analysed 873 manufacturing firms to determine how the price increases and decreases responded to cost and demand shocks. They found that in the presence of a cost shock, price increases

occur more than decreases. The reverse is true when firms face a demand shock, price decreases are more frequent than price increases. Buckle and Carlson (2000) had similar results in their investigation of shocks on quarterly prices of manufacturing firms in New Zealand. Using an ordered probit model, the authors observed that in general higher prices were more likely to occur when costs increased and that prices were more likely to fall when demand weakened. Furthermore, when they accounted for rises in inflation, the above results were amplified significantly, particularly on the cost side.

Some studies have disaggregated the nature of cost shocks into different components and tested their significance. Bils and Chang (1999) investigated annual data on manufacturing firms from 1958 -1994 to see which type of cost shock prices responded to more, an increase in factor prices or an increase in marginal costs due to an expansion in production. They reported that factor prices played a more dominant role in influencing price changes than increases in marginal costs as a result of growth.

Hoeberichts and Stockman (2010) found evidence of asymmetric response of prices to different changes in costs and market conditions on a cross sectional survey of Dutch firms. Based on average scores received by firms, different cost factors were important in influencing price changes. Labour costs were considered the most important factor resulting in a price rise. Labour costs and the cost of raw materials were the top two cost factors perceived to cause a price cut. With market conditions, competitors' prices were the major factor resulting in price adjustments and overall costs were perceived as more influential factors causing prices to change than demand factors.

Loupias and Sevestre (2013) also used a disaggregated cost approach. They studied the effect of intermediate input costs and labour costs on product prices of manufacturing firms in France. They also included sector inflation and output level as regressors in their ordered probit model on price changes. Of the above explanatory variables, only intermediate costs were significant factors causing prices to change. Additionally, a permanent cost shock influenced prices to change more steeply and more frequently.

This study followed a similar approach to Sahinoz and Saracoglu (2011) and Copaciu et al (2010). Research on the effect a financial shock has on prices is scarce and to our knowledge, apart from work done by Copaciu et al (2010), no other study has looked into the effect of a financial cost shock, in the form of interest rates, on the adjustment of prices and no work has been done in this regard for an emerging economy in Africa. This research fills this gap by modelling the effect of interest rates on product prices of firms in Lesotho.

The first paper similar to this study is by Sahinoz and Saracoglu (2011). They observed 488 Turkish firms over an 18 year period, and covered a wide range of sectors, including manufacturing, industry services, retail and wholesale firms. Using a disaggregated firm level, monthly product price dataset, they investigated how private companies in Turkey set their prices. Of particular relevance to this study is their empirical model of a shock on the adjustment of prices. Although changes in price, demand and cost shocks were not quantified, the authors used indicator variables to capture whether an increase, decrease or no change occurred in the variables of interest. When accounting for different inflation conditions, Sahinoz and Saracoglu (2011) reported that the probability of a price change is much higher when costs change compared to when demand changes. The probability of a price change when costs increased and demand stayed the same was almost twice as high compared to when demand increased whilst costs remained constant. This result was replicated across almost all industries in the sample. In the reverse situation of a negative shock, prices were 1.5 times more likely to decrease as a result of a cost decline than when demand fell. Although they do not specify the type of cost shock, the authors maintained that prices in general are more responsive to cost changes than demand changes. On the speed of adjustments their results showed that prices respond more quickly to cost shocks than to demand shocks but the revision of prices upwards or downwards after the same shock is symmetric. Their findings of the symmetric adjustments of prices challenges most of the literature which suggests that the direction of price adjustments are asymmetric (Amirault *et al.,* 2006; Greenslade and Parker, 2012; Hoeberichts and Stockman, 2010; Kwapil *et al.,* 2005). The authors' findings on inflation in Turkey are however in line with most literature, when inflation is higher, prices are more likely to change.

Copaciu et al. (2010) investigated price setting in Romanian firms but went a step further by also exploring the effect of a financial shock on firms' prices. Their investigation included both an exchange rate shock and an interest rate shock. The author's did not investigate the effect of these shocks based on actual data but rather presented 3 different scenarios for each financial shock and asked firms to rank each scenario on a scale to indicate the level of importance such a shock would have on influencing a price to change. The scale ranged from 4 to 1 with a scenario giving a score of 4 if it was very important and a score of 1 if it was not important. The potential exchange rate shocks were either 10%, 20% or 30% change, with the first and the last of these values being associated with a depreciation of the domestic currency. For the interest rate shocks, all three scenarios visualised a rise in interest rates. The first two scenarios were a shock of either an increase in the domestic interest rate to 20% and 30%. The last scenario was an increase in the interest rate to 15% for loans denominated in euro. The average interest rates at the time the firms were approached were roughly 13.5% for domestic loans and 7.5 % for loans in euros. Based on the overall average scores received for the potential shocks, exchange rates were considered more important than interest rate shocks. The authors credit their findings of the lower importance of interest rates to the fact that during the time the survey was administered, most firms were net creditors to banks and so higher interest rates had little effect on the firms raising their prices or costs. In fact, most firms' reported that they financed their activities via trade credit or internal funds, insulating them from financial shocks caused by higher interest rates. The importance of an exchange rate shock reflected the historic pattern in which some Romanian firms set their prices according to the exchange rates facing the country.

In line with Sahinoz and Saracoglu (2011), this research uses panel data to analyse the effect of a cost shock on the adjustment of firms' prices. It also investigates whether asymmetries exist in line with the shock. Similar to Copaciu et al. (2010), the financial shock is that of a change in interest rates but this study does not include the role of exchange rates. Unlike the authors' response based analysis of potential shock scenarios, this research uses actual data on interest rates changes and models these changes for the probability of a price change.

Before presenting the theoretical model for a price change as a result of an interest rate rise, a detailed description of the manner in which monetary policy affects firm prices is discussed.

2.3 Monetary policy and its role in pricing

One of the main objectives of monetary policy is price stability. A widespread practice in national economies is that the Central Bank (CB) uses the official short term interest rate as one of its primary tools[1] to impact economic activity and inflation. Decisions taken on the interest rate can have outcomes of conflicting desirability. For example, if the CB decreases interest rates that will increase aggregate demand and as a result, promote economic growth. If the economy however is unable to meet the excess demand in the economy, increased aggregate demand will put upward pressure on prices and this increases inflation. Changes in the official interest rate are transmitted to the economy through different channels to affect inflation and economic growth and these channels are collectively known as the monetary transmission mechanism.

The monetary policy transmission mechanism is mainly about how a change in the monetary policy variable affects inflation (prices) and growth (output). The Bank of England (1999) decomposes the transmission mechanism of monetary policy into the following three stages. The first stage deals with the response of other financial and asset market rates to changes in the official interest rate. The second stage captures the modifications in the manner in which individuals and firms spend as a result of changes to the interest rate and price adjustments in the financial markets. The last stage shows how adjustments in spending behaviour alters aggregate demand which in turn affects gross domestic product (GDP) and inflation. In summary, the CB influences activity in the economy largely by affecting total demand.

Monetary policies target prices. Although the CB's monetary policy committee (MPC) aims to keep inflation within a particular target range, it is economic agents in

[1] Another primary tool the central bank uses is buying and selling of reserve assets through open market operations in order to change the monetary base (Hörngren, 1995).

the private sector who are the primary drivers for setting prices of goods and services (Hörngren, 1995). Consequently, firms' price setting behaviour plays a crucial role in the functioning of the transmission mechanism and the influence this mechanism has on the economy (Nchake, 2013). Many of the models used in monetary policy work on the assumption that prices are rigid and it is this inability of prices to respond quickly to changes that enables monetary policy to impact the real economy in the short run (Greenslade and Parker, 2012).

2.3.1 How monetary policy affects prices via demand and cost conditions facing a firm.

According to the Bank of England (1999) the monetary transmission mechanism can be classified into four main categories: the interest rate channel, the asset price channel, the exchange rate channel and the credit channel. Changes in monetary policy via the interest rate (hereafter, all reference to monetary policy decisions are with respect to changes in the official short term interest rate) affect both the demand side and the cost side of a firm and how these changes affect firms are described below. The literature on the dynamics behind a change in demand initiated by a change in interest rates and how that translates into a price change is first discussed. Then the manner in which changes in interest rates affect firms' cost structures, influencing their prices is discussed. The first three channels pertain to the demand side effect and the last channel affects the cost side.

2.3.2 Demand side effects

How does demand respond to a change in interest rates? In order to answer this question, assume the interest rate change is not expected, the rate set for it will not be reversed soon, nor do people anticipate any future changes on this new rate. The change described is that from an increase in interest rates. The opposite reaction will occur in the event of a decrease (Bank of England, 1999).

The most acute and direct effect of monetary policy changes on most individuals is via the change in the rates of interest they face on their personal debt and rates earned on their savings. For many individuals, mortgages, unsecured loans, credit card debt and bank loans make up their personal debt. An interest rate rise increases the real interest rate and will increase mortgage payments for those with floating rate agreements. As such, for net borrower at any level of income, there is a reduction of disposable income due to higher mortgage rates, reducing the amount left to spend on goods and services (Ireland, 2008). Higher credit costs on high risk loans, bank loans and credit card debt have a similar effect. A reduction in disposable income makes it difficult to maintain previous spending levels without incurring further debt. Consumers will cut down on consumption and in turn reduce demand for goods and services.

On the other hand, for individuals who are net savers, higher interest rates makes returns on saving more attractive than spending. This may induce even more saving, shifting funds away from current consumption. Thus overall, consumption spending will fall for both net savers and net borrowers. Higher rates also increases the required return for new investment projects for companies. Firms whose financial position is influenced by short term market rates will be deterred from spending and many will be discouraged from making new investments, which in turn reduces aggregate demand in the economy as a result of higher rates (Ireland, 2008; Mohr and Fourie, 2004). Thus both firms and households reduce demand, resulting in a decrease in output, reducing the price of goods and services (Bank of England, 1999; Frank, 2006).

The asset price channel operates as follows; contractionary monetary policy increases interest rates. Higher rates mean the future value of an asset is discounted by a larger amount, reducing the present value of assets and reducing current wealth. This decreases investment and price of equity which in turn leads to a reduction in consumption as individuals feel poorer. Households swap out current spending for savings, putting downward pressure on prices (Ireland, 2008).

The exchange rate channel operates through international trade. When exchange rates respond to higher interest rates, there is a shift away from domestic produced to foreign produced goods that results from an appreciation of the domestic

currency. Foreign goods and services become more affordable than they were before, boosting imports relative to exports and this affects the competitiveness of domestic products and services (Mohr and Fourie, 2004). This shift towards foreign produced goods and services and the rise in net imports translates directly into a reduction of total aggregate demand in the domestic economy (Bank of England, 1999).

2.3.3 Cost side effects

The credit channel of the transmission mechanism is made up of two categories, the broad credit channel (balance sheet channel) and the bank lending channel. The main idea about the credit channel is that monetary policy has additional effects because interest rate decisions by the central bank affect the cost of credit by more than would be implied by the associated movement in risk free interest rates (Mishkin, 1995).

For the balance sheet channel, increases in the interest rate affect the financial health of a firm which is reflected in its balance sheet. A higher interest rate in turn increases firms' debt service costs, and this impairs assets and the collateral of households and firms. This automatically leads to a weakening of the strength of a firm's balance sheet, a deterioration in the borrowers' net worth and a decline in collateral values. Since asymmetric information and moral hazard problems are quite common in such a setting, the negative effect on the balance sheet of a firm undermines its creditworthiness, makes it more difficult and or more expensive for the firm to obtain credit. So firms face a higher financial cost for their activities and they increase their prices (Ireland, 2008; Mateut, 2005).

The bank lending channel deals mainly with how the availability of bank loans are affected by changes in monetary policy and this channel relies on market frictions. Monetary tightening has a direct effect on firms that rely on bank finance to fund their investments and activities (Bank of England, 1999). Banks pay a special role in the economy not just by issuing liabilities in the name of bank deposits that contribute to the broad monetary aggregates but also by holding assets in the name of bank loans which have few substitutes. Because banks rely on reserve demand deposits as an

important source of funds, a rise in interest rates affects banks' required reserve ratio, reducing the aggregate volume of bank reserves. This will result in banks imposing stricter credit conditions and decreasing their loan supply (Ireland, 2008).

Less availability of bank loans often results in a rise in interest costs, which increases total financial costs for a firm. If these costs are not met with higher revenues, their profits will decrease and cost of holding inventories increase (Bank of England, 1999). Higher interest also means that any new project that a firm wants to investment in needs to be met with higher returns, reducing the chances of new investment projects commencing. In general, increased rates of return reduces investment spending and inventories, which may lead to a cut back in production or an increase in prices in order to retain current production levels (Bank of England, 1999; Lawless et al., 2015; Mateut, 2005). The rise in borrowing costs results in firms reducing their investment consumption, cutting down on production, holding less inventories and firms pass-through [2]the increased financial cost to their prices. In essence, if there are no close substitutes for bank borrowers, theory suggests that the bank-lending channels amplifies the impact of a negative interest rate shock. (Bank of England, 1999; Gopinath and Itskhoki, 2010; Mateut, 2005; Mateut, Bougheas and Mizen, 2006).

Studies seeking empirical evidence of the existence of the bank lending channel often investigate the response of bank assets and deposit categories to changes in the official interest rate. Mateut (2005) noted that literature in this regard particularly in the US had found a crucial role played by the bank lending channel. In the UK, he also noted credible evidence of this channel, transmitted particularly through small banks and affecting bank dependent, smaller sized firms. This evidence was also supported by some studies done in Europe and Canada. Hejazi and Georgopoulos (2009) demonstrated that an industry with a high number of firms that rely heavily on bank financing will be affected more severely when interest rates increase.

Although evidence about the existence of the bank lending channels is strong in North America, the same is not always the case in Europe. Contrary to the existence

[2] Cost pass-through is when a business passes on to its prices a cost shock it experiences in order to compensate for the extra funds that have to be diverted towards the additional costs, given all else remains constant (Bonnet, Dubois, Villas-Boas and Klapper, 2013)

found by some studies mentioned by Mateut (2005), he also indicated that some studies done on the countries in Europe did not find supporting evidence for the lending channel. These contrary studies did however acknowledge that banks in particular countries respond in different ways to protect the supply of loans from a liquidity squeeze. Bougheas et al (2006) also indicated that studies that attempted to measure the influence of policy tightening on the level of bank lending did not distinguish between demand-side influences working via liabilities of banks (interest rate channel) and supply shifts, and therefore could not establish beyond doubt that a separate credit channel did exist.

Evidence supporting a bank-lending channel of monetary policy transmission depends upon the degree of substitutability between bank and non-bank sources of finance. Such substitutability will vary in time and across sectors due to financial innovation. In other words, the effect of a rise in interest rates on firm costs is dependent on the type of borrowing available to firms. One of the reasons that could be offered to explain the lack of evidence of a bank lending channel is that when bank lending becomes more difficult to obtain, firms make use of another source of finance to overcome liquidity shortages, namely trade credit (Guariglia and Mateut, 2006).

In order to study channels of monetary policy transmission recent empirical research has looked at different external financing options such as bank finance, market finance and trade credit (Mateut, 2005). Particularly during times of contractionary monetary policy, bank lending decreases reducing the supply of bank loans. Trade credit (both accounts payable and accounts receivable) then increases. The reduced supply of bank loans affects majority of firms that either have low credit ratings or do not have sufficient collateral so, presenting a high risk to banks that lend to them, or firms that have very few alternatives to bank finance (Nilsen, 2002). So although bank lending decreases, trade credit issued increases and is made available to those firms that failed to finance their activities due to the lack of available bank loans. Thus, effects of tighter monetary policy are likely to be smoothed out and this channel may cancel out the bank lending channel. Studies done by Choi and Kim (2003) and Mateut and Mizen (2002) both provided evidence of this.

In addressing the strength of the bank lending channel it is important to take into account that business finance sources are not restricted to trade and bank credit.

Funding options are diverse and firm characteristics often explain the level of diversification of funds and the possible funding sources that are actually used. Larger and older firms often have more diversified funding options which gives them greater ability to buffer themselves from adverse effects of higher interest rates on their operations. However, larger firms often are the producers of durable goods and have greater financing requirements, which increases their sensitivity to interest rate changes (Dedola and Lippi, 2005, Lawless *et al.*, 2015). Smaller, younger firms are more likely to have a smaller borrowing capacity which limits their funding options and their ability to avoid higher interest costs. However, smaller firms are more likely to switch from bank credit to trade credit during credit tightening. Using trade credit as a substitute to bank loans helps firms to reduce the sensitivity of their investments to their liquidity position (Mateut, 2005).

Since different firms have different finance sources and varying levels to which they depend on those finances for their operations, prices respond very differently to changes in interest rates, depending on firm characteristics. Thus unlike with individuals who mostly respond to a change in interest rates in a similar fashion, firms pricing decisions are expected to vary greatly depending on how firm characteristics interact with changes in interest rates.

2.3.4 Heterogeneous effect of interest rates by sectors and firm size

Theoretical models and academic textbooks often assume that all agents in an economy are impacted in the same way by monetary policy shocks. However, empirical evidence shows that uniform national pricing does not apply to all agents of the same country (Arnold and Vrugt, 2004; Georgiadis, 2015; Yang *et al.,* 2010). In particular, regional and industry deviations from national pricing exist, thus significant differences are observed in response to a common monetary interest rate shock (Georgiadis, 2015; Yang *et al.,* 2010).

A richer understanding of how policy shocks transmit to the economy is achieved by using a disaggregated approach to the transmission mechanism. In other words, knowledge of how interest rate changes affect the different microeconomic

components of an economy is central to understanding how the economy as a whole is affected (Dow and Montagnoli, 2007; Yang *et al.,* 2010).

Price deviations across regions are largely explained by differences in economic activities and financial structures. Industry distribution and firm size explain why some regions are more responsive to changes in interest rates than others. In their study, Arnold and Vrugt (2004) explained that regions with more interest sensitive industries such as construction, manufacturing and financial services are more responsive to unexpected policy shocks. Georgiadis (2015) notes that a more diverse financial market system insulates a region from unexpected monetary impulses, as industries have different financing options available to them.

Certain industrial characteristics make some industries more sensitive to the transmission mechanism than others. Strong relationships exist between the strength of monetary policy and industry characteristics such as investment intensity, product durability, firm size and financial requirements (Dedola and Lippi, 2005). The first two variables relate to the interest channel. When prices are said to be sticky in the short-run, real interest rates and the cost of capital increase as a result, affecting investment consumption, particularly for industries whose investment decisions rely heavily on the cost of capital (Ramlogan, 2004). Heavy industries (manufacturing and construction) and the financial services are known to be highly interest sensitive sectors. These heavy industries produce goods with the highest durability which demand high levels of investment intensity. When interest rates change, investment decisions of heavy industries are affected, resulting in strong responses to policy shocks. For the financial services, interest rates are key drivers of activity in the sector, making it naturally responsive to rate changes (Dedola and Lippi, 2005; Georgiadis, 2015).

Firm size and financial requirements are often used to account for the credit channel of the transmission mechanism. This channel affects the economy by altering the amount of credit banks make available to firms. A tightening of monetary policy reduces banks' willingness to avail credit to firms, affecting the spending and investment decisions of those that rely heavily on banks for credit funding. Smaller firms have small levels of investment intensity but are generally more dependent on banks for funding. This makes them less likely to be able to hedge against unexpected monetary shocks, making them quite responsive to interest changes. Larger firms on

the other hand often have high financial requirements but have access to capital markets. Most large firms rely less heavily on bank financing and have better hedging options, insulating them from interest rate fluctuations (Dedola and Lippi, 2005; Georgopoulos and Hejazi, 2009). Thus not all regions, industries or firms have a common response to adjustments in interest rates.

2.4 Theoretical model

This study adopts a modified version of a partial equilibrium model on retail price determination used by Crucini *et al.*, (2005). The modified model focuses on a firm's price response to an economic shock (*demand and supply shocks*).

Consider a retail firm that sells output Y and experiences diminishing returns to scale. Output can consist of a single product or a range of products. That is $(q_1, \dots, q_n) \subset Y$, where q_n is the n^{th} product of the firm and $1 \leq n < \infty$. Assume production is made up of traded inputs, non-traded inputs and credit. We assume that some retail prices are sticky, meaning a firm has the option to let the price of its product or service respond slowly to market changes. As Hoeberichts and Stockman (2010) suggest, in order to do this, a firm needs to exercise some market power when it comes to pricing decisions, hence the preferred firm of choice to be able to account for price setting in our model, is a monopolistically competitive one. The retail firm exercises a cost-based pricing strategy, that is, production costs are a major factor in determining the price of the firm's output and thus the price of the firm generally stays the same until costs change (Amirault *et al.,* 2006). We assume the firm charges a mark-up over marginal costs.

The marginal costs of the firm consist of the wholesale input price of the goods it will retail, transportation for the goods and finance it needs to borrow in order to purchase the goods (credit). Thus marginal cost (mc) which increases with output is represented as $(c + cr)$, where c is the wholesale price plus transportation cost and r is the interest rate to cover the cost of borrowing finance. For output Y, the profit function of the firm is as follows;

$$Profits\ (\pi) = PY - cY - rcY \tag{1.1}$$

In monopolistic competition, in order to realise profits, firms produce output where marginal revenue is greater than marginal cost. The optimal setting for short run equilibrium is as follows; the optimum quantity is where marginal revenue is equal to marginal cost. The equilibrium price is then the price at which consumers are willing to pay for that quantity supplied. As a firm that has some degree of market control, the demand schedule (average revenue) it faces is higher than marginal revenue, so the price set for its output is higher than the marginal cost incurred to produce it. In addition, when setting its price the firm is sensitive to the price elasticity of demand.

Let the linear demand curve facing the firm be denoted as,

$$Y = a - mP \tag{1.2}$$

where Y is the quantity demanded for the good, P price of the product, a is the intercept term, m is the slope of the demand curve which represents how responsive demand is to a change in price. Equation (1.2) expresses quantity demanded as a function of the price of a good. Thus when price changes, one can determine what happens to the quantity demanded for a product. This study however is interested in how prices respond to changes in demand conditions and this is best seen when price is expressed as a function of quantity demanded, shown as an inverse demand function.

Let the linear demand curve facing the firm be as follows;

$$P = a - bY \tag{1.3}$$

where b in this case shows how price changes in response to a change in quantity demanded. Assume that although the firm may face multiple inverse demand schedules if it sells more than one product, it is only highly responsive to the demand elasticity for its main product. That is, the product that brings in the highest revenue.[3]

[3] Revenue rather than sales is a more representative figure of the main product being demanded by customers of a profit maximizing firm. Some studies however have used number of sales as an indication of the size of a firm, after other indicators such as number of employees and total assets. The choice of which relies on the objectives of a firm that affect that pricing decisions. (Dedola and Lippi, 2005; Love, Preve and Sarria-Allende, 2007; Casey and O'Toole, 2014)

Thus the optimal retail price will be a function of the cost of sales and the elasticity of demand for the product. The optimal price is the solution to the profit maximizing problem and it obtained as follows

$$\max_{\{P,Y\}} \pi \; = \; PY - (cY + rcY) \tag{1.4}$$

First order conditions to maximize profit require differentiating equation (1.4) and equating to zero. Since profit equals total revenue minus total costs, optimum quantity can be obtained by equating marginal revenue to marginal cost.

Marginal revenue is obtained as follows;

$$MR = \frac{\mathrm{dPY}}{\mathrm{dY}} \tag{1.5}$$

Using the product rule, equation (1.5) can be expressed as follows;

$$MR \; = \; P + \frac{YdP}{dY} \tag{1.6}$$

and when P is factored out, marginal revenue can be further expressed as;

$$MR \; = \; P + \frac{YdP}{dY} \; = P\left(1 + \frac{Y}{P}.\frac{dP}{dY}\right) \tag{1.7}$$

The expression for price elasticity can be written as $e_p = \left(\frac{dY}{dP}\right).\left(\frac{P}{Y}\right)$ with ${e_p}^{-1}$ being its inverse, elasticity can be factored into equation (1.6) resulting in the following;

$$MR = P(1 - \; 1/e_p) \tag{1.8}$$

Marginal cost is obtained as follows;

$$MC = \frac{dTC}{dY} = (c + rc) \tag{1.9}$$

where TC is the total cost. Equating marginal revenue and marginal cost, we get

$$MC = (c + rc) = P(1 - 1/e_p) \tag{1.10}$$

By solving for P, the optimal price for the firm can be expressed as

$$P^* = \left[1 - 1/e_p\right]^{-1}[c(1 + r)] \tag{1.11}$$

where e_p is the elasticity of demand facing the firm, $c(1 + r)$ is the marginal cost and P^* is the optimal price for the firm.

Source: Microeconomics (Pindyck and Rubinfeld, 2005)

How does a firm's price respond to a demand shock? Consider an increase in interest rates as the stimulus that results in a demand shock but does not affect a firm's cost. The effect on a firm's price solely via the demand channel is as follows.

Of the three possible effects on the demand side, the one felt immediately and most directly by individuals is the effect on personal debt. Higher interest rates increases the rates on personal debt (e.g. mortgage rates, credit card debts, unsecured debt or loan repayments) if credit rates are not fixed (Bank of England, 1999). This reduces the remaining disposable income available to spend on goods and services. For some consumers, to maintain previous spending levels, individuals either have to incur further debt or decrease savings. However, for most consumer, higher interest rates reduce consumer spending. Higher interest rates also reduce investment spending and these together reduce aggregate demand. Lower aggregate demand will reduce the intercept of the demand curve, variable *a* in equation (1.2) shifting the entire demand curve inwards. Then depending on the nature of a good being sold, a reduction in consumption may also be accompanied by an increase in the elasticity of demand, especially if the good the consumer is willing to buy is not a necessity. The shift in the demand curve will also shift the marginal revenue curve resulting in a new equilibrium quantity. If the firm faces a more elastic demand curve due to less disposable income, that is if e_p increases in equation (1.11) the firm will reduce its mark-up and charge a lower price, reducing P^* (Mohr and Fourie, 2004; Nicholson and Snyder, 2011, RBB, 2014).

A similar result will be seen for the other two demand side effects. Higher interest rates reduce asset prices and results in decreased wealth. When individuals fell less wealthy, they save more and consume less, decreasing their demand for products. Higher interest rates make foreign goods more attractive than domestic goods thus demand for domestic goods decreases as there is a shift away from domestic to foreign products. Both these result in an inward shift of the demand curve facing a firm, which reduces a, resulting in firms charging a lower price (Bank of England, 1999; Mohr and Fourie, 2004).

Next, consider the effect of interest rates on prices solely via the cost side for the firm. That is, the rise in interest rates only affect firms' credit cost, and consumption spending is unaffected by interest rate changes. A rise in interest rates will affect the costs of all firms that rely on credit finance sources that are linked to the short term interest rates. Higher interest rates will lead to banks increasing the rates on the loans they supply by a similar magnitude. Other credit supplying agents may also increase their repayment rates if their ability to provide credit is linked to the short term interest rate. Some suppliers of credit who are not as sensitive to interest hikes may also increase their loan repayment rates but to a lesser extent, or may even keep their rates constant (Bank of England, 1999; Mateut, 2005).

Higher interest rates increase the marginal cost of a firm financing its costs of production through bank credit[4]. Higher marginal cost is captured by an increase in the term $C(1+r)$ in equation (1.11). If elasticity is taken to be constant, then higher marginal costs, increases the cost of production causes the firm to push up its prices, increasing P^* (Nicholson and Snyder, 2011).

Now consider the elasticity of demand facing a firm is not constant. Firstly an inelastic demand curve is discussed. When a demand curve is inelastic, consumers are not sensitive to price changes. When a firm experiences higher marginal costs, it is able to pass through this cost onto consumers by setting a higher mark-up. Since consumers are price insensitive, quantity demanded of the good will not change much and so a firm can increase its price, increase P^*. If however a firm faces an elastic demand curve, its consumers are sensitive to changes in the firm's product. Thus, a small increase in price will result in a large decrease in quantity demanded. Higher

[4] A similar result will occur for other credit sources that are closely linked to short-term interest rates.

credit cost resulting in higher marginal costs will cause a firm to increase its price. However, since it faces an elastic demand, higher prices will reduce the number of products bought by consumers. To retain sales in order to reduce decreases in revenue, the firm will charge a lower mark-up and so its price will fall, decreasing P^* (Mateut, 2005; Mohr and Fourie, 2004; Nicholson and Snyder, 2011, RBB, 2014). Consequently, when a firm's price is a function of price elasticity of demand and costs, the effect on its price as a result of changes in interest rates is ambiguous, from a cost side perspective. A firm has to balance the need to pass on increased cost of the higher interest cost onto prices against the demand-side sensitivity to price increases. This ambiguity forms the focal point of this study.

The findings from the literature review suggest that prices have generally become more flexible over time, responding to both cost and market shocks. A unique shock to firm prices is that of interest rates as these have a dual effect on prices, a demand shock and a cost shock. All firms are expected to be affected by an interest rate shock via the demand side. Furthermore, firms with credit will have an even higher sensitivity to interest rates via the cost side. Higher interest rates will result in negative demand conditions facing a firm, whereas on the cost side, a firm will face higher financial costs. Thus firms will have the burden of balancing between their demand and cost conditions. However, since cost shocks have a stronger influence on prices than demand shocks, the cost effect arising from higher rates will dominate the demand effect and firms are expected to pass through the higher cost onto their prices.

The main research question of the study aimed to test this ambiguity and verify whether the findings proposed by the literature replicate themselves for prices in Lesotho by posing the following question. *Do firm prices respond differently to the same shock in interest rates?* This was address this by answering the following interrelated sub questions. *What is the relationship between price changes and interest rates? Does this relationship differ when price changes are decomposed into price increases and price decreases?* Lastly, *is this relationship between price and interest rates the same for firms that finance their costs of production via credit?*

Based on the theoretical model presented, the study tests the following two hypotheses which relate to the main research question:

1. Firm prices are likely to adjust to changes in interest rates as firms are influenced either by consumer demand (elastic demand conditions, i.e. increase in e_p), cost of producing goods (changes in $c(1+r)$) or both.
2. Firms with credit facing the pressure of balancing demand and cost conditions are more likely to adjust their prices due to the additional financial cost compared to firms without credit.

The next chapter looks at the empirical model used to test the hypotheses and answer the above questions.

3. RESEARCH DESIGN AND METHODOLOGY

3.1. Introduction

This chapter presents the methodology for the empirical work conducted by this study. The source of the data, the analytical sample and the construction of the key variables are first discussed. Descriptive statistics on the sample are then presented. This is followed by the empirical methods used to relationship between interest rates and firm prices. The chapter concludes with a section on the limitations of the data.

3.2. Data description and Summary statistics

3.2.1 Sample

To examine the relationship between monetary policy and price adjustments in firms, this study used highly disaggregated data from retail outlet firms located in Lesotho: a Low Income Country (LIC) in Southern Africa. Data was obtained from two sources, first being a Private Enterprise Development in Low-Income Countries' (PEDL's) funded project. PEDL is a research initiative that funds projects aimed at studying firm behaviour in LICs. The project of interest for Lesotho was on "Price integration in low-income countries: market structure and retail price setting behaviour in Lesotho"[5]. This project had data on firm product prices, collected by Lesotho's Bureau of Statistics (BOS). The price observations were obtained from retail outlets in both urban and rural areas for use in constructing Lesotho's Consumer Price Index (CPI). The project also collected information on firm characteristics, obtained from a cross-sectional survey. The surveyed firms sold a variety of products such as food, beverages, clothing and footwear, fuel products, furniture, household equipment,

[5] The project website is available at http://pedl.cepr.org/node/1162. Due to confidentiality of some of the data, restricted access can be obtained by contacting Mamello Nchake, post doctorate researcher at the University of Cape Town, South Africa. Email address: NCHMAM001@myuct.ac.za.

personal care products and services. The survey included information such as background details about the firm, its years in operation and some demographic information about the owner(s). Questions about sales and assets were also administered. Details about the firms operations were included such as; the number of sales, the type of assets owned, the main product or service offered, the nature of the competitive environment for the respective industries in which they operate in, (these reflect mainly on the demand side of a firm), and also the method used to set their prices, their employment structure and their finances (which pertain mainly to the cost side of a firm). The firms in this survey were drawn from those sampled by the BOS.

The third data source was monthly short term interest rate figures published by the South African Reserve Bank (SARB). Data on product prices and interest rates covered an 8 year period from 2002-2009. Firm characteristics however were only based on responses to a questionnaire administered in 2013.

Combining the three datasets resulted in an overall sample of 243 firms available for analysis. The analytical sample was restricted to those stores that when asked how they set prices for their main product or service, responded with 'fixed margin over production costs'. These firms represent those firms that had some market power and were not entirely price takers. This also eliminated firms that had their prices controlled by government as these were not likely to respond to monetary changes until the government decided so. This limited the sample to 153 monopolistically competitive retail stores representing 63% of those available for analysis. Data began on the fourth month of 2002 and ended on the last month 2009. Cases with missing information on relevant variables described below were excluded from the sample thus as a result, the final analytical sample retained 131 firm cases (85% of the firms of interest) and 6904 observations on monthly product prices.

Most variables were only found in one dataset however, two variables were present in more than one dataset; the unique identifier for firms, *id,* was available in both the price and firm datasets, and the *month* variable was present in both the price and interest rate datasets.

3.2.2 Dependent variables

The core focus of this study was to investigate what effect higher interest rates have on firm pricing behaviour and whether the effect varies across firms. The focus was on a directional change in price, (that is, do firms revise their prices upwards, downwards or take no action at all?) rather than a change in magnitude of the price (that is, by how much does a firm's price change in response to an interest rate shock?). This enabled testing of the ambiguity of a price change as proposed by the theoretical model. Two dependent variables of concern were used for the empirical analysis.

The first dependent variable was the binary response variable, $freq_{ijt}$ indicating whether firm (i) changed the price of its product (j) in a particular month(t). This dependent variable took on a value of 1 if a price change for a product item took place and 0 if no change occurred. All observations that had a missing value on the frequency of a price change variable were excluded from the sample. Of the remaining firm-product observations, 80% did not undergo any price change whereas 20% either had a price increase or a price decrease.

The second dependent variable $price\_change_{ijt}$ determined the direction of a price change of product (j) by firm-(i) at time-(t). It was constructed using $freq_{ijt}$ and two other binary variables from the price data, $pincrease_{ijt}$ denoting a price increase and $pdecrease_{ijt}$ denoting a price decrease respectively. The variable $pincrease_{ijt}$ took a value of 1 if a price increase occurred and 0 otherwise. Similarly $pdecrease_{ijt}$ took a value 1 for a price decrease and 0 otherwise.

The multinomial variable, $price\_change_{ijt}$ was then constructed as follows;

$$price\_change_{ijt} = \begin{cases} 1\ if\ freq = 0 \\ 2\ if\ freq = 1\ and\ pincrease = 1 \\ 3\ if\ freq = 1\ and\ pdecrease = 1 \end{cases}$$

Thus the two main dependent variables were $freq_{ijt}$ and $price\_change_{ijt}$.

3.2.3 Key explanatory variables

In line with the literature, credit is one of the main ways short term interest rates affect firms, via the cost channel. The study focused on this channel by looking at credit owed by firms. In order to differentiate between firms that had debt and those that did not, a $debt_i$ variable for firm (i) was created based on the question "In the year 2012, what was the main source of financing for your supplies or material inputs?" The debt variable was a proxy for firms owing credit to finance their inputs and thus had credit cost as part of their variable cost structure. An outlet was considered to have debt if their supplies were financed via a credible financial institution such as a bank, a microfinance lender or if their suppliers extended trade credit to the store in question. Otherwise the store was not regarded as having debt[6].

To measure the direct effect of higher interest rates, the unit cost of capital $(1 + r)_t$ was used, where r was the short term interest rate. This measure was based on the current interest rate. The variable to capture this was defined as *capital_cost*. *Ln(capital_cost)* was its logarithmic value.

To capture firm specific characteristics, the following variables were used:

firm_size

In line with international conventions the size of a firm can either be measured in terms of the number of employees or its total assets. In our case, information on balance sheet data was not available for the sample, thus *firm_size* was defined as the number of employees in a firm and it was used to proxy for a firm's level of risk to credit constraints. *Ln(firm_size)*, was defined as the logarithmic value of the *firm_size* variable. The reason of working with a log transformation was that the transformation not only acts as a variance stabilizing transformation but also helps normalize the variable of interest. The inclusion of the variable was important in the analysis because

[6] The criteria for debt is based on the ease of access by which one can observe how an interest rate increase affects the lending rates offered by these institutions or suppliers. Although some firms may have had their supplies financed by family members or friends, repayment of this debt is usually based on different terms than debt supplied by financial institutions such as banks, for example.

according to literature, larger firms generally have other financing options apart from bank loans and thus are less sensitive to policy changes in interest rates.

firm_age

This variable was defined as the number of years a firm had been in operation as of the year 2013. Inclusion of this variable stems from the tendency of firms to improve their financial structure with the number of years they have been in operation. Older firms tend to be larger in size, more likely to have higher profits which can be used for reinvestment, higher equity ratios and are less likely to have high debt ratios and thus owe less debt to banks or micro lenders. *Ln(firm_age)* was its corresponding logarithmic value.

region

The variable *region* was a categorical variable that captured the regional area in which a firm operated. All ten regions[7] in Lesotho were represented by this variable. We included this variable because literature finds a region with a more diverse financial market is better insulated from unexpected monetary impulses (Georgiadis 2015).

productgrp

This variable described the product group category to which a product item belonged. This variable was included because the degree of price flexibility also depends on the type of product a firm produces. For example food products change their prices more than non food products, and generally, products that are exposed to higher transportation and distribution costs often have more flexible prices. Examples of product groups in our sample were food, clothing and footwear, health and transport services.

outlet

This was a dummy variable indicating whether the store sold retail goods or provided services as its product. Literature proposes that variablility within the same industry exists when it comes to price setting behaviour. For example prices for goods

[7] The 10 regions in Lesotho are Maseru, Butha Buthe, Leribe, Berea, Mafateng, Mohales Hoek, Quthing, Qachas Neck, Mokhotlong and Thaba Tseka.

are more flexible than prices for services and in particular cyclical products such as fuel. Retail good stores formed the base category and so retail outlets were assigned a value of 0 and service outlets a value of 1.

Table 3.1 below describes the variables of interest in the data.

Table 3.1: Variable description table.

Variable name	Variable Descriptions
freq	1 if a price change occurs, 0 otherwise
price_change	1 if no price change occurs, 2 if a price increases, 3 if a price decreases
debt	1 if a firm owes debt, 0 otherwise
outlet	1 if firm is a service outlet, 0 if firm is a goods outlet
interest rate	repurchase rate (repo) in percent
capital cost	unit cost of capital in percent (1+int rate)
ln(capital cost)	logarithmic value of unit cost of capital
firm size	number of employees in firm
firm age	number of years firms has been in operation as at 2013
productgrp	categorical variable containing different product groups
region	categorical variable containing regions in Lesotho

3.2.4 Descriptive statistics

Summary statistics for the dependent variables and key independent variables are shown in Table 3.2. The final sample had 131 firms and a total of 6,904 product observations. The manner in which the table reports different statistics is unique to the way panel data is structured. Panel data, also known as longitudinal data measures

repeated observations on the same individuals/firms over a period of time. The different firms form the cross sectional element of panel data whereas the repeated observations over time on a particular firm forms the time series element of panel data. The *variable* heading encompasses two columns. The left column lists the variables on which descriptive statistics are reported. The right column displays three types of variation for each reported variable

The three types of variations capture the structure of panel data. The "overall" variation shows the average change of a variable across time and observations; the "between" captures average variation from one firm to another and the "within" variation captures how a variable for a unique firm evolves over time. Time invariant variables are variables that are constant over time and so have no within variation. Typical examples of time invariant variables are demographics of the owner of the firm and geographical location. Variables with no between variation are those with values that are common to all firms. For example, the national growth rate in the country in which firms operate will not vary across firms.

The middle section of the table reports the mean, variations from the mean (standard deviation) and minimum and maximum values for the different categories. The rightmost section of the table records the number of observations for the different components of the panel data. Total observations, that is the number of firm-product combinations over the entire 8 years is represented by N. The number of firms included (that is the number of participants that were followed over time) is n.

Some variables related to firm characteristics like $debt, \ln(firm\_size), \ln(firm\_age)$ $and\ outlet$ were only captured at one point in time and so they were included as if they were time invariant hence they have no within variation. $Frequency, pric\_\ change\ and\ \ln(capital\_cost)$ had greater within variation than between variation. For these variables, variation within a firm over time was much more than variation across different firms. For the dependent variables, this meant that price changes did not vary that much across firms but varied more substantially within a firm from 2002-2009. An exception was the variable *productgrp* which had more variation across firms than within firms.

Table 3.2: Summary statistics displaying the different types of variation (overall, within and between) of key variables over the period 2002-2009

Variable	Variation	Mean	Std. Dev.	Min	Max	Observations
freq of a price change	overall	0.202609	0.401972	0	1	N= 6904
	between		0.123326	0	0.666667	n=131
	within		0.389778	-0.46406	1.185065	T-bar = 52.7023
price_change	overall	0.277971	0.592856	0	2	N= 6904
	between		0.171385	0	0.833333	n=131
	within		0.576705	-0.55536	2.242883	T-bar = 52.7023
Debt	overall	0.13971	0.346711	0	1	N= 6904
	between		0.361052	0	1	n=131
	within		0	0.13971	0.13971	T-bar = 52.7023
lncapital_cost	overall	2.305368	0.205135	2.079442	2.674149	N= 6904
	between		0.083497	2.079442	2.382744	n=131
	within		0.201581	2.002066	2.728658	T-bar = 52.7023
product_grp	overall	6.15087	5.065192	1	15	N= 6904
	between		4.655937	1	15	n=131
	within		2.007316	-5.25654	18.16337	T-bar = 52.7023
lnfirm_size	overall	2.01565	1.131767	0	5.056246	N= 6904
	between		1.084769	0	5.056246	n=131
	within		0	2.01565	2.01565	T-bar = 52.7023
lnfirm_age	overall	2.339962	0.880196	0	4.143135	N= 6904
	between		0.877931	0	4.143135	n=131
	within		0	2.339962	2.339962	T-bar = 52.7023
outlet	overall	1.259705	0.4385042	1	2	N= 6904
	between		0.4357754	1	2	n=131
	within		0	1.259705	1.259705	T-bar = 52.7023

Source: Author's own calculations using Lesotho firm data from 2002-2009

Table 3.3: Panel descriptive statistics on dependent variable frequency

Panel summary statistics for frequency of a price change					
Dependent variable					
	Overall		Between		Within
freq	Freq.	Percent	Freq.	Percent	Percent
0	5497	79.62	131	100.00	80.18
1	1407	20.38	119	90.84	21.82
Total	6904	100.00	250	190.84	52.40
firm sample size (n) = 131					

Source: Author's own calculations using firm data on 131 firms from Lesotho over the 2002-2009 period.

In Table (3.3), the descriptive statistics for the frequency of a price change are recorded. The overall summary shows that 80% of the 6904 firm-product observations (total observations) had freq = 0 and 20% had freq = 1. The summary between firms shows that of the 131 firms, 100% kept their prices constant for at least one month of the entire 8 year period and 91% changed their prices in one of the months at the very least. The between total percentage is greater than 100 because 90.84% of sampled firms (119 firms) were counted twice because in some months, these firms kept their prices constant and in other months they changed their prices. The within summary shows that 80% of firms that kept their prices constant, did so for the entire duration that the panel covers and that 22% of the firms that changed their prices did so for the duration of the panel.

Table 3.4: Panel descriptive statistics on dependent variable price change

Panel summary statistics for the price change categories					
	Overall		Between		Within
price_change	Freq.	Percent	Freq.	Percent	Percent
1. no change	5497	79.62	131	100.00	80.18
2. increase	851	12.33	114	87.02	14.04
3. decrease	556	8.05	108	82.44	9.22
Total	6904	100.00	353	269.47	37.11
firm sample size (n) = 131					

Source: Author's own calculations using firm data on 131 firms from Lesotho over the 2002-2009 period.

Table (3.4) shows the panel summary of the type of price change, no price change, an increase or a decrease. The table reports an overall summary that 80% of the total observations did not change their prices, 12% increased their prices and only 8% decreased their prices. The between summary shows that out of the 131 firms, in at least one of the months, 100% kept their prices constant, 87% increased their prices and 82% decreased their prices of their products. Firms were counted more than once because at some point, some firms increased, decreased and kept their prices constant over the 8 year period. The within summary shows that 80% of firms kept their prices constant throughout, 14% only increased their prices and 9% only decreased their prices from 2002-2009.

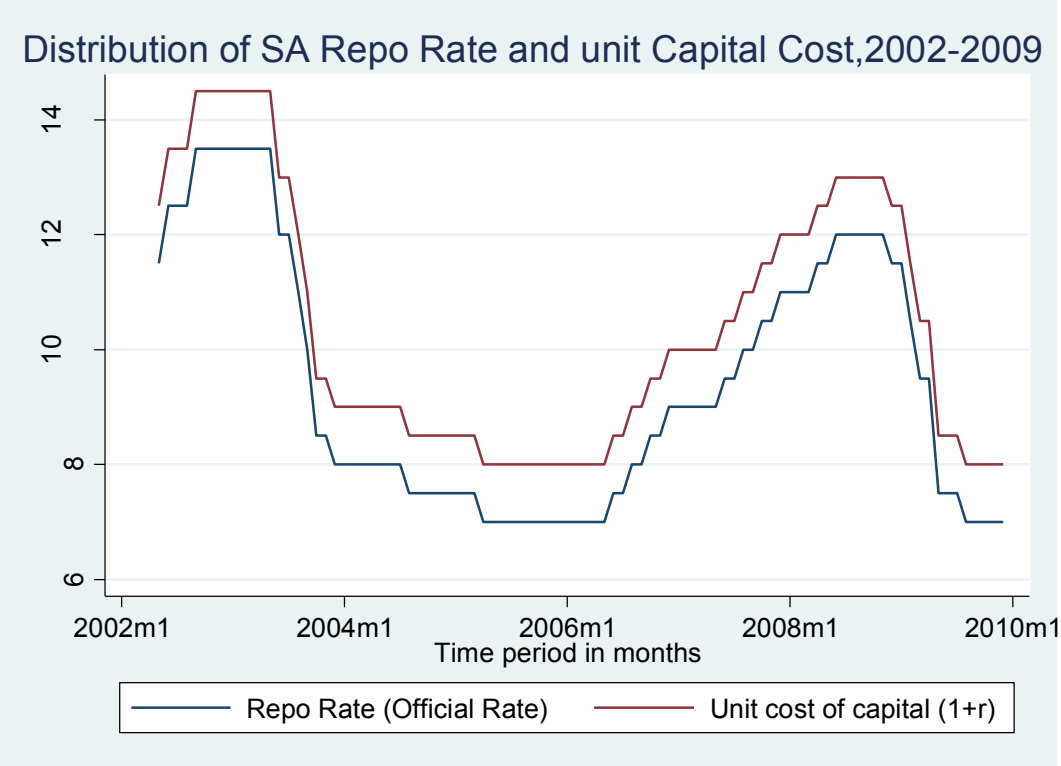

Figure 1: Line graph of interest rates facing Lesotho, from 2002-2009.

Source: Author's calculations on information from South African Reserve Bank

Figure 1 above shows the distribution of the main explanatory variable, interest rates. Between the years 2002 and 2009, the interest rate had a bimodal distribution shape, peaking first at 13.5% around 2003 and peaking again at 12% towards the end of

2008. The sharp rise in interest rates after 2006 coincides with the 2007-2008 financial crisis. The rapid decline in interest rates towards the end of 2002 occurred during the commodities boom period. The log transformation of the cost of capital also has a bimodal distribution, and had a minimum value of 2.1% and a maximum value of 2.7%.

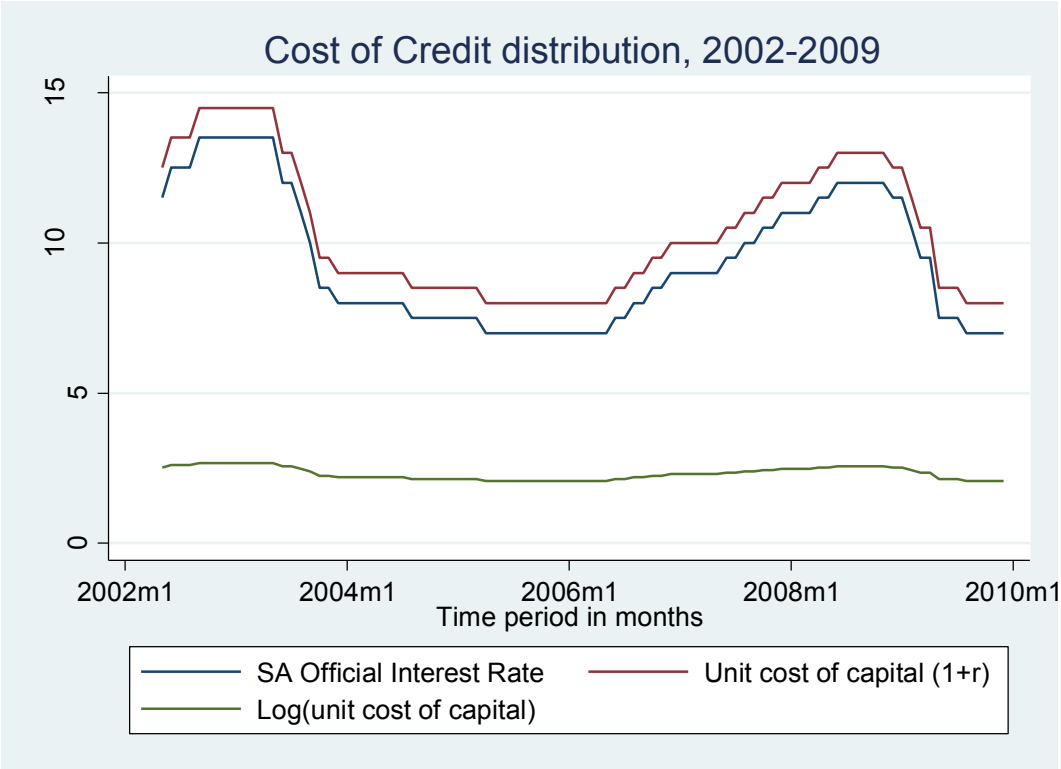

Figure 2: Distribution of interest rates, from 2002-2009.

Source: Author's calculations on information from South African Reserve Bank

Figure 2 above shows the same distributions as in figure 1 but with the inclusion of the logarithmic value of unit capital cost. In both figures (1) and (2), between the two peaks, the interest rate was fairly stable. This likely led to inflation in Lesotho being low and stable. The inflationary environment has the ability to influence the pricing conduct of firms. Low inflation indicates that cost and price adjustments are not likely to persist. In a competitive environment, if cost changes are not persistent, a firm may hold back on passing on increased costs to its prices in fear of losing customers to firms that do not pass on higher costs. Thus, if most firms in Lesotho adopted this

strategy, a low inflationary environment may have reduced their pricing ability (Taylor, 2000).

3.3 Empirical method

The key empirical test around the main research question was to investigate whether firm prices responded differently to the same shock in interest rates. This analysis began with a simple regression model to test the relationship between the frequency of price change and interest rates. The $freq$ variable represented aggregate price change, which could represent an increase or a decrease in price. The variable used to capture a change in interest rates in a manner that directly affects economic agents was *capital_cost.* Since the dependent variable was binary, the regression model was in logistic form.

A logistic model is one of the models used to analyse qualitative binary outcomes that are mutually exclusive. The outcome variable (y) takes on 2 possible values, which indicate if an observation falls into a particular category or if an observation satisfies a certain condition. In essence, the outcome can be seen as a response to a yes no question for the observations. Thus (y) is an indicator variable showing whether a condition has been met or not. The outcome has a value of 1 if an observation satisfies a condition and a value 0 otherwise. The category or condition that is assigned the value 1 is the condition or category of interest, the success event and 0 is the failure event.

When one attempts to make the value of (y) change from a 0 to a 1, in essence this is similar to increasing the likelihood of a success event occurring. If one denotes the likelihood of a success outcome with a probability (p), such that $(p = \Pr(y = 1))$ then modelling the variation in (y) as it changes from 0 to 1 is the same as explaining what increases (p). Since we are interested in modelling what changes $y's$ values from 0 (a failure) to 1 (a success), that means we are interested in modelling what increases the probability of a success outcome; modelling the response probability $(\Pr(y = 1)$.

Modelling (y) using a simple linear regression will have the following form;

$$\Pr(y = success|\, \boldsymbol{x}) = p = F(\beta_0 + \boldsymbol{x\beta} + e) \quad (3.1)$$

where the probability of a success is modelled as a linear function (i.e. the functional form of $F(.)$ is linear) of the coefficients of the respective explanatory variables. Ordinary least squares (OLS) estimation technique fits a linear probability model (LPM) to a success event. The major issue with this model is that the LPM has an unbounded range and probabilities are bounded whereby $0 \leq p \leq 1$. The LPM will thus produce unrealistic values for p and is thus an unsuitable model (Wooldridge, 2009).

The logistic function is one that can model a success outcome while retaining the bounds of probability. The logit does not model a success event as a linear function of the $\beta's$, but rather applies a transformation to p and the transformed result is expressed as a linear function. If the probability of a success is p, the probability of a failure is $1 - p$. One can express the odds of a success, that is the probability of a success relative to the probability of a failure, as follows;

$$odds\ of\ a\ success = p/1 - p.$$

The log odds is then the natural log of the above expression, denoted as $\ln(p/1 - p)$. The logit function expresses the log odds of a success as a linear function of the $\beta's$, so it can be expressed in the following manner

$$\ln(p/1 - p) = \beta_0 + \boldsymbol{x\beta} + e$$

For the logit model, the response probability is then modelled as follows;

$$p = \Pr(y = 1|\boldsymbol{x}) = F(\beta_0 + \boldsymbol{x\beta}) \quad (3.2)$$

where the functional form of the logit model $F(.)$ is the cumulative distribution function of the logistic distribution which is fitted by maximum likelihood estimation techniques[8] and the error terms have a standard logistic distribution. This form ensures that the estimated probabilities from the regression are bounded between 0 and 1[9]. A probit model also enables the response probability to be within the bounds of probabilities but its functional form $F(.)$ is the standard normal cumulative distribution function and

[8] See Cameron and Trivedi (2010) for the full specification of the logit functional form.
[9] The bounds on probabilities are satisfied when $0 \leq p \leq 1$.

the error terms associated with it have a standard normal distribution (Wooldridge, 2009; Cameron and Trivedi, 2010).

Running a regression on the response probability helps explain the effect regressors (attributes) have on influencing the probability of a success. The magnitude of the $\beta's$ present a level of complexity[10] when it comes to interpretation due to the nonlinear nature of $F(.)$ (Wooldridge, 2009). Interpretation of the sign of the estimated parameters has the following direct meaning. A positive estimated parameter $(\hat{\beta}_k > 0)$ means that higher values of the explanatory variable increase the likelihood of a success, whereas a negative sign on the coefficient $(\hat{\beta}_k < 0)$ means that higher values of the associated explanatory variable decrease the probability of a success.

The first logistic model specification looked at the association between frequency of price change and cost of capital. It was developed as follows. The binary outcome *freq* with a success probability p is modelled as a function of capital cost. The model takes on the following form;

$$Pr(freq = 1)_{ijt} = \beta_0 + \beta_1 lncapital\_cost_t + \beta_2 debt_i + \beta_3 lncapital\_cost_t * debt_i + \varepsilon_i \quad (3.3)$$

where $lncapital\_cost$ is the unit cost of capital in logarithmic form, $debt$ is a binary variable, indicating whether a firm owes debt or not, $lncapital\_cost_t * debt_i$ is an interaction term and ε_i is the error term. A higher interest rate increases the unit cost of capital. We anticipate a positive value for $\hat{\beta}_1$ as firms are more likely to revise their prices either upwards or downwards due to a higher cost of capital. Likewise, we expect a positive value for $\hat{\beta}_2$ as firms with debt are more likely to change their prices than firms without debt. Lastly, our interaction term captures the different response to higher interest rates via cost of capital for firms with debt compared to those without debt. As discussed in the literature, firms with debt are more exposed to changes in interest rates than firms without debt. Thus as the cost of capital increases, firms that owe are more likely to change their prices than firms that do not, and we expect this relationship to be displayed by a positive value for $\hat{\beta}_3$.

[10] See Wooldridge (2009) on how to calculate the magnitude of the parameters.

In order to control for omitted variable bias, we add control variables to the above equation. Region, the natural log of firm size and firm age are variables likely to influence the probability of a price change. In addition, because we have panel data, running model *(3.3)* fails to take into account the fact that we have multiple observations on the same firms. Thus we run a fixed effect model form of equation *(3.3)* because we believe there are time-invariant differences amongst the firms that are correlated to the regressors of interest. In so doing, we control for firm specific time-invariant unobserved heterogeneity that may contribute to bias in the estimated parameters (Wooldridge, 2009). In the model, we control for firm and time fixed effects and at the very extreme, we also include product group and product fixed effects.

The above model specification is well suited to analyse aggregate frequency but in order to study price movement in more detail, a multinomial logit was used to study disaggregated frequency. This allows one to investigate how interest rates affect firms' decisions to raise or reduce prices as the effect may not be symmetrical.

A multinomial logit (MNL) model, when run as a multinomial logistic regression, is a model which generalizes logistic regression by allowing more than two discrete outcomes. That is, it is a model that is used to predict the probabilities of the different possible outcomes of a categorical dependent variable, given a set of independent regressors. When using multinomial logistic regression, one category of the dependent variable is chosen as the reference category. Separate odds ratios are determined for each category of the dependent variable with the exception of the reference category, which is omitted from the analysis report output (Wooldridge, 2010).

To interpret the coefficients of the respective regressors, the base category, which is the category with the lowest numerical value is chosen as the reference. In this analysis the reference is the category which denotes constant prices. The other two categories are each compared to the reference group of constant prices. For an explanatory variable(x_j), its estimated coefficient $(\hat{\beta}_j)$ can be viewed as a parameter from a binary logit model whereby alternative *w* is compared to alternative *1,* the base group. So a positive coefficient from a multinomial regression means that as the regressor increases, one is more likely to choose alternative *w* than alternative *1*. The opposite will apply for a negative coefficient, one is more likely to choose alternative *1* than alternative *w* (Cameron and Trivedi, 2010).

Our second core specification is shown below.

$$P(price\_change = w)_{ijt} = \beta_0 + \beta_1 lncapital\_cost_t + \beta_2 debt_i + \beta_3 lncapital\_cost_t * debt_i + \varepsilon_i \quad (3.4)$$

where w captures the different categories of the dependent variable and the explanatory variables are as explained above. The dependent variable has three categories; 1 represents the category of no price change, 2 is the category for a price increase and 3 is the category for a price decrease. As with the logistic regression, we add controls and fixed effects to reduce omitted variable bias.

We first deal with our expectations for the price increase group in reference to the base, then we look at the price decrease group. We anticipate a positive value for $\hat{\beta}_1$, because as capital cost increases, firms are more likely to increase their prices than to keep their prices constant. We expect a positive value for $\hat{\beta}_2$ as firms with debt are more likely to increase their prices. For the interaction term, we expect a positive value for $\hat{\beta}_3$. Indebted firms are more likely to increase their prices than other firms.

For the price decrease group, we only anticipate a positive value for $\hat{\beta}_1$ because as the cost of lending goes up, firms are more likely to reduce their prices than keep them constant due to a decrease in aggregate demand, if firms do not owe any credit. We anticipate negative values for the other two coefficients. Firms with debt in general are more likely to keep their prices constant then to revise them downwards and when faced with higher interest rates, these very same indebted firms are even more likely to keep prices the same than to reduce them as they face a higher credit cost they need to cover with their revenue.

In summary, we investigate how the different price change dynamics are influenced by higher interest rates and the presence of debt. We anticipate that many firms will respond to higher interest rates by changing their prices due to their sensitivity to demand. However, we expect firms with debt to be more sensitive to changes in capital costs as they are exposed to interest rate changes from both the demand and the cost side. We test the above relationships using logistic and multinomial logit regression models. After discussing the limitations of the study, the next chapter presents the results of these models.

3.4 Limitations of the study

One of the weaknesses of this research is that information on firm characteristics do not fall into the time period that the panel study covers. Whilst data on price and interest rate information spans 2002-2009, firm characteristics were based on information obtained in 2013. One of the major issues with this data mismatch is that firm characteristics may have changed over the years and the most recent information may not be an accurate representation of the state of the firms when their prices were changing during 2002-2009.

Moreover, the two time frames of the different data fall into two different conditions of the economy. The 2013 period was post the most recent financial crisis whereas the bulk of 2002-2009 was prior to the financial crisis. Conditions, particularly pertaining to credit conditions, sources and availability may have changed significantly post the financial crisis, so the credit variable used in this study may have told a different story during the panel time of interest than it did in 2013. In addition, information on firms may have been influenced by the economic conditions prevailing in 2013 and this may bias the results of the study as economic conditions[11] were not controlled for (Hoeberichts and Stockman, 2010).

Another issue this study may suffer from is a possible misrepresentation of the main dependent variable, i.e. frequency of a price change. Sahinoz and Saracoglu (2011) cautioned that is needed when dealing with frequency of a price change especially if a firm has multiple products, a study is likely to overestimate how frequently prices change if a firm indicates it experienced a price change for some products but not for most of the products it sells.

Lastly, Blinder (1991) cautioned that the degree of rigidity or flexibility of prices might depend strongly on how stable the underlying conditions are at the time of study, thus making it difficult to establish with certainty how rigid prices are on the basis of frequency alone.

[11] Conditions such the fluctuation of the exchange rate with major global currencies and the prevailing inflation rate may significantly affect the domestic economic conditions faced by a country.

4. RESULTS

4.1. Introduction

In this chapter the results from the analysis of interest rates on price changes are presented. The bivariate relationships between the key independent and dependent variables is first discussed. Then the empirical results are presented.

4.2. Associations between key explanatory variables

Table 4.1 presents a panel of bivariate relationships on cost of capital, debt, firm size and region for frequency of a price change. In panel (A), products whose prices did not change had an average capital cost of 10.1% and products whose prices did change experienced a mean capital cost of 10.8%. The capital cost differences between products that changed and did not change their prices were statistically significant, as were the log forms of capital cost. Firms with more employees (2 more employees) on average changed their product prices more compared to firms with fewer employees. The relationship was even stronger when firm size was measured in logarithmic form.

Debt was more prevalent in products that changed their prices compared to those that did not. The three regions that had the highest proportion of products that did not undergo any price change were Maseru, Quthing and MohalesHoek (19.4%, 10.5% and 10.4% respectively). The three regions that had the highest proportion of products that did have a price change were Maseru, MohalesHoek and ButhaButhe (4.6%, 3.1% and 2.7% respectively). For all regions however, proportion of products that remained constant were much higher than the proportion of product that had undergone a price change.

In panel (B), the first column reports the pairwise correlations between a price change and the respective variables. Cost of capital along with firm size and the type of outlet were all highly correlated with a price change. Retail stores were more likely

to change their prices than stores that provided services. On average higher values for both capital cost and firm size increased the likelihood of a price change. The relationship between these variables was highly significant as represented by a p value <0.01.

Table 4.1: Table with panels of bivariate relationships between frequency of price change and independent variables

Panel A: Associations of capital cost, firm size, debt and location with frequency of price change for Lesotho Retail Outlets, 2002-2009

	Freq =	
Variables	No price change (N=6,900)	Price change (N=6,900)
Cost of capital*		
mean (%)	10.10	10.80
Ln(Cost of Capital)*		
mean	2.29	2.36
Firm size*		
mean (number of employees)	14.61	16.07
Ln(Firm size)*		
mean	1.98	2.16
Debt		
average owing debt (%)	13.9	14.3
Region *(occurrence rate in %)*		
Maseru*	19.4	4.6
ButhaButhe*	8.3	2.7
Leribe*	3.7	1.4
Berea	8.5	1.8
Mafateng	6.0	1.7
MohalesHoek*	10.4	3.1
Quthing	10.5	2.7
QachasNeck	5.8	1.1
Mokhotlong*	4.6	0.7
ThabaTseka	2.7	0.6

Note: Variables with * showed differences between freq groups were statistically significant at (p<0.05)

Panel B: Pairwise correlation coefficients between key variables

	freq	capital cost	ln(capitalcost)	firm size	firm age	Debt	service.outlet
freq	1.0000						
capitalcost	0.1308*	1.0000					
ln(capitalcost)	0.1302*	0.9973*	1.0000				
firm size	0.0333*	0.0202	0.0202	1.0000			
firm age	-0.0106	0.0150	0.0157	-0.0500*	1.0000		
debt	0.0305	0.0062	0.0054	0.2099*	-0.0247	1.0000	
service.outlet	-0.0971*	-0.0024	-0.0006	-0.2516*	-0.0697*	-0.1670*	1.0000

Note: Significance level of coefficients; * p<0.01
Source: Author's own calculations using firm data from Lesotho, 2002-2009

4.3. How do interest rates affect firm pricing behaviour?

The primary goal of this study was to investigate what effect interest rates had on the pricing behaviour of firms. The two main objectives of the analysis in order to achieve this goal were firstly to determine how interest rates affect price changes by firms and secondly to uncover whether this response to interest rates differed by firms that had credit. The results of this investigation are presented below.

4.3.1. Does a negative interest rate shock increase the likelihood of a price change?

Literature has found that interest rates affect retail prices via two main channels, the demand channel and the cost channel. The demand channel suggests that higher rates increase loan repayments by households and firms. Consequently, for households this reduces the amount of disposable income available for consumption, which in turn reduces the demand for goods and services. Similarly, higher interest rates increase firms' loan repayments and reduce firm investment, further decreasing

demand for goods and services. As such reduced demand from consumers and firms results in downward pressure on prices.

On the cost channel side (via the bank lending route) firms face increased cost of credit due to higher rates. For firms that rely heavily on credit finance, particularly bank credit and have no alternatives, higher credit costs increases their marginal costs, which increases their cost of production. This in turn has to be compensated for by higher prices for their products.

This led us to our first hypothesis which we stated as follows;

Hypothesis 1: Higher cost of capital is likely to cause firms to adjust their prices.

i.e. $\hat{\beta}_1 > 0$, where $x_1 = \ln(capital\_cost)$

The econometric model to test the hypothesis was modelled as shown in equation (4.1)

$$Pr(freq = 1)_{ijt} = \beta_0 + \beta_1 \, ln(capital\_cost)_t + e_{ijt} \qquad (4.1)$$

where the dependent variable is the response probability $Pr(freq = 1)_{ijt}$, i.e. the probability that a price change took place at firm (i), for product (j) during month (t). The error term e_{ijt}, captures all unobserved factors that cause variation in frequency of a price change. The results for this test are presented below.

Table 4.2 presents the regression coefficients from estimating equation (4.1). Models (1) to (3) display a simple analysis of the relationship between capital cost and the frequency of a price change. In model (1), we applied a simple linear model to the binary outcome to stablish a relationship. The coefficient on capital cost had the expected sign. As shown in the linear probability model (LPM), every additional unit of the log of capital cost increases the probability of a price change by 26%. In other words a 1% increase in capital cost increases the probability of a price change by 0.03% and this result is statistically significant. For comparison, the study applied the logit and probit models to equation (4.1). Models (2) and (3) are the logit and probit models respectively and both models confirmed the expected result of a positive coefficient for $\hat{\beta}_1$. As the study's core focus was on a directional change, and due to

the complexity of interpreting the magnitudes of the coefficients[12], the study concentrates on the sign of the coefficients alone when it comes to the logit and probit models.

Table 4.2: LPM, Logit and Probit estimates of the probability of a price change

	Dependent Variable: Frequency of a price change					
	(1)	(2)	(3)	(4)	(5)	(6)
	LPM	Logit	Probit	LPM		
Independent Variables	(OLS)	(MLE)	(MLE)	(OLS)	Logit (MLE)	Probit (MLE)
ln(capital cost)	0.256***	1.546***	0.889***	0.249***	1.518***	0.870***
	(0.0235)	(0.144)	(0.0830)	(0.0234)	(0.146)	(0.0841)
ln(firm size)				0.00845	0.0547*	0.0323*
				(0.00522)	(0.0322)	(0.0187)
ln(firm age)				-0.00885	-0.0590	-0.0354*
				(0.00584)	(0.0362)	(0.0209)
service.outlet				-0.0797***	-0.563***	-0.310***
				(0.0125)	(0.0858)	(0.0475)
2.Butha Buthe				0.0297	0.182	0.0968
				(0.0181)	(0.112)	(0.0647)
3.Leribe				0.0843***	0.440***	0.255***
				(0.0237)	(0.135)	(0.0807)
4.Berea				-0.0187	-0.123	-0.0719
				(0.0182)	(0.118)	(0.0671)
5.Mafateng				0.00507	0.0330	0.0139
				(0.0202)	(0.126)	(0.0726)
6.Mohales Hoek				0.0369**	0.237**	0.130**
				(0.0171)	(0.108)	(0.0620)
7.Quthing				0.0227	0.144	0.0792
				(0.0171)	(0.108)	(0.0618)
8.Qachas Neck				0.0122	0.0744	0.0366
				(0.0218)	(0.142)	(0.0805)
9.Mokhotlong				-0.0666***	-0.565***	-0.315***
				(0.0243)	(0.184)	(0.0989)
10.Thaba Tseka				-0.00737	-0.0458	-0.0319
				(0.0294)	(0.194)	(0.109)
Constant	-0.387***	-4.956***	-2.892***	-0.277***	-4.245***	-2.483***
	(0.0543)	(0.339)	(0.194)	(0.0621)	(0.391)	(0.225)
Observations	6,904	6,904	6,904	6,904	6,904	6,904
Percent correctly predicted		79.6	79.6		79.6	79.6
Log-likelihood value	-	-3433.26	-3433.29	-	-3374.65	-3375.29
Pseudo R-squared	0.017	0.0165	0.0165	0.033	0.0333	0.0331

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[12] The magnitudes of the coefficients for logit and probit models cannot be directly interpreted due to the nonlinear form in which the parameters are related to the dependent variable.

The estimates from the logit and probit models suggest that as the cost of capital increases, the probability of a price change increases and the result is highly significant. The first three models do not control for several other observable factors that may cause variation in the likelihood of a price change. So models (4) – (6) estimated equation (4.1) using the same techniques as mentioned above but in order to avoid omitted variable bias, in addition to the cost of capital, these models also control for observable differences in geographical and industrial composition, captured by the region variable and the following firm characteristics; age of a firm, the size of a firm and the type of outlet the firm is, i.e. whether a retail goods outlet (the base case) or a service outlet.

Model (4) presents the results from the LPM of the frequency of a price change. Once again, the effect of the cost of capital was an increase in the likelihood of a price change. Having controlled for other variables that explain variation in the response outcome, a unit increase in the log of capital cost increased the probability of a price change by 25%. Once again for comparison with the LPM, estimations using logit and probit models were done. Model (5) shows the results obtained when a logit model was used and model (6) reports the results from the probit model. In both cases, higher values of capital cost increase the likelihood of a price change. Both results are highly significant when observable factors were controlled for. In general, the results suggest that as the cost of capital increases, firms are more likely to change their prices.

Next, the study investigated whether this response differed for firms that owed debt. In order to explore whether higher capital cost affected the chances of a firm changing its price differently, depending on whether the firm had debt or not, an interaction term between capital cost and debt was included in the model. Based on literature, firms with credit are more exposed to changes in the interest rates compared to firms without credit. Higher interest rates are particularly felt by firms that owe debt, as both the demand side and the cost side influence their prices. Thus we hypothesized that firms with debt are more likely to adjust their prices in response to a policy rate change, compared to firms without debt.

The second hypothesis was stated as follows;

Hypothesis 2: Firms with debt are more likely to adjust their prices in response to higher rates compared to firms without debt.

i.e. $\hat{\beta}_2 > 0,$ where $x_2 = \ln(\text{capital\_cost}) * \text{debt}$

The econometric model to test this hypothesis was modelled as shown in equation (4.2)

$$Pr(freq = 1)_{ijt} = \beta_0 + \beta_1 ln(capital\_cost)_t + \beta_2 ln(capital\_cost)_t * debt_i + debt_i + other\ controls + e_{ijt} \quad (4.2)$$

Table 4.3 displays the results of estimating equation (4.2) including the interaction term to differentiate the results for firms with credit and those without. Model (1) in table 3 are the results from applying a simple linear model to the likelihood of a price change. The results show that firms with debt are 11.6% less likely to change their prices compared to firms without debt when the cost of capital increases. This result is not statistically significant however. Results from the logit model (2) also reported a negative sign for the coefficient for the interaction term and this is significant. The same observation was noted with the probit model (3). Both logit and probit models found that firms with debt were less likely to change their prices in response to higher costs of capital. This result was contrary to what the study hypothesized. We anticipated that firms with debt are more likely to change their prices in response to higher rates but the analysis found that firms with debt are less likely to change their prices and more likely to keep their prices constant in response to higher rates, compared to firms without debt.

In Table 4.2 and 4.3, all the estimation techniques used modelled the mean response of the outcome (i.e. modelled the probability of a price change) whereby the means of the variables were calculated for each firm across time. That is, the results reported in those tables considered differences between firms but the results did not account for factors that vary across time within a particular firm. Put differently, the results reported thus far did not account for the possibility that repeated observations on the same firms could leave unobserved some characteristics that make firms different from one another and these differences tend to be constant over time. Furthermore, these differences may be correlated with our explanatory variables of interest and have not been controlled for, resulting in bias in the reported coefficients.

Table 4.3: Estimated coefficients from LPM, Logit and Probit models

Dependent variable: Frequency of a price change			
	(1)	(2)	(3)
Independent Variables	LPM (OLS)	Logit(MLE)	Probit(MLE)
ln(capital cost)	0.266***	1.650***	0.943***
	(0.0253)	(0.159)	(0.0915)
ln(capital cost)*debt	-0.116*	-0.832**	-0.468**
	(0.0663)	(0.396)	(0.231)
debt	0.300*	2.153**	1.213**
	(0.154)	(0.926)	(0.538)
ln(firm size)	0.00639	0.0425	0.0252
	(0.00531)	(0.0327)	(0.0190)
ln(firm age)	-0.00678	-0.0455	-0.0274
	(0.00592)	(0.0367)	(0.0213)
services.outlet	-0.0777***	-0.551***	-0.303***
	(0.0125)	(0.0862)	(0.0477)
2.region	0.0379**	0.238**	0.130*
	(0.0185)	(0.115)	(0.0664)
3.region	0.0927***	0.496***	0.289***
	(0.0241)	(0.139)	(0.0824)
4.region	-0.0209	-0.139	-0.0795
	(0.0182)	(0.119)	(0.0672)
5.region	0.0138	0.0926	0.0493
	(0.0207)	(0.130)	(0.0744)
6.region	0.0423**	0.277**	0.154**
	(0.0173)	(0.110)	(0.0630)
7.region	0.0188	0.116	0.0627
	(0.0172)	(0.109)	(0.0624)
8.region	0.0140	0.0891	0.0462
	(0.0218)	(0.143)	(0.0807)
9.region	-0.0670***	-0.570***	-0.318***
	(0.0243)	(0.184)	(0.0991)
10.region	-0.000885	0.00191	-0.00361
	(0.0295)	(0.195)	(0.110)
Constant	-0.403***	-5.177***	-3.000***
	(0.0630)	(0.402)	(0.230)
Observations	6,904	6,904	6,904
Percent correctly predicted		79.6	79.6
log-likelihood value		-3370.02	-3370.59
Pseudo R-squared	0.034	0.035	0.034

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Therefore to check the credibility of the results above, the study incorporated fixed effects into equation (4.2).

The firm characteristics that were added to equation (4.2) controlled for observable differences present in the data. Adding fixed effects controls for unobserved differences present in the data, thus controlling for both observed and unobserved heterogeneity has the advantage of further reducing bias in the estimates of the explanatory variables of interest and helps to determine as closely as possible, the actual effect of the explanatory variables in the data.

When unobserved effects are accounted for, the equation of interest takes on the following form;

$$Pr(freq = 1)_{ijt} = \beta_0 + \beta_1\, ln(capital\_cost)_t + \beta_2\, ln(capital\_cost)_t * debt_i + debt_i + \boldsymbol{X_{ijt}\beta} + a_i + e_{ijt} \quad (4.3)$$

In the equation (4.3), $\boldsymbol{X_{ijt}\beta}$ represents the other observed controls, and a_i is the firm specific residual (unexplained, unobserved characteristics) that differs between firms but does not differ across time within firms. This firm fixed effect is controlled for by creating dummy variables for the different firms. This assigns the observations to the respective firms and by so doing, allows each firm to be different by having its own unique intercept. Each time there is an unobserved effect that needs to be controlled for, the effect falls into the a_i term and dummy variables are created for the different unobserved group effect that is being controlled for. The dummy variables that are created depend on what unobserved effect is being controlled for; product group dummies are created if one is controlling for product group unobserved fixed effects, month dummies if one is controlling for time fixed effects and so forth.

Table 4.4 reports the results from estimating equation (4.3) while controlling for varying fixed effects. The coefficient on capital cost is consistently positive across all models. When controlling for product group fixed effects, (model 1) higher interest rates had a significant effect on the likelihood of a price change. The same result was found when firm fixed effects were accounted for, (model 2). In model 3, since the interest rates are constant in a month, the cost of capital is also constant in a month, so when controlling for month fixed effects, the cost of capital variable gets absorbed into the month dummy variables, and no coefficient is reported for it.

Table 4.4: Coefficients from logit fixed effects regressions on the frequency of a price change controlling for unobserved fixed effects.

Dependent variable: Frequency of a price change			
	(1)	(2)	(3)
Independent Variables	Logit	Logit	Logit
ln(capital cost)	1.732***	1.771***	
	(0.163)	(0.165)	
ln(capital cost)*debt	-0.922**	-1.031**	-1.074**
	(0.403)	(0.409)	(0.424)
debt	2.346**		
	(0.945)		
ln(firm size)	-0.00656		
	(0.0514)		
ln(firm age)	-0.0215		
	(0.0556)		
service.outlet	-0.0229		
	(0.181)		
2.region	0.114		
	(0.173)		
3.region	0.476**		
	(0.204)		
4.region	-0.0946		
	(0.174)		
5.region	0.169		
	(0.199)		
6.region	0.158		
	(0.169)		
7.region	0.221		
	(0.163)		
8.region	0.0870		
	(0.190)		
9.region	-0.513**		
	(0.240)		
10.region	0.201		
	(0.252)		
Constant	-5.220***		
	(0.443)		
Fixed effects included?			
product group	yes	yes	yes
firm	no	yes	yes
month	no	no	yes
Observations	6,904	6,810	6,810
Number of id	131	119	119

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4.5: Coefficients from probit random effects regressions on the frequency of a price change.

Dependent variable: Frequency of a price change			
	(1)	(2)	(3)
Independent variables	Probit	Probit	Probit
ln(capital cost)	0.993***	0.993***	1.777***
	(0.0934)	(0.0934)	(0.524)
ln(capital cost)*debt	-0.514**	-0.514**	-0.547**
	(0.235)	(0.235)	(0.242)
debt	1.302**	1.302**	1.387**
	(0.549)	(0.549)	(0.564)
ln(firm size)	-0.00527	-0.00527	-0.00194
	(0.0295)	(0.0295)	(0.0308)
ln(firm age)	-0.0138	-0.0138	-0.00887
	(0.0319)	(0.0319)	(0.0333)
service.outlet	-0.00850	-0.00850	-0.00576
	(0.102)	(0.102)	(0.107)
2.region	0.0602	0.0602	0.0602
	(0.0993)	(0.0993)	(0.104)
3.region	0.278**	0.278**	0.276**
	(0.119)	(0.119)	(0.124)
4.region	-0.0512	-0.0512	-0.0728
	(0.0982)	(0.0982)	(0.103)
5.region	0.0914	0.0914	0.0916
	(0.113)	(0.113)	(0.118)
6.region	0.0833	0.0833	0.101
	(0.0961)	(0.0961)	(0.100)
7.region	0.125	0.125	0.138
	(0.0928)	(0.0928)	(0.0971)
8.region	0.0492	0.0492	0.0819
	(0.107)	(0.107)	(0.113)
9.region	-0.282**	-0.282**	-0.245*
	(0.133)	(0.133)	(0.138)
10.region	0.104	0.104	0.184
	(0.142)	(0.142)	(0.148)
Constant	-3.020***	-3.020***	-4.676***
	(0.252)	(0.252)	(1.232)
Observations	6,904	6,904	6,824
Number of id	131	131	131

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Likewise, the coefficient on the interaction term is consistently negative. Regardless of what unobserved effect is controlled for, firms with debt are more likely

to keep their prices constant compared to firms without debt, when faced with higher capital costs.

Table 4.5 presents the results from fitting a probit model to equation (4.3) but where the unobserved effects are considered as random. The results echo the same findings as the results from the logit regressions.

In general, our results showed that higher interest rates increased the likelihood of a price change. Higher interest rates have a negative effect on both demand and firm costs. In this regard, the results from this study are similar to those found by Klenow and Malin (2010) and Sahinoz and Saracoglu (2011). These papers found that prices adjusted to negative cost and demand shocks. However, this study finds that firms with debt are more likely to keep their prices constant, compared to firms with no debt when faced with higher credit costs. This contradicts the findings of Mateut (2005) and Ireland (2008) that stated that firms with credit are more likely to pass on higher credit costs to their consumers.

4.3.2 Does an interest rate shock result in asymmetric price adjustments?

Since the price change referred to above was an aggregate change, (i.e. it included both a price increase and a price decrease) the study was interested in whether interest rates affected firms decision to raise or reduce their prices, as the effect may not be symmetrical. To determine this, a new variable was created, $price\_change$. This variable measured three mutually exclusive events; no price change, a price increase and a price decrease. This new dependent variable with three categories was modelled with a multinomial logit to test whether firms were more likely to raise and reduce their prices. The three categories of the new variable were as follows; level 1 referred to the no price change category, level 2 identified the price increase category and level 3 referenced the price decrease category. The regression results are shown in table 4.6 below.

Table 4.6: Estimated regression coefficients from a multinomial logit model on price change categories

Panel A: Multinomial parameter estimates for the direction of a price adjustment. Base case is no price change.

	Model 1		Model 2		Model 3	
VARIABLES	Price Increase	Price Decrease	Price Increase	Price Decrease	Price Increase	Price Decrease
ln(capital cost)	1.667***	1.360***	1.752***	1.563***	1.726***	1.532***
	(0.177)	(0.213)	(0.193)	(0.235)	(0.194)	(0.236)
debt			1.454	3.088**	1.449	3.064**
			(1.154)	(1.322)	(1.156)	(1.325)
ln(capitalcost)*debt			-0.564	-1.193**	-0.542	-1.212**
			(0.490)	(0.567)	(0.491)	(0.569)
ln(firm size)					0.00907	0.0924*
					(0.0402)	(0.0476)
ln(firm age)					-0.0291	-0.0698
					(0.0449)	(0.0539)
service.outlet					-0.522***	-0.602***
					(0.105)	(0.133)
2.region					0.287**	0.164
					(0.140)	(0.172)
3.region					0.508***	0.480**
					(0.169)	(0.197)
4.region					-0.196	-0.0571
					(0.149)	(0.172)
5.region					0.191	-0.0706
					(0.155)	(0.199)
6.region					0.261*	0.302*
					(0.135)	(0.163)
7.region					0.0753	0.177
					(0.135)	(0.159)
8.region					0.172	-0.0556
					(0.171)	(0.224)
9.region					-0.565**	-0.580**
					(0.230)	(0.280)
10.region					-0.232	0.291
					(0.261)	(0.264)
Constant	-5.745***	-5.447***	-5.963***	-5.972***	-5.305***	-5.271***
	(0.418)	(0.502)	(0.455)	(0.554)	(0.514)	(0.626)
Observations	6,904	6,904	6,904	6,904	6,904	6,904

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The multinomial model is a generalization of the binary logistic model but with K categories instead. The estimated coefficients from the regression output are all in reference to the base category. In this case the base category is level 1, no price

change. Since the estimated coefficients reported are of the respective category relative to the base category, estimates that have a negative sign favour the likelihood of the base group relative to the group of interest. In other words, negative coefficients reduce the likelihood that the category of interest will occur, relative to the base category. As such, positive coefficients increase the likelihood of the category of interest occurring, relative to the base category. As with prior analysis, the sign of the coefficients are the most that can be interpreted due to the complexity of the nonlinear models used.

In the base specification in model (1) of panel (A), higher values of capital cost increase the likelihood of both a price increase and a price decrease relative to no price change occurring. When controlling for firm characteristics and geographical traits, an increase in the cost of capital retained the same effects. The higher chance of prices increasing as a result of higher capital cost reflects the cost channel and the likelihood of prices decreasing due to higher interest rates reflects the demand channel.

The interaction term told a different story. In model (3) both firm and regional traits have been accounted for. As the cost of credit increases, the results showed that firms with debt are more likely to keep their prices constant than to increase them (as seen by a negative coefficient on the interaction term). The same result was found for the price decrease group. Firms with debt are more likely to keep their prices constant than to reduce their prices compared to firms with no debt. The outcome for the price decrease group was what we anticipated. Decreasing prices in response to higher rates is an action most likely to be experienced by firms facing lower demand conditions. This factor will be more dominant for firms without debt. For firms with debt, the increased sensitivity to rates due to credit will result in firms opting rather to keep their prices constant than to decrease them.

The outcome for the price increase group was contrary to what was expected, that firms with debt were more likely to increase their price due to higher credit costs. Results from the models reported that prices are likely to stay constant, however the result was not significant.

To verify these results, unobserved fixed effect were added to the model. The results are reported in table 4.7 below. For higher cost of credit, the results are

consistently positive. When product differences and month fixed effects were controlled for, firms are both more likely to raise or reduce their prices, rather than keep them constant. This is consistent with theory that states that firms are affected by both the demand and the cost side. In model (5) month fixed effects absorbed the capital cost variable. The interaction term had a negative sign on its coefficient but only the sign in favour of a price decrease was significant. Higher credit costs are associated more with lower prices for firms with debt than for those without.

To further validate the results from the empirical investigation, the study performed three robustness checks on the data using different model specifications. Firstly, the study kept the demand side constant in order to observe the outcome when the cost side is the only factor at play. If demand remains the same after a rise in interest rates, prices are expected to rise for the price increase group and to stay constant for the price decrease group. When keeping the demand side constant, the coefficient for the interaction term remained negative for the decrease group. Thus our analysis consistently reported that higher interest rates are likely to cause firm prices to adjust and that this adjustment is in favour of lowering prices compared to keeping prices constant, when firms with debt were compared to firms without debt. Results from this first check are consistent for the decrease group when controlling for unobserved effects. For the price increase group there was no definitive outcome.

The second test modelled the direction of a price change using an ordered probit model with random effects, in line with testing our results using a model common in the literature. Although not as strong as from the multinomial models, the results from the probit model suggested that higher rates were associated with an upward or downward price adjustment. No definitive finding could be concluded when firms with debt were compared to firms without.

Table 4.7: Multinomial coefficients on the direction of a price adjustment, controlling for fixed effects.

	Model 4		Model 5	
VARIABLES	Price Increase	Price Decrease	Price Increase	Price Decrease
ln(capital cost)	1.779***	1.604***		
	(0.196)	(0.238)		
debt	1.582	3.209**	1.609	3.438**
	(1.162)	(1.331)	(1.189)	(1.369)
ln(capitalcost)*debt	-0.568	-1.329**	-0.575	-1.426**
	(0.494)	(0.571)	(0.506)	(0.588)
ln(firm size)	-0.0438	0.0353	-0.0385	0.0337
	(0.0446)	(0.0516)	(0.0458)	(0.0526)
ln(firm age)	0.0149	-0.0368	0.0178	-0.0336
	(0.0481)	(0.0563)	(0.0494)	(0.0573)
service.outlet	-0.00189	-0.125	-0.00937	-0.104
	(0.154)	(0.194)	(0.159)	(0.197)
2.region	0.206	0.0292	0.207	0.0288
	(0.144)	(0.176)	(0.148)	(0.180)
3.region	0.475***	0.443**	0.485***	0.451**
	(0.174)	(0.203)	(0.179)	(0.207)
4.region	-0.134	-0.137	-0.175	-0.167
	(0.156)	(0.180)	(0.159)	(0.183)
5.region	0.355**	-0.0442	0.356**	-0.0601
	(0.166)	(0.209)	(0.170)	(0.212)
6.region	0.173	0.187	0.199	0.203
	(0.146)	(0.175)	(0.150)	(0.178)
7.region	0.176	0.307*	0.199	0.337**
	(0.141)	(0.167)	(0.145)	(0.170)
8.region	0.209	-0.0326	0.287	-0.0120
	(0.175)	(0.229)	(0.183)	(0.236)
9.region	-0.448*	-0.495*	-0.385	-0.471
	(0.240)	(0.285)	(0.246)	(0.292)
10.region	-0.104	0.420	0.0796	0.477*
	(0.268)	(0.274)	(0.275)	(0.282)
Fixed Effects?				
Product group incl?	yes	yes	yes	yes
Month incl?	no	no	yes	yes
Constant	-5.843***	-5.738***	-8.318***	-7.435**
	(0.534)	(0.645)	(2.425)	(3.606)
Observations	6,904	6,904	6,904	6,904

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Lastly, the model specification was adjusted to account for the different responses for firms that owed bank debt compared to firms that had trade credit. If trade credit was an alternative form to bank credit and was also made available at a cheaper rate, firms owing bank debt were more likely to increase their prices than firms owing trade credit debt. However, no significant result of this was found.

Overall, the results showed that higher interest rates influence firms to adjust their prices either upwards or downwards and that owing credit played a significant role in asymmetric price responses from a similar shock in interest rates. Firms with debt are more likely to decrease their prices, in comparison to firms without debt when the interest rate increases. This result may suggest that firms with debt have access to cheaper finance alternatives compared to firms without debt, making them better positioned to reduce their prices compared to their counterparts. The next chapter discusses these results in line with the literature reviewed.

5. DISCUSSION

This chapter discusses the results presented in the previous chapter, measuring up the findings against what earlier studies on price setting behaviour had found.

5.1 Price changes as a result of an interest rate shock

Literature on price setting behaviour attribute price changes to cost shocks and changes in market conditions (Greenslade and Parker, 2010; Hoeberichts and Stockman, 2010; Park *et al,* 2010). Changes in interest rates result in both changes in market conditions (demand facing a firm) and a cost shock, in the form of a financial shock. Empirical studies by Klenow and Malin (2010) and Sahinoz and Saracoglu (2011) found that a negative cost and demand shock leads to price changes. The results of this study on the effect of an increase in the cost of capital support these findings.

When considering the above relationship in the presence of credit owed by firms, literature proposes that higher interest rates will cause firms to pass through the higher credit cost onto their prices and so are more likely to adjust their prices (Ireland, 2008; Mateut, 2005). Our empirical findings contradict this. Instead it was observed that firms with debt are less likely to adjust their prices in response to higher credit costs compared to firms without debt. This result seems to reflect Hoeberichts and Stockman's (2010) finding that firms do not respond strongly to financial costs.

In an effort to further evaluate the above relationship, the study disaggregated price changes into upward, downward or no revisions.

5.2 In what direction do prices adjust in response to interest rate shocks?

Do higher interest rates influence prices to increase, decrease or both? The transmission mechanism provides that both may occur. In general if both demand and cost sides are at play, some prices will decrease as a result of the demand channel whilst other prices will increase as a result of the cost channel (Ireland, 2008; Mateut, 2005). Here the results of this study are consistent with the literature. For the price increase group, the results suggest that firms favour a price increase over keeping them constant. The same is true for the price decrease group. Firms favour a downward price revision over keeping prices constant when there is a negative interest rate shock. When demand is controlled for, leaving the cost channel at play, literature proposes that for the price increase group, higher prices will be favoured even more over keeping prices constant whereas for the decrease group and, when demand is not responsive to interest rate changes, firms will opt to keep prices constant over decreasing them. The results, under constant demand confirm the later proposal, prices remain constant but there was no significant evidence for the former proposal.

How does this relationship differ for firms with debt? Since prices with credit are more sensitive to interest rate changes and negative cost shocks have a stronger influence on prices than negative demand shocks, the cost effect will take precedence over the demand for firms with debt (Ireland, 2008; Mateut, 2005; Sahinoz and Saracoglu, 2011). This means that a price increase will be chosen over keeping prices constant and that firms are less likely to favour a price decrease over keeping prices constant. This research supported these expectations of the price decrease group but did not find any significant result to support the expectations of the price increase group. One possible explanation for the lack of evidence that, in response to higher capital costs, firms with debt increase their prices compared to firms with no debt is that firms with debt have access to cheaper credit options than their counterparts. Trade credit is one example. Trade credit is used by many firms, particularly small and medium sized firms, as a source of external finance. This alternative to bank finance often has cheaper credit conditions. Firms with trade credit may also be seen as signalling their credit worthiness to credit providers. In the event of higher interest rates, firms with access to cheaper credit may switch from bank credit to trade credit and face lower credit costs. As such these firms are faced less pressure to increase their prices compared to firms that do not have credit. Lack of debt may signal that a firm is not credit worthy and so may only have access to expensive external finance

options (Love *et al.,* 2007; Mateut, 2005). Another possible explanation is that the low inflationary environment which prevailed throughout the majority of the time frame covered by this study, reduced firms' ability to pass through higher production costs on prices as noted by Taylor (2000). However, this study's findings on debt should be treated with caution since the information pertaining to a firm's credit source was relevant for a date outside of the time period when information on price and interest rate movements were obtained.

6. CONCLUSION

The manner in which changes in the interest rates set by the monetary policy committee affects inflation and the economy rest heavily on the way firms set their prices. Hence it is crucial for central banks to understand how firms adjust their prices in response to interest rate shocks.

This study set out to fill a gap in the literature on price responses to interest rate changes in a developing economy by investigating whether prices are more likely to adjust in the presence of a negative interest rate shock, the direction of adjustment, given it occurred and whether the relationship between price changes and interest rates differed for firms with credit. The findings of this research are stated below.

Firstly, in general, higher interest rates are more likely to influence firms to change their prices. Interest rate changes lead to cost and demand shocks for a firm and firms tend to adjust prices more in the presence of shocks. Surprisingly, firms holding credit with financial institutions or firms with trade credit were found to be less likely to adjust their prices in response to a negative interest rate shock.

Further unpacking these adjustments by looking into the directional change, the findings suggest that firms are more likely to revise their prices upwards or downwards when interest rates increase. Firms with credit outstanding however are more likely to keep their prices constant than to decrease them but interestingly no evidence was found that supports the view that firms pass through higher credit cost onto their prices. This may be due to a low inflationary environment, which suppresses the ability for firms to pass on higher costs to prices or may be a result of firms with debt having access to cheaper financing options. Since these firms face lower credit conditions, they may not face pressure to pass on credit costs onto their prices for their daily operations than firms without credit. This study recommends that policy makers pay more attention to the demand conditions facing firms than the credit channel effects when using contractionary monetary policy to address inflation in developing economies. Further research in this area using data on firm characteristics that are measured at the same time as price and interest rate movements is crucial for correctly underpinning the relationship between firm price changes and interest rates.

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