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Exchange Rate Pass-through in South Africa: Panel Evidence from Individual Goods and Services

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Abstract

This study estimates pass-through for South Africa using samples of final goods and services, and homogenous imports. Estimated pass-through to consumer goods prices is low, roughly 16 percent in the two years following an exchange rate change; surprisingly, it is somewhat higher for services. Deviations from long run PPP appear to disappear relatively quickly, with a half-life of about 16 months. For imports, pass-through estimates are much higher, averaging around 60 percent, but with wide source-country variation. Finally, there is virtually no support for a simple linear trend change in either pass-through or in reversion to PPP during the sample.

JEL classification: C1, C4, F3, F4

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1 Introduction

Exchange rate movements have important implications for the domestic macroeconomy, including the international transmission of business cycles and inflation, the adjustment of the current and financial accounts, and for the conduct of monetary policy. In addition, exchange rate volatility can potentially induce instability and increase uncertainty in each of these areas, thus making economic decision making more difficult for firms, consumers, and policymakers. As economies become more globally integrated, these linkages potentially become more important. The key transmission mechanism in these relationships is via price changes; hence the relation between exchange rates and prices, specifically exchange rate pass-through, is central to open economy macroeconomic research and to economic policy.

Exchange rate pass-through is usually defined as the percentage response of domestic prices to exchange rate changes. This straightforward definition however lacks precision. For example, *which* prices are we considering? Where we measure the price change, e.g., at the dock into import prices, into intermediate prices or to final goods prices, is relevant because presumably the link between exchange rates and 'prices' becomes less immediate as we move from the dock to the consumer. This weakening in the response of consumer prices may reflect the bundling of local value added (marketing or distribution costs) into the final consumer price, or substitutions among final consumer goods – or inputs into their production, as well as monetary policy responses, etc. Secondly, to be precise, we should specify *when* the price response is measured, e.g., the next period or after several years. Differences between short-run

and long-run pass-through estimates may inform us about price stickiness or the perceived permanence of observed exchange rate changes – both important for monetary policy.

At least as problematic however, is the empirical estimation of pass-through using price level aggregates (e.g., Consumer Price Indexes). First, the composition of the aggregate price indexes can and do change over time, raising the question of what is being measured. Moreover, if measurement error is correlated with the exchange rate, pass-through estimates will be biased.[1] For example, suppose a new product is introduced into the CPI which has a higher pass-through coefficient than the average of the rest of the basket; this alone would raise pass-through – though for a reason not due to a change in the monetary environment, or to a change in pricing behaviour by firms. Chain-weighted price indexes, which adjust the basket to better reflect actual consumer purchases, exacerbate this problem of interpreting changing pass-through estimates over time.

Perhaps of lesser importance, given remediation attempts by statistics agencies, is that price changes may reflect quality change. Aggregate price indexes, by definition, try to include most products/services consumed, and many of the goods and services included undergo quality change. Stated simply, the question is whether observed changes in the price index reflect price changes, or composition changes, or quality changes. The strategy in this study will be to focus on a fixed, though admittedly small, number of goods and services for which quality changes have been minimal. Some potential drawbacks of this strategy are discussed below.

Another methodological issue is that exchange rates influence aggregate prices which in turn influence exchange rates, ensuring that in single equation pass-through estimates the dependent variable is correlated with the error term. Not only will this result in biased pass-through estimates, but the estimates may also be unstable, leading to inappropriate and diverse inferences. Simultaneity is often handled in other contexts via the use of instrumental variables or via simultaneous equations estimation. However, since exchange rate movements are notoriously hard to explain, even ex-post, these 'solutions' are effectively ruled out in studies of pass-through.

Instability in pass-through, especially changes in pass-through over time, is an active area of research for both academics and policy. However, the implications for monetary policy of a decline in pass-through depend on the source of the decline. Mishkin (2008) notes that there is some evidence suggesting that improved monetary policies – in particular, a strong commitment to an explicit nominal anchor in many countries, have contributed to their recorded declines. He also cites several additional possible explanations including: more pricing in the importer's currency, a greater share of distribution costs, which he argues are 'fairly insensitive to shocks driving the exchange rate of foreign costs' (p1), and more cross border production, which implies that costs are denominated in a basket of currencies; hence exchange rate movements may be partly offset by offsetting movements in costs. Mishkin concludes however by noting that a weaker relationship between exchange rates and nominal demand may make it easier for monetary policy to stabilize inflation and real activity. Combined, these considerations suggest pass-through estimation is both challenging and important.

The focus of this study is on pass-through in South Africa – an interesting case on a number of dimensions, but with relatively few published academic investigations. A key aspect of the approach taken in this paper is to study a fixed set of individual prices instead of price level indexes. Specifically, this study estimates pass-through using prices of well defined, specific goods and services. In this study, exchange rate pass-through is estimated using final consumer goods prices (e.g., Butter 500g, Toothpaste with fluoride 120g), and for final services (e.g., the cost to tune up a car, or to visit a dentist for a cleaning), and additionally, at the 'dock' using import unit values (e.g., silicon dioxide). It should be acknowledged up front that though this study examines highly disaggregated imports, unit values are notoriously unreliable; hence this study uses several methods (including focusing on homogenous imports) to mitigate these concerns.

This focus on disaggregated goods and services has several advantages as well as some disadvantages. Conceptually, at an individual good (or service) level, the assumption of exogeneity of exchange rate changes is more plausible since the i^{th} price (the dependent variable) arguably has little impact on the exchange rate (the independent variable).[2] Second, barring changes in the production technology, there are no index changes to speak of at the level of an individual good; hence, this paper's main advantage is that the estimate of pass-through is not affected by changes in the goods and services within the price index being studied.[3] A third benefit of the data set and the empirical approach taken here is that estimates of pass-through, and separately of reversion to Purchasing Power Parity (PPP), are obtained both for goods and for services separately. Services are an important (and growing) category within the overall

CPI – and are therefore interesting in their own right.[4] Moreover, differences in price adjustment between goods and services categories are at the center of the debate over bias in estimated real exchange rate mean reversion (e.g., Imbs et. al 2005), as well as instability in pass-through over time (e.g., Goldfajn 2000). Hence estimating both using the same methodology, time period, and data set may provide new insights into these questions. Finally, it should be noted that we make no attempt to estimate different rates of pas-through across products; the goal is to extract the response to exchange rate shocks that is common to all products or services in the respective good/service category.

Turning to pass-through at the dock, this study's use of a three-dimensional panel (goods, time, and source countries) of disaggregated products to estimate pass-through at the import point of entry permits separate (country-level) pass-through elasticities to be estimated for each of South Africa's top ten trading partners for these products. Evidence of a decline in pass-through, or widely different pass-through across source countries would have important implications for monetary policy because pass-through affects both forecasts of inflation and the effects of changes in monetary policy on inflation. Hence, changes in the country composition of trade may have direct (and possibly unanticipated) implications for the conduct of monetary policy. To preview the results overall, pass-through is estimated to be much higher at the dock than for final consumer goods and services, and despite substantial variation in pass-through across import trading partner, there is no evidence of a secular decline in pass-through in either final goods and services, or for imports.

Finally, an advantage of focusing on South Africa is that it conforms better to the standard 'small-country' assumption implicit in much of the theoretical analysis lying behind the empirical strategies, which makes for a cleaner interpretation of the results. Also, as an inflation targeter, South Africa is an interesting case study both due to the growing acceptance and implementation of inflation targeting regimes around the world, and due to the hypothesized link between inflation targeting and the estimated declines in pass-through around the world.[5] Thus the results provide a basic check whether this 'conventional wisdom' holds for South Africa. Interestingly, given the failure to detect any secular declines in pass-through, the results suggest that it does not.

The next section summarizes some interesting findings from recent research. Section 3 discusses the econometric framework adopted, and Section 4 discusses the data used. Section 5 presents the results and the final section concludes.

2 Additional motivation and links to recent research

Most studies of exchange rate pass-through have estimated pass-through using aggregate import price indexes from industrialized countries, rather than examining pass-through in developing countries, and much of existing research finds a secular decline in pass-through. For example, in a recent systematic study of aggregate U.S. imports, Marazzi et al (2005) document a dramatic and "sustained" decline in exchange rate pass-through from about 65 percent in the 1980s to around 12 percent in the decade ending in 2004. This decline in pass-through to U.S. prices has been noted at least since Mann (1986). Similarly, Otani, Shiratsuka, and Shirota (2003) find a decline in pass-through for imports into Japan, which they attribute to increased penetration by intra-firm imports and to a decline in global inflation. Also, Campa and Goldberg (2005)

find a decline in the pass-through coefficient in the 1990s for OECD countries, which they attribute to a changing commodity composition of trade more than to a less inflationary environment.

The focus on the high income countries in the literature on pass-through may be particularly misleading. Indeed, it has long been noted that pass-through was lower in the United States and other rich countries, and there is some evidence that it is higher still in emerging, developing and lower income countries. For example, Choudhri and Hakura (2001) reported that for a sample of 12 emerging market economies during 1979-2000, their average one-year pass-through is 26% (with some individual pass-through as high as 40%). This is much higher than the average one-year pass-through for a group of non-G3 industrial countries (12%) or G3 (only 7%).[6] In a cross-country study examining 76 countries over the period 1990-2001, Frankel, Parsley and Wei (2005) argue that slow pass-through was "imported" by lower-income countries in the 1990s. Several large devaluations occurred in East Asia, Latin America, and other emerging market countries between December 1994 (Mexico) and December 2001 (Argentina), and yet local currency prices failed to rise in proportion to these devaluations.

In addition to Choudhri and Hakura (2001), there are several relevant studies that include lower-income countries. Borensztein and De Gregorio (1999) and Goldfajn and Werlang (2000), study the low pass-through of recent large devaluations in developing countries.[7] Barhoumi (2006) studies pass-through to import prices in 24 developing countries. All of these are studies of influences on aggregate price measures, the CPI in

particular, not on import prices. Few studies concentrate on imports of specific goods into developing countries.[8]

Though the focus in Marrazi et al (2005) is on the United States, the study is particularly relevant because they evaluate several reasons for the estimated decline in pass-through. One hypothesis, observed by Parsley (1993) for Japan, and more recently by Campa and Goldberg (2005) for the U.S. is that the commodity composition of trade has changed; i.e., goods with lower pass-through are becoming more prevalent in trade. Marrazi et al (2005) also find this to be the case, but they argue that this can only explain part of the observed decline in U.S. pass-through. A second hypothesis they examine is the growing role of Chinese exports to the U.S, which have grown from 5.8 percent of merchandise imports in 1994 to 13.4 percent in 2004 (this case is also relevant for South Africa since China has now risen to the third largest supplier of imports, following the euro area and the U.S.). While this increase is impressive, it is still too small to directly account for the decline in pass-through in the U.S.; hence Marrazi et al (2005) hypothesize a self-limiting price effect working on other exporters to the U.S. market. That is, other exporters may feel pressure to limit pass-through for fear of losing market share to Chinese exporters. Marrazi et al (2005) find some confirmation for this hypothesis by documenting a high correlation in the decline in pass-through by import sector with the sector-by-sector increase in China's import penetration. In addition to growing imports from China, a third hypothesis is a shift in the source country of the import basket, e.g., from high-wage countries toward low-wage countries. They find little evidence that this could account for the decline in U.S. import price pass-through.

The world-wide decline in inflation has been another often cited explanation for declining rates of pass-through (e.g., Taylor, 2000, and Gagnon and Ihrig, 2004). That is, since cross-country estimates of pass-through exhibit a positive correlation to inflation, declining global inflation is also associated with declining pass-through around the globe. Interestingly, there is no clear consensus over what the driving forces behind this convergence in inflation are, or whether the trend will continue. In particular, the financial crisis that began in 2007, and which led to a variety of responses by the world's fiscal and monetary authorities, may lead to similarly diverse inflation experiences. Thus the implications for inflation and pass-through are uncertain.

Another potential 'compositional' (or technological) reason for a decline in estimated pass-through is a declining share of traded inputs into final goods. That is, as the share of local content rises, pass-through (in percentage terms) declines. To take an extreme example, suppose exchange rates do not affect costs of distribution services in the import market at all. If distribution services count for a large and growing fraction of the final good's price, the fraction of the final good's price that is responsive to exchange rates shrinks. Hence even 100 percent pass-through will have a muted impact on the final good's price. Recent estimates for non-traded input shares are indeed large, e.g., as much as 65 percent of the price of a Big Mac hamburger (Parsley and Wei, 2007). The evidence presented below casts some doubt on the presumption that this explanation is based on. In particular, the evidence for South Africa is that (at least at the consumer level and for the services studied) services have as high, or higher, rates of pass-through. The relatively higher pass-through for services is

consistent with more effective market segmentation for goods, e.g., via tariffs and/or non-tariff barriers.

Finally, models of exchange rate pass-through in the 1980s emphasized the role of market segmentation – a model seemingly well suited to emerging countries where pass-through was typically estimated as very high. Indeed, the conventional wisdom had long been that pass-through is relatively rapid and complete in small and/or less developed countries. For South Africa, Bhundia (2002, p4) notes that "the South African Reserve Bank ... reports long run pass-through at seventy-eight percent for import prices". This study used monthly data from January 1980 to December 2001. Recently, Karoro et. al (2009) re-confirm this high import price pass-through using a sample that extends through 2005. Thus, at least for South African import prices, there appears to be stability in pass-through estimates. For South African consumer prices however, pass-through has been estimated to be much lower. Choudhri and Hakura (2001) find pass-through to the South African CPI at only seven percent after two years. Bhundia (2002) finds a similarly low pass-through to consumer prices of only twelve percent after two years(his sample period ended in 2000). All these studies use aggregate price level indexes, and all use differing methodologies. One objective of this study is to check whether estimating pass-through using a fixed set of individual price data leads to widely differing conclusions from previous studies. Secondly, given the criticisms associated with employing aggregate price index data, an objective is to provide complementary consumer price pass-through estimates obtained from individual price data.

3 A basic small-country framework

Profit maximization by a perfectly competitive foreign exporter pricing in its own currency (producer currency pricing, or PCP), implies that price equals marginal cost, or $P_i = C_i$, where, P_i is the price of the *i*th good in the producer's currency. If the good is competitively traded internationally, the price in importing currency, P_i^*, is simply $P_i^* = C_i / S$, where *S* is the producer currency price of foreign exchange. With constant marginal cost, pass-through, i.e., the elasticity of importing currency price with respect to the exchange rate $\left(d \ln P^* / d \ln S\right)$, is equal to one (in absolute value). Thus, in the small country, perfect competition benchmark, local (import) currency import prices fully reflect exchange rate changes. At the other extreme, however, if the exporting firm chooses to preset price in the local currency (LCP), exchange rate pass-through will equal zero.[9]

Given this theoretical result, one might conclude that the degree of pass-through is not really an interesting question. However, from an empirical perspective this conclusion is too extreme. There are at least four cases where pass-through may lie between zero and 100 percent. First, as noted above the price indexes typically used to measure the price change actually refer to a price basket; aggregate pass-through is thus a weighted average of individual rates of pass-through, and will likely take an intermediate value. Moreover, baskets change over time – both the goods and services included, and in the origin of the goods in the basket. Changes in the price index, for any of these reasons, will increase the likelihood for variation in pass-through. Third, as noted above, imported goods may involve distribution services and other local content.

This implies, for example, that full pass-through at the dock need not be translated to full pass-through at the retail level. Finally, in a dynamic setting, firms may alternate pricing policies (PCP & LCP) over time, thus implying that pass-through can take intermediate values. Unless one can rule out these possibilities, the degree of pass-through remains an interesting question.

Relaxing the perfect competition assumption implies that the first order condition must include a markup,

$$P_i^* = \lambda_i C_i / S, \qquad (1)$$

where the markup (λ_i) is a function of the elasticity of demand (ε_i), $\lambda_i = \varepsilon_i / (\varepsilon_i - 1)$. Thus, pass-through can be less than complete if the markup varies with exchange rates (Campa and Goldberg 2005), with import market demand conditions, or due to strategic interactions (e.g., Froot and Klemperer 1989). Note that the perfect competition case is also a special case of equation (1) when the demand elasticity is infinite; LCP is a special case where the markup varies perfectly with the exchange rate, and PCP occurs if markups are constant.

Though both of these models are quite simple, it should be noted that a number of more realistic theoretical models with e.g., different assumptions about price setting or the structure of markets, yield similar empirical specifications (e.g., Yang, 2005, Engel 2006, Devereux and Yetman, 2010). That is, even though the framework specified above is simple, virtually all empirical estimates of pass-through elasticities are obtained from first-differenced, log linear specifications of equation 1, augmented with various controls for competitor prices, demand shifters and lags (recent examples

include Marazzi et al, 2005, and Mumtaz, Oomen, and Wang, 2006) using aggregate (e.g., import price index) data.

The empirical analysis is presented first for final consumer goods and services, since estimation of pass-through in that setting proceeds most directly from the basic result summarized by equation (1). Section 3.1 describes the econometric equations estimated before turning to the development of the slightly different estimation strategy used for imports. It will become clear that the import data set offers some unique advantages, as well as some limitations as compared to the final goods and services. The specific equations estimated for imports are discussed in section 3.2.

3.1 Pass-through to Consumer Prices

The first estimation reported below is described by equation (2a) which is a first-differenced log-linear specification based on equation (1). Specifically,

$$\Delta p_{it}^{*} = \sum_{j=0}^{1} \beta_j \Delta s_{t-j} + \gamma \Delta c_t + \delta \Delta rgdp_t + \varpi \Delta G7gap_t + product\ \ dummies \qquad (2a)$$

In this equation, Δ is the first-difference operator, p_{it}^{*} is the natural log of the rand price of the good or service *i* at time t, c_t is the log of the world export price index (an indicator of costs of production), *rgdp* is log real gross domestic product (an indicator of changes in domestic demand conditions inside South Africa), and the G7 output gap (a proxy for world demand conditions) is indicated by *G7gap*. Since the goods are pooled into a single regression, product dummies are also included.

The next reported specification is described by equation (2b), where, in an effort to mitigate potential autocorrelation of the residuals, lags of all right hand side variables,

as well as the dependent variable, are added to the specification. In the empirical results we present several variations on lag length (*J*) chosen.

$$\Delta p_{it}^{*} = \sum_{j=0}^{J} \beta_j \Delta s_{t-j} + \sum_{j=0}^{J} \gamma_j \Delta c_{t-j} + \sum_{j=0}^{J} \delta_j \Delta rgdp_{t-j} + \sum_{j=0}^{J} \varpi_j \Delta G7gap_{t-j} + \lambda \Delta p_{it-1}^{*} + product\ dummies \tag{2b}$$

Equations (2a) and (2b) are estimated for goods and services separately. By pooling all goods (and separately, pooling services) the constraint that pass-through is equal across all goods (or services) is imposed in the respective estimations. If one were building a 'ground-up' approach, the individual prices could be weighted by their CPI weights to form a measure of 'average' pass-through more comparable to those estimated using aggregate price level indexes. However, this is not possible here since the data set is not comprehensive in coverage of the overall aggregate CPI. Hence, the 'equal-weighting' restriction employed here may actually be less representative of overall CPI pass-through since here the basket is unchanging as well as incomplete.

One potential problem with differenced-data specifications, such as equation (2b), is that applying the difference operator to achieve stationarity may be inappropriate since unless the data generation process is known, differencing will also transform the error in the original (levels) equation, thus unintentionally resulting in biased coefficient estimates. However, a specification that captures both short run dynamics and long run dynamics, i.e., a tendency toward reversion to Purchasing Power Parity, can be estimated via an error correction specification.

$$\Delta p^*_{it} = \sum_{j=0}^{J} \beta_j \Delta s_{t-j} + \sum_{j=0}^{J} \gamma_j \Delta c_{t-j} + \sum_{j=0}^{J} \delta_j \Delta rgdp_{t-j} + \sum_{j=0}^{J} \varpi_j \Delta G7gap_{t-j} + \sum_{j=0}^{J} \lambda_j \Delta p^*_{it-j} + \theta ecm_{t-J-1} + product\ \ dummies \quad (2c)$$

The error correction mechanism (*ecm*) term is obtained as the lagged residuals from an unconstrained regression of the South African consumer price index on the U.S. CPI, the nominal rand/$ exchange rate, and a constant. This first stage co-integrating regression was run using annual data from 1990-2008.[10] Incorporating an error correction term thus allows for cointegration, but does not impose it. Overall, the results implied from the estimated error correction specifications suggest a relatively short half-life for deviations from PPP.

In the final specification (for goods and services) both the pass-through coefficient, and the reversion to long-run PPP (i.e., the coefficient on the error correction term), are allowed to change over time. The specification is given as equation (2d):

$$\Delta p^*_{it} = \beta_1 \Delta s_t + \beta_2 trend * \Delta s_t + \sum_{j=0}^{J} \gamma_j \Delta c_{t-j} + \sum_{j=0}^{J} \delta_j \Delta rgdp_{t-j} + \sum_{j=0}^{J} \varpi_j \Delta G7gap_{t-j} + \sum_{j=0}^{J} \lambda_j \Delta p^*_{it-1} + \theta_1 ecm_{t-J-1} + \theta_2 trend * ecm_{t-J-1} + product\ \ dummies \quad (2d)$$

In this specification β_1 measures pass-through in the first period and β_2 measures the change in pass-through each year; a similar logic applies to θ_1 and θ_2. The time variation in pass-through is modeled as a secular trend in pass-through – as found in many other studies of pass-through or in convergence to PPP (e.g., Frankel et. al 2005; Marazzi et. al 2005). Of course, different forms of parameter change (e.g., first rising, then falling) may not be captured by this simple specification.

3.2 Pass-through to Imports

We next consider pass-through at the dock. The empirical specification below relies heavily on the framework developed in Knetter (1989) in his study of pricing to market in U.S. and German exports. It is useful to review some of the basic features of that analysis since it was the first to rely on a panel of disaggregated prices to estimate pass-through. Knetter considers an exporter selling to N foreign destinations. Maximizing profit subject to demand conditions in each foreign market subject to minimizing cost yields a set of first order conditions similar to equation (1):

$$P_{jt}^{*} = \lambda_{jt} C_t / S_{jt} \,, \tag{3}$$

where *j* represents the destination country for the firm's exports of good *i*. For the moment we omit the goods' subscripts and consider a single product. The key to the estimation strategy is that it uses multiple observations of the export price at each point in time to pin down marginal cost. The common price across all markets is equal to marginal cost, and the difference from marginal cost is the local market markup. Utilizing multiple destination markets for each product, marginal costs are captured by the time fixed-effect in an OLS regression. That is, by utilizing the panel structure of the data and estimating a regression with a full complement of fixed effects – i.e., with fixed effects for country (markup), and time (marginal cost), any residual correlation with the exchange rate (i.e., non-zero pass-through) implies a rejection of the simple constant markup, perfect completion model. Put another way, this methodology obviates the need for finding proxies for marginal cost and factors affecting markups; they are completely subsumed in the fixed-effects. The panel structure of the estimation, and the

inclusion of the full complement of fixed effects, also mitigates concerns about unit roots in the estimation.

Here, we adapt Knetter's methodology to import unit values of twenty-six disaggregated import products into South Africa from the ten largest suppliers. In particular, the dimensions of the data set are: goods (26), countries (10), and time (46 quarters). Specifically, consider the following general empirical specification:

$$\ln p^{*}_{ijt} = \theta_t + \lambda_j + \gamma_i + \beta_j \ln s_{jt} + \nu_{ijt} \qquad (4)$$

According to equation (4) the rand price of import *i*, is determined by good, time and source-country fixed effects, plus a random error. Augmenting the equation with country specific (log) exchange rates allows an estimate of the country-specific pass-through elasticities. The results reported below present estimates of equation (4) for (a) the full sample, (b) for the sample excluding outliers, and (c) constraining all the country-specific coefficients ($\hat{\beta}_j$) to be equal.

We next describe the data in more detail. In Section 4 we present the results from estimating equations (2a)-(2d) for final goods and services, before turning to the results from estimating equation (4) for imports.

4 Data [11]

Briefly, the individual goods prices used in this study were compiled by the *Economist Intelligence Unit (EIU)*. Specifically, 158 goods and services prices recorded annually (1990-2009) from Johannesburg, South Africa were chosen. For Imports, the data are taken from a CD provided by Global Insight, which "cleans" raw data on the

value and quantities of goods shipped, by good and by source country; the original data are collected by the Customs and Excise branch of the South African Revenue Service; the sample is monthly from January 1998 to June 2009.

5 Empirical Results

5.1 Pass-through to Consumer Prices: Results

Table 1 presents estimates from equations 2a, 2b, 2c, and 2d – as well two intermediate specifications for final goods prices; results for services are presented analogously in Table 2.[12] According to the estimates in the most basic specification (column 1, corresponding to equation 2a), exchange rate pass-through is eleven percent in the first year and twenty-six percent (11+15) in the first two years, with a t-statistic of 5.61. This is larger than other (earlier) estimates for South African consumer prices, though the estimates decline in subsequent estimations (columns 2-6). Pass-through of world cost changes is roughly twice that, and more immediate, at 50 percent, and the coefficient is again highly statistically significant. The difference in these two types of pass-through (exchange rate and cost) is more evidence that the law of one price does not hold; hence this restriction (i.e., the equality of the two coefficients) is not imposed in subsequent regressions. Increases in real income lead to lower pass-through, a pattern seen throughout the results. The effect is economically much smaller, but still highly statistically significant. Note that in the context of the data used here, this effect cannot be driven by shifts in trade (the basket is the same) or from changes in the proportion of local content (again, because the basket is constant). Finally, the effect of the world

business cycle (G7gap) is economically smaller still; booms in the G7 tend to increase South African prices slightly.

In column 2, we add one lag of the dependent variable to the specification, which is highly statistically significant. The most noticeable change is a decline in estimated pass-through to 18 percent in the first two years (from 26 percent), due mostly to a drop in the coefficient on the contemporaneous exchange rate. There is a marked improvement in the fit of the equation as evidenced by the much higher R-squared statistics; these have risen to 10 percent overall, 57 percent for the between variation, and 11 percent for variation within goods. The coefficients and significance levels on the other independent variables are similar to those in column 1. In column 3 we add another lag of the dependent variable. Despite being statistically significant, the other coefficients do not change much; for this reason, and the potential loss of observations, we do not add lags of the dependent variable. In column 4 we add one lag of all the independent variables, while keeping two lags of the dependent variable. Pass-through, as measured by the sum of the first two coefficients has declined further, to 14 percent, with a t-statistic of 2.43.

In the final two columns we model the equation dynamics as an error correction specification, i.e., equations (2c) and (2d). Thus the equations allow for both short-run and long-run dynamics. The coefficients on the error correction term capture long-run reversion to purchasing power parity at the aggregate level. In both equations the error correction term is statistically significant, and implies that deviations from purchasing power parity have a half life of only about 16 months (1.3 years = ln(0.5)/ln(1-0.4143). This is below Rogoff's consensus 3-5 year half life, but is consistent with declining trade

barriers during the sample period. Interestingly, the trend*error correction interaction term (column 6) is not statistically significant which suggests no (linear) change in speed of mean reversion toward PPP during the sample time period. The fact that the trend interaction with the exchange rate is statistically significant should not be confused with economic significance however. This term, which is multiplied by 1000 in the table, is in reality very small. Thus while it appears that pass-through has been increasing, the increase has been negligible.

Table 2 presents the estimates for pass-through to final services prices. This is a unique aspect of the current study since most studies do not focus on services prices. Based on theoretical grounds, our priors are that services have lower pass-through, since services involve higher shares of non-traded inputs. If the input is non-traded, the direct link between the exchange rate and price is severed. Interestingly, there is little support for these arguments in the data, i.e., estimated pass-through is larger. Indeed, estimated pass-through to services prices over the first two-years is roughly ten percentage points higher, depending on the specification, and still statistically significant for this group of 45 services. The estimated coefficients on world export prices and real income are smaller for services, and the point estimates decline and lose statistical significance in later specifications. The error correction terms are roughly the same size as in the goods price equations, though only in column 5 is the coefficient estimate statistically significant. As with goods, there is no evidence for a secular trend in either pass-through, or reversion to long run PPP for services prices.

To summarize, tables 2 and 3 suggest that short-run pass-through is higher for services than for final goods prices. Perhaps the anomalous services result is due to the

regression's lack of a control for domestic costs within South Africa, which should be relatively more important for services. However, despite pass-through to services being higher than for goods, the main finding is a relatively low rate of pass-through at the consumer level when measured either at the end of the first year, or at the end of the first two years. This corroborates earlier findings of low consumer price pass-through in Choudhri and Hakura (2001), and in Karoro et. al (2009). Reassuringly, the findings suggest that the goods prices data set from the Economist Intelligence unit (admittedly a selection of only 113 prices) provides roughly similar point estimates of pass-through as the more traditional CPI based estimates.[13] A second (and new) finding is that reversion to long run PPP occurs relatively quickly. This is consistent with declining trade barriers over the sample period. Finally, there is virtually no evidence of a secular change in either pass-through or in reversion to PPP. This is in contrast to many recent studies of pass-through (although none are for South Africa), but is consistent with an interpretation that the estimated changes are being driven by changes in the composition of the price basket being measured. In contrast, in this study, which focuses on a fixed basket of goods/services, there is no evidence of a change in pass-through.

5.2 Pass-through to Imports: Results

Table 3 presents the pass-through coefficient estimates of equation (4) with robust standard errors in parenthesis, for each of the ten countries supplying exports to South Africa. Column (1) presents the full panel results, while column (2) gauges the sensitivity of these results by dropping the top and bottom 5 percent of the residuals

from the regression. Column (3) constrains all the country-specific coefficients ($\hat{\beta}_j$) to be equal (after dropping the two countries where zero pass-through could not be rejected), and column (4) again drops the top and bottom 5 percent of the residuals from that regression.

In Column 1 we see that the two countries with the highest import price pass-through to South Africa are Brazil and the United States, at about 75 percent. Following closely behind are Taiwan, Switzerland, India, Great Britain, and Germany, at around 60 percent, while pass-through from Japan has the lowest statistically significant value of only 38 percent (this may reflect Japan's domestic deflationary environment). The overall fit of the regression equation is quite good.

The two countries where pass-through is not statistically different from zero are China and Sweden. For China extremely rapid growth and exchange rate peg to the dollar might identify this country as a 'special' case. However, the low pass-through from Sweden is a puzzle. The low pass-through for China echoes results in Marrazi et al (2005) for the US; however China's growing presence and low pass-through have not lowered pass-through from other source countries for South Africa.

In column 2 the largest and smallest five percent of the residuals have been removed before re-estimating equation (4). The results are very similar, except that China becomes statistically significant at the 5% level (and still very low). Estimated pass-through from Sweden again remains statistically insignificant, despite the fact that the R-squared statistics all improve. In column (3) we constrain the pass-through coefficient to be the same – despite it differing clearly across source country. The regression in column (3) also drops the two countries with statistically insignificant pass-

through (China and Sweden) from the regression. According to the resulting coefficient estimate, “average” pass-through to import prices in South Africa since 1998 has been around 60 percent, somewhat lower than Bhundia’s (2002) estimate of 78 percent; though the sample period here (1998-2009) is almost non-overlapping with Bhundia’s which ends in 2000. Finally, the regression in column (4) checks for evidence of a (linear) secular change in average pass-through during the sample. The coefficient on the exchange rate-trend interaction term is not statistically significant; hence we cannot reject the hypothesis that pass-through to import prices has not changed over the course of the sample.

6 Conclusions

This study estimates pass-through into consumer goods and services for South Africa using panels of final goods and services prices, and at the dock using unit values for a sample of disaggregated homogenous imported items. Estimates derived from a fixed set of individual good or services prices can potentially mitigate some important measurement problems and simultaneity biases present in studies using price level aggregates (e.g., CPI), while a comparison of pass-through to final goods to that at the dock can potentially help forecast the ultimate inflationary implications of exchange rate shocks. It is important to note that the ‘equal-weighting’ restriction imposed by the pooled estimation strategy used in this study may yield a pass-through estimate that diverges from that obtained from using the CPI since that basket changes over time. Hence the resulting pass-through estimates may not be strictly comparable.

The study finds low pass-through to final consumer goods prices (between 14 and 27 percent in the two years following an exchange rate change). Somewhat surprisingly, estimated pass-through to services is actually higher than that for final goods. One possibility is that the services used in this study are targeted at expatriates; hence there may be more sensitivity to exchange rates than for other services in the 'typical' basket. An important implication of this finding however is that it diminishes the argument (found in other studies) that shifts toward more services is behind estimates of declines in pass-through. This study also finds relatively fast convergence to long run purchasing power parity. Finally, the evidence suggests no economically important tendency for pass-through – or mean reversion to long run PPP to have declined secularly (linearly) during the last twenty years – contrary to evidence found for many other economies. This supports findings from other studies that suggest that recent reported declines in pass-through may be due to changes in the consumer basket, rather than to changes in the monetary environment, or to changes in pricing behaviour of firms. Moreover, to the extent that recent changes in the consumer basket persist, pass-through can be expected to remain low even if higher inflation returns. Alternatively, the link between lower inflation and decoupling from 'foreign shocks' may be illusory; that is the pass-through of exchange rate shocks may have declined simply because the commodity composition of trade changed.

Pass-through to import unit values are estimated as much higher, averaging around 60 percent for eight of the ten source countries studied, and as with consumer goods and services, there was no evidence of a trend decline, although other temporal change patterns (e.g., rising then falling) are not ruled out. These estimates are below

those obtained from aggregate price indexes (e.g., 78 percent estimated by Karoro et. al, 2009), but are similar enough to suggest that some of the concerns with aggregate price indexes may be overstated. One interesting and novel finding is the considerable cross-country diversity in the estimates of pass-through at the dock; how much of this is due to the quality of the import unit value data remains an open question. Relatively high estimates were found for pass-through from Brazil and the United States (75 percent), while Taiwan, Switzerland, India, Great Britain, and Germany were nearer the overall average of 60 percent. However, import pass-through from Japan recorded the lowest statistically significant estimate of pass-through at 38 percent, and the two countries where pass-through estimates were not statistically different from zero are China and Sweden. For the case of China, the low estimates could indeed be due to very rapid productivity gains over this period. Sweden remains anomalous. Note these differences in estimates are not due to differences in the commodity composition of trade since the panel was chosen such that each product was imported from multiple source countries. Hence, the results suggest that if trade with China continues to grow (as seems likely), import pass-through may yet follow international patterns and register a decline.

Table 1: Passthrough to Final Goods

	(1)	(2)	(3)	(4)	(5)	(6)
Δ log Exchange rate $_t$	0.1100***	0.0592*	0.0517	0.0568*	0.0814**	0.0819**
	(0.037)	(0.035)	(0.035)	(0.034)	(0.035)	(0.037)
Δ log Exchange rate $_{t-1}$	0.1517***	0.1327***	0.1098***	0.0797**	0.0804**	
	(0.020)	(0.023)	(0.025)	(0.033)	(0.033)	
Trend*Exchange rate $_t$ *(1000)						0.0405**
						(0.0178)
Δ log World Export Prices $_t$	0.5023***	0.4631***	0.4841***	0.4284***	0.5410***	0.5434***
	(0.102)	(0.097)	(0.098)	(0.100)	(0.114)	(0.120)
Δ log World Export Prices $_{t-1}$				-0.0557	0.1841	0.1857
				(0.153)	(0.151)	(0.150)
Δ log Real Income $_t$	-0.0151***	-0.0197***	-0.0251***	-0.0239***	-0.0318***	-0.0318***
	(0.003)	(0.003)	(0.005)	(0.006)	(0.006)	(0.006)
Δ log Real Income $_{t-1}$				-0.0000	0.0009	0.0010
				(0.003)	(0.003)	(0.003)
Δ G7 Gap $_t$	0.0072**	0.0074**	0.0109***	0.0158**	0.0134**	0.0134*
	(0.003)	(0.003)	(0.004)	(0.006)	(0.007)	(0.007)
Δ G7 Gap $_{t-1}$				-0.0354***	-0.0374***	-0.0375***
				(0.008)	(0.008)	(0.008)
Δ log prices $_{t-1}$		-0.2617***	-0.2881***	-0.2973***	-0.2999***	-0.3000***
		(0.040)	(0.041)	(0.041)	(0.041)	(0.041)
Δ log prices $_{t-2}$			-0.0822***	-0.0904***	-0.0870***	-0.0871***
			(0.028)	(0.027)	(0.028)	(0.028)
Error Correction term $_{t-3}$					-0.4143***	-0.4103**
					(0.147)	(0.161)
Trend*Error Correction term $_{t-3}$ *(1000)						0.0023
						(0.048)
Observations	1997	1991	1878	1878	1878	1878
Number of good	113	113	113	113	113	113
R2: within	0.0413	0.113	0.116	0.132	0.137	0.137
between	0.009	0.571	0.654	0.661	0.664	0.664
overall	0.0406	0.0996	0.0962	0.112	0.117	0.117

***, **, * indicate significance at the 1, 5, and 10 percent levels respectively. Robust standard errors are shown in parenthesis, clustered by good. Column 1 presents estimates of equation (2a); Columns 2-4 presents estimates of equation (2b), with varying lags of included regressors; Columns 5-6 present estimates of equation (2c) and (2d).

Table 2: Passthrough to Services

	(1)	(2)	(3)	(4)	(5)	(6)
Δ log Exchange rate $_t$	0.2215**	0.2168**	0.2047**	0.1927**	0.1634*	0.1625*
	(0.085)	(0.084)	(0.081)	(0.090)	(0.081)	(0.091)
Δ log Exchange rate $_{t-1}$	0.1454**	0.1449***	0.1550***	0.1260*	0.1173*	
	(0.055)	(0.050)	(0.048)	(0.071)	(0.067)	
Trend*Exchange rate $_t$ *(1000)						0.0582
						(0.039)
Δ log World Export Prices $_t$	0.3986***	0.3697***	0.1727	0.1496	0.0423	0.0385
	(0.143)	(0.135)	(0.169)	(0.180)	(0.185)	(0.247)
Δ log World Export Prices $_{t-1}$				-0.1396	-0.4466*	-0.4488*
				(0.298)	(0.239)	(0.250)
Δ log Real Income $_t$	-0.0140***	-0.0136**	-0.0015	-0.0012	0.0071	0.0072
	(0.005)	(0.005)	(0.006)	(0.010)	(0.010)	(0.011)
Δ log Real Income $_{t-1}$				0.0032	0.0027	0.0026
				(0.006)	(0.006)	(0.007)
Δ G7 Gap $_t$	0.0200***	0.0197***	0.0131***	0.0109	0.0131	0.0131
	(0.005)	(0.005)	(0.005)	(0.014)	(0.015)	(0.015)
Δ G7 Gap $_{t-1}$				-0.0044	-0.0043	-0.0042
				(0.014)	(0.014)	(0.013)
Δ log prices $_{t-1}$		-0.0064	-0.0011	0.0006	0.0049	0.0047
		(0.074)	(0.088)	(0.089)	(0.090)	(0.090)
Δ log prices $_{t-2}$			-0.1196**	-0.1186**	-0.1209***	-0.1208***
			(0.046)	(0.045)	(0.044)	(0.045)
Error Correction term $_{t-3}$					-0.4363*	-0.4315
					(0.255)	(0.284)
Trend*Error Correction term $_{t-3}$ *(1000)						-0.0029
						(0.085)
Observations	765	750	705	705	705	705
Number of good	45	45	45	45	45	45
R2: within	0.0402	0.0400	0.0532	0.0538	0.0579	0.0579
between	0.0831	0.0846	0.715	0.696	0.682	0.680
overall	0.0378	0.0374	0.0445	0.0458	0.0499	0.0499

***, **, * indicate significance at the 1, 5, and 10 percent levels respectively. Robust standard errors are shown in parenthesis, clustered by service. Column 1 presents estimates of equation (2a); Columns 2-4 presents estimates of equation (2b), with varying lags of included regressors; Columns 5-6 present estimates of equation (2c) and (2d).

Table 3: Pass-Through to Imports

Exporter (β_i):	(1)	(2)	(3)	(4)
Brazil	0.7526	0.7131		
	(0.1567)***	(0.1654)***		
China	0.2327	0.2648		
	(0.1597)	(0.1283)**		
Germany	0.5816	0.5012		
	(0.1936)***	(0.1475)***		
Great Britain	0.6055	0.5619		
	(0.2121)***	(0.1608)***		
India	0.6211	0.8068		
	(0.3209)*	(0.2203)***		
Japan	0.3767	0.4365		
	(0.1741)**	(0.1303)***		
Sweden	0.0741	-0.0461		
	(0.2362)	(0.2037)		
Switzerland	0.6328	0.4694		
	(0.3303)*	(0.2128)**		
Taiwan	0.6418	0.5911		
	(0.1864)***	(0.1508)***		
United States	0.7357	0.6692		
	(0.1691)***	(0.1499)***		
$\beta_i=\beta$			0.5935	0.5704
			(0.1316)***	(0.1346)***
*trend*log exchange rate*$_t$				0.001
				(0.0007)
Observations	6668	6000	5600	5600
Product dummies	yes	yes	yes	yes
Country dummies	yes	yes	yes	yes
Time Dummies	yes	yes	yes	yes
R-squared within	0.17	0.25	0.18	0.19
R-squared between	0.90	0.94	0.90	0.90
R-squared overall	0.84	0.90	0.83	0.83

Robust standard errors in parentheses, clustered at the good level. * significant at 10%; ** significant at 5%; *** significant at 1%. Column 1 presents estimates of equation (4) in the text for the full sample; column 2 for the sample excluding outliers; column 3 constraining all the country-specific pass-through coefficients ($\beta_i=\beta$) to be equal (excluding some countries, see text); and column 4 excludes outliers and tests for a change in pass-through. The estimation time period is January 1998 – June 2009.

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Data appendix

(a) Description of the Disaggregated Consumer Price Data

The individual goods prices used in this study were compiled by the *Economist Intelligence Unit (EIU)*. The *EIU* data are collected as part of the *Worldwide Cost of Living Survey*, and are designed for use by human resource managers in the design of compensation policies.

The *EIU* description is at http://store.eiu.com/product/130000213.html. The data set contains more than 160 local currency retail prices of (mostly generic) goods and services collected from 140 cities around the world. Some goods are priced at two locations and both prices appear in the data set, bringing the total number of goods and services to more than 330. The data are reported annually, each December, since 1990 however the exact timing of the survey is not specified by the *EIU;* the sample ends in 2009.

For this study, 158 goods and services prices recorded for Johannesburg, South Africa are selected.[2] The bilateral exchange rate (rand/US$) is provided in the EIU data set, which is also recorded as of the date of the price survey.[3] Overall, the price data are relatively complete: of the potential 3160 observations in the data (=20 years x 158 prices) there are only 103 (3 percent) missing observations. It should be acknowledged that, despite the obvious advantages of these data (e.g., data collected by a single source on precise, well-defined and unchanging final goods and services) the data set is not comprehensive, or even representative of the entire consumer price basket. In fact, many of the items are representative of what a mid-level expatriate manager would purchase; indeed the stores sampled are those where the mid-level manager's family is presumed to shop. Hence, it is not clear how representative the resulting pass-through estimates are for the overall economy. Despite these reservations, the ability to focus on a fixed set of final goods prices presents some important advantages over the price index data generally studied, as discussed above.

Table 1 lists all of the goods (indicated by "G") and services (S) included in this study. Of the total 158 prices, 45 are services, and 113 are goods. The goods/services breakdown is somewhat arbitrary – especially given the quite high estimates of the share of non-traded inputs in the price of traded goods. For example, Feenstra (1998) reports that Barbie dolls cost around ten dollars in the U.S., but the imported doll costs only one dollar; thus around 90 percent of the price of a Barbie doll in the U.S. is value added between the manufacturer and the consumer. Nonetheless, goods and services are reported separately in the regression analysis.

[2] There are also data for Pretoria beginning in 2003, which is not used due to the limited time span.
[3] For the import pass-through analysis, end of quarter exchange rates were taken from the International Financial Statistics.

All of the price series were checked for coding errors. First, price observations (in common currency) that differed from the cross-sectional mean by more than a factor of three were set to missing. Next, potential coding errors were screened by focusing on within-product price swings. Specifically, price changes within a given city of more than one hundred percent that were subsequently reversed in the next period (there were three) were also replaced by the average of the previous and next year's values. Finally we checked for outliers in our regressions by deleting the observations associated with the top 1 percent of the residuals.

In addition to the individual goods and services price data, additional macroeconomic data as controls are used in the regression analysis. First, the world export price index data (December values) was taken from the International Financial Statistics (series 174..DZF). Additionally, two series were taken from the April 2009 World Economic Outlook (WEO) data base (www.imf.org/external/ns/cs.aspx?id=28). The first, was the G7 output gap, which was taken as a measure of aggregate demand conditions outside South Africa. The second series from WEO was South Africa's real gross domestic product. WEO data are only available on an annual basis.

(b) Description of the Import Unit Value Data

The source of the data is from a CD provided by Global Insight, which "cleans" raw data on the value and quantities of goods shipped, by good and by source country; the original data are collected by the Customs and Excise branch of the South African Revenue Service. Despite being cleaned, the data are a great deal more variable, and have more missing observations than that typically used in macroeconomic research.

Hence, a number of additional filters were applied to the data before using it in the analysis. The data on the CD is monthly from January 1998 to June 2009.

Unit values, i.e., value divided by quantity for each item included, are taken as the basic 'price' measure in estimating pass-through at the dock. Unit value data are notoriously suspect; unit values can change due to changes in items being shipped (not their prices). Even for imports of identical goods, unit values can change due to changes in the price, or to changes in the way the goods are bundled. For example, a product can be shipped in bulk, or in cartons, which may be subdivided further into packets, etc. Presumably pricing would be different based on the quantity being purchased. We acknowledge this problem, and attempt to mitigate it by focusing on the most homogeneous and disaggregated (HS8-digit) commodity classifications possible – and by 'cleaning' the data in a variety of ways. This focus hopefully minimizes changes in price due to changes in the basket being imported, as well as changes in the 'bundling' of the product. Ultimately however, the reader should appreciate that the basic unit of observation remains as unit value, not price, data.

In an effort to be representative, a minimum of 120 monthly observations out of a possible 137 observations was imposed as a requirement, as well as a requirement that the good be imported from a minimum of four trading partners.[4] Next the large variations in the data were identified. All price swings of more than 100 percent (month-to-month) that were reversed in the subsequent month were set to missing. Next, all unit values that differed from the mean by more than three standard deviations were set to missing. Similarly, all observations where the difference between the maximum and

[4] The four country minimum requirement was relaxed in an effort to focus on six arguably more homogenous imports of chemicals. Three of the six chemicals are imported from only three source countries.

minimum values was greater than 10000 percent (in absolute value) were set to missing. Next we linearly interpolated values where there were no more than two consecutive months missing. Finally, quarterly averages of the monthly values are used for all subsequent analysis at the quarterly frequency. Out of concern for the veracity of the import unit value data, the statistical analysis was repeated after (a) dropping the largest and smallest 5 percent of the observations, (b) dropping one country at a time (not reported), and (c) dropping one good at a time (not reported) as further checks on the robustness of the results. Despite these steps the unit value data are far from a balanced panel since not all products are imported from all source countries. Table 2 displays the ultimate data availability in terms of goods and source countries, as well as providing a listing of the product codes and brief descriptions.

Table 1: Final Goods and Services included

1	S	American /English school: annual tuition, ages 5-12 (avg.)	80	G	International weekly news magazine (Time) (avg.)
2	S	American/English school: extra costs, ages 5-12 (avg.)	81	G	Kodak colour film (36 exposures) (avg.)
3	S	American/English school: kindergarten annual fees (avg.)	82	G	Lamb: chops (1 kg) (supermarket)
4	S	Annual premium for car insurance (low)	83	G	Lamb: leg (1 kg) (supermarket)
5	G	Apples (1 kg) (supermarket)	84	G	Lamb: Stewing (1 kg) (supermarket)
6	G	Aspirins (100 tablets) (supermarket)	85	S	Laundry (one shirt) (standard high-street outlet)
7	S	Babysitter's rate per hour (avg.)	86	G	Laundry detergent (3 l) (supermarket)
8	G	Bacon (1 kg) (supermarket)	87	G	Lemons (1 kg) (supermarket)
9	G	Bananas (1 kg) (supermarket)	88	G	Lettuce (one) (supermarket)
10	G	Batteries (two, size D/LR20) (supermarket)	89	G	Light bulbs (two, 60 watts) (supermarket)
11	G	Beef: filet mignon (1 kg) (supermarket)	90	G	Lipstick (deluxe type) (chain store)
12	G	Beef: ground or minced (1 kg) (supermarket)	91	G	Liqueur, Cointreau (700 ml) (supermarket)
13	G	Beef: roast (1 kg) (supermarket)	92	G	Low priced car (900-1299 cc) (low)
14	G	Beef: steak, entrecote (1 kg) (supermarket)	93	S	Maid's monthly wages (full time) (avg.)
15	G	Beef: stewing, shoulder (1 kg) (supermarket)	94	S	Man's haircut (tips included) (avg.)
16	G	Beer, local brand (1 l) (supermarket)	95	G	Margarine, 500g (supermarket)
17	G	Beer, top quality (330 ml) (supermarket)	96	G	Men's business shirt, white (chain store)
18	G	Boy's dress trousers (chain store)	97	G	Men's business suit, two piece, medium weight (chain store)
19	G	Boy's jacket, smart (chain store)	98	G	Men's shoes, business wear (chain store)
20	S	Business trip, typical daily cost	99	G	Milk, pasteurised (1 l) (supermarket)
21	G	Butter, 500 g (supermarket)	100	G	Mineral water (1 l) (supermarket)
22	G	Carrots (1 kg) (supermarket)	101	S	Moderate hotel, single room, one night including breakfast (avg.)
23	G	Cheese, imported (500 g) (supermarket)	102	G	Mushrooms (1 kg) (supermarket)
24	G	Chicken: fresh (1 kg) (supermarket)	103	G	Olive oil (1 l) (supermarket)
25	G	Chicken: frozen (1 kg) (supermarket)	104	G	One drink at bar of first class hotel (avg.)
26	G	Child's jeans (chain store)	105	S	One good seat at cinema (avg.)
27	G	Child's shoes, dresswear (chain store)	106	S	One X-ray at doctor's office or hospital (avg.)
28	G	Child's shoes, sportswear (chain store)	107	G	Onions (1 kg) (supermarket)
29	G	Cigarettes, local brand (pack of 20) (supermarket)	108	G	Orange juice (1 l) (supermarket)
30	G	Cigarettes, Marlboro (pack of 20) (supermarket)	109	G	Oranges (1 kg) (supermarket)
31	G	Coca-Cola (1 l) (supermarket)	110	G	Paperback novel (at bookstore) (avg.)
32	G	Cocoa (250 g) (supermarket)	111	G	Peaches, canned (500 g) (supermarket)
33	G	Cognac, French VSOP (700 ml) (supermarket)	112	G	Peanut or corn oil (1 l) (supermarket)
34	G	Compact car (1300-1799 cc) (low)	113	G	Peas, canned (250 g) (supermarket)
35	G	Compact disc album (avg.)	114	G	Pipe tobacco (50 g) (avg.)
36	G	Cornflakes (375 g) (supermarket)	115	G	Pork: chops (1 kg) (supermarket)
37	S	Cost of a tune up (but no major repairs) (low)	116	G	Pork: loin (1 kg) (supermarket)
38	S	Cost of developing 36 colour pictures (avg.)	117	G	Potatoes (2 kg) (supermarket)
39	G	Cost of six tennis balls eg Dunlop, Wilson (avg.)	118	G	Razor blades (five pieces) (supermarket)
40	G	Daily local newspaper (avg.)	119	G	Regular unleaded petrol (1 l) (avg.)
41	G	Deluxe car (2500 cc upwards) (low)	120	S	Routine checkup at family doctor (avg.)
42	G	Dishwashing liquid (750 ml) (supermarket)	121	G	Scotch whisky, six years old (700 ml) (supermarket)
43	G	Drinking chocolate (500 g) (supermarket)	122	G	Shampoo & conditioner in one (400 ml) (supermarket)
44	S	Dry cleaning, man's suit (standard high-street outlet)	123	S	Simple meal for one person (avg.)
45	S	Dry cleaning, trousers (standard high-street outlet)	124	G	Sliced pineapples, canned (500 g) (supermarket)
46	S	Dry cleaning, woman's dress (standard high-street outlet)	125	G	Soap (100 g) (supermarket)
47	G	Eggs (12) (supermarket)	126	G	Socks, wool mixture (chain store)
48	G	Electric toaster (for two slices) (supermarket)	127	G	Spaghetti (1 kg) (supermarket)
49	S	Electricity, monthly bill for family of four (avg.)	128	G	Sugar, white (1 kg) (supermarket)
50	S	Entrance fee to a public swimming pool (avg.)	129	S	Taxi rate per additional kilometre (avg.)
51	G	Facial tissues (box of 100) (supermarket)	130	S	Taxi: airport to city centre (avg.)
52	G	Family car (1800-2499 cc) (low)	131	S	Taxi: initial meter charge (avg.)
53	G	Fast food snack: hamburger, fries and drink (avg.)	132	G	Tea bags (25 bags) (supermarket)
54	G	Flour, white (1 kg) (supermarket)	133	S	Telephone line, monthly rental (avg.)
55	S	Four best seats at cinema (avg.)	134	S	Telephone, charge per local call from home (3 mins) (avg.)
56	S	Four best seats at theatre or concert (avg.)	135	G	Television, colour (66 cm) (avg.)
57	S	French school: annual tuition, ages 5-12 (avg.)	136	S	Three-course dinner at top restaurant for four people (avg.)
58	S	French school: extra costs, ages 5-12 (avg.)	137	G	Toilet tissue (two rolls) (supermarket)
59	S	French school: kindergarten annual fees (avg.)	138	G	Tomatoes (1 kg) (supermarket)
60	G	Fresh fish (1 kg) (supermarket)	139	G	Tomatoes, canned (250 g) (supermarket)
61	G	Frozen fish fingers (1 kg) (supermarket)	140	G	Tonic water (200 ml) (supermarket)
62	G	Frying pan (Teflon or good equivalent) (supermarket)	141	G	Toothpaste with fluoride (120 g) (supermarket)
63	S	German school: annual tuition, ages 5-12 (avg.)	142	G	Two-course meal for two people (avg.)
64	S	German school: extra costs, ages 5-12 (avg.)	143	S	Unfurnished residential apartment: 2 bedrooms (moderate)
65	S	German school: kindergarten annual fees (avg.)	144	G	Vermouth, Martini & Rossi (1 l) (supermarket)
66	G	Gin, Gilbey's or equivalent (700 ml) (supermarket)	145	S	Visit to dentist (one X-ray and one filling) (avg.)
67	G	Girl's dress (chain store)	146	S	Water, monthly bill for family of four (avg.)
68	S	Green fees on a public golf course (avg.)	147	G	White bread, 1 kg (supermarket)
69	G	Ground coffee (500 g) (supermarket)	148	G	White rice, 1 kg (supermarket)
70	G	Ham: whole (1 kg) (supermarket)	149	G	Wine, common table (750 ml) (supermarket)
71	G	Hand lotion (125 ml) (supermarket)	150	G	Wine, fine quality (750 ml) (supermarket)
72	G	Heating oil (100 l) (avg.)	151	G	Wine, superior quality (750 ml) (supermarket)
73	S	Hilton-type hotel, single room, one night including breakfast (avg.)	152	S	Woman's cut & blow dry (tips included) (avg.)
74	S	Hire car, weekly rate for lowest price classification (avg.)	153	G	Women's cardigan sweater (chain store)
75	S	Hire of tennis court for one hour (avg.)	154	G	Women's dress, ready to wear, daytime (chain store)
76	S	Hourly rate for domestic cleaning help (avg.)	155	G	Women's shoes, town (chain store)
77	G	Insect-killer spray (330 g) (supermarket)	156	G	Women's tights, panty hose (chain store)
78	G	Instant coffee (125 g) (supermarket)	157	S	Yearly road tax or registration fee (high)
79	G	International foreign daily newspaper (avg.)	158	G	Yoghurt, natural (150 g) (supermarket)

Table 2: Import Unit Values and Source Countries Included

Panel A: Import commodities and number of countries exporting to South Africa

Good	HS8 Code	HS 8th level product description	# countries
1	28112200	silicon dioxide	4
2	28211000	iron oxides and hydroxides	4
3	29153990	esters of acetic acid	3
4	29157000	palmitic acid, stearic acid, their salts and esters	3
5	29239000	Quaternary ammonium salts and hydroxides; lecithins and other phosphoaminolipids, whether or not chemically defined	3
6	29362700	vitamin c and its derivatives	4
7	32151100	printing ink, black	5
8	33041000	lip make-up preparations	4
9	33042000	eye make-up preparations	4
10	39241000	tableware and kitchenware	6
11	40169100	floor coverings and mats	7
12	48191000	cartons, boxes and cases, of corrugated paper or paperboard	5
13	73181526	socket screws	8
14	73182200	other washers	10
15	73182300	rivets	6
16	73182400	cotters and cotter-pins	10
17	73202000	helical springs	6
18	83021000	hinges	9
19	84824000	needle roller bearings	6
20	84825000	other cylindrical roller bearings	4
21	85044000	static converters	6
22	85322200	aluminum electrolytic	6
23	85364120	electromagnetic and permanent magnet relays	8
24	85393290	other	4
25	85411000	diodes, (excluding photosensitive or light emitting diodes)	5
26	96081000	ball point pens	8

Panel B: number of goods, by country

	Country	# of products
1	Brazil	8
2	Switzerland	6
3	China	16
4	Germany	26
5	Great Britain	24
6	India	10
7	Japan	16
8	Sweden	8
9	Taiwan	12
10	United States	22

End notes

[1] Parsley (1993) for Japan, and Campa and Goldberg (2005) for the U.S. document that Price Index changes over time do in part, reflect changes in the commodity composition of trade – with concomitant effects on estimated pass-through.

[2] However, prior to estimation, the goods (113 items), and services (45 items), are separately pooled, which begs the question whether *combined* these prices can impact the exchange rate, thus invalidating the exogeneity assumption. One argument against this is the small combined weight of the sample of goods and services in the overall Consumer Price Index – which suggests a correspondingly small impact on the exchange rate. However, in the limit, the method proposed in this paper cannot sidestep the simultaneity problem.

[3] Of course, another criticism is that pass-through is accurately estimated, though only for those goods and services included in the study. This is perhaps the greatest drawback of the approach in this paper. More individual price data would clearly be preferable. However with 158 prices the data do represent a large publically available data set of well defined (and internationally comparable) goods and services.

[4] Services are typically viewed as non-traded, but this view is too narrow. For example, service providers may arbitrage may via movement in factors of production, rather than via the item itself, Moreover, customers can also shop across jurisdictions for some items. A good example is tourist services (e.g., hotels). Hence, economic forces limit the extent of cross-border price differences even among services, though the presumption is that reversion to a common price would be slower, and the average absolute price differential would be larger for services than for goods.

[5] South Africa's average inflation rate declined from over 14 percent in the 1980s, to 9 percent in the 1990s (some argue the SARB adopted an 'implicit' inflation target, at least for part of the 1990s), to just over 6 percent since 2000, and has declined further (with some hiccups, especially in 2008) after formal inflation targeting was adopted.

[6] Ho and McCauley (2003).

[7] The BIS (2002, p. 92) is among those attributing the low pass-through to the CPI of recent large devaluations in developing countries to a decline in long-run inflation. But Burstein, Eichenbaum and Rebelo (2002) attribute the low observed pass-through in general price indices to a substitution of newly expensive import goods to local substitutes in the indices following large devaluations.

[8] Aw (1993) examines exports from Taiwan to four countries of footwear, but they are heavily affected by quotas. Parsley (2003) examines pass-through to Hong Kong import prices (unit values), and finds pass-through to be nearly complete within one year.

[9] Engel (2006) shows that the implications for pass-through are the same, whether an optimizing firm chooses its prices in advance in either the home (PCP) or importer's currency (LCP).

[10] The null hypothesis of a unit root in this term is easily rejected in an augmented Dickey-Fuller test (p-value < 0.0001). As an alternative to the U.S. based error correction term, one could construct a measure based on G7 exchange rates and consumer price indexes. Another alternative for an ECM term could be one constructed by extracting the common inflation factor for use in the ECM in a two-step procedure. First, by regressing the dependent variable on fixed effects and time dummies over the whole sample, and then cumulating the coefficients from the initial year on the time dummies (which give the year-specific inflation rates) to give the price levels for the common inflation rate that corresponds. I acknowledge a referee for this suggestion.

[11] The complete description of the data is provided in the Data Appendix.

[12] In tables reporting regression results, all standard errors (reported in parentheses) have been adjusted for intra-group (good, service, country, etc.) correlation using STATA's cluster option on the xtreg command. This option provides robust variance estimation for cluster-correlated data, see Wooldridge (2002, Ch 13.8.2) or Williams (2000).

[13] Unfortunately a similar comparison of the results for services cannot be made since extant studies focus either on import prices, or consumer prices.