PEDL Research Papers

This research was partly or entirely supported by funding from the research initiative Private Enterprise Development in Low-Income Countries (PEDL), a Department for International Development funded programme run by the Centre for Economic Policy Research (CEPR).

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International Review of Economics and Finance 54 (2018) 154–164

Contents lists available at ScienceDirect

International Review of Economics and Finance

journal homepage: www.elsevier.com/locate/iref

Closer monetary union and product market integration in emerging economies: Evidence from the Common Monetary Area in Southern Africa

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ARTICLE INFO

JEL codes:
F10
F13
F14
F15
F42

Keywords:
Botswana
Exchange rate
Monetary union
Product market integration

ABSTRACT

This study utilizes detailed micro price data to estimate the impact of closer monetary union on the integration of product markets across countries, considering two policy shocks from Botswana. Using the difference-in-difference approach, the results reveal that the adoption by Botswana of a crawling peg exchange policy reduced price differences between South Africa and Botswana by 4 percentage points. Subsequent changes in the Botswana monetary policy regime further reduced price gaps by 2 percentage points. These results provide support for the effectiveness of alignment in interest rate and exchange rate policies in enhancing the integration of product markets between countries.

1. Introduction

Despite the recent European crisis, closer monetary union remains a stated goal of many, particularly developing, country groupings. For example, the African Union aims to establish a monetary union and a single currency by 2021. This is to be preceded by monetary unions amongst the regional economic communities, including the South African Development Community (SADC) (Jefferis, 2007). A central aim of monetary unions is to eliminate transaction costs and uncertainties that arise from exchanging one currency for another, allowing for greater price transparency since all goods are priced in the same currency (De Grauwe, 2014). Greater price transparency, if accompanied by freer movement of goods and services should in turn lead to greater product market integration and price convergence between members.

In general, a positive link between monetary unions and product market integration has been established in the empirical literature (Beck & Weber, 2001; Mathä, 2006; Allington, Kattuman, & Waldmann, 2005; Goldberg & Verboven, 2004, 2005; Cavallo, Neiman, & Rigobon, 2012, 2014; Martin & Mejean, 2013 and; Dvir & Strasser, 2014). However, many of these studies focus on the Euro area, and research on developing countries, particularly African countries, is limited.[1] Emerging economies lack the deep institutional framework

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[1] Exceptions include Dvir and Strasser (2014); Cavallo et al. (2014); Tsangarides, Ewenczyk, and Hulej (2006); Parsley and Wei (2003); Carrère (2004); Rose and Engel (2002) and Honohan (1992).

http://dx.doi.org/10.1016/j.iref.2017.08.004
Received 17 June 2016; Received in revised form 4 August 2017; Accepted 14 August 2017
Available online 18 August 2017

that has governed the integration programme in Europe. Consequently, the outcomes of monetary unions in emerging economies may differ from those in advanced economies. Furthermore, the establishment of (or joining into) a monetary union is the culmination of a number of steps as countries more closely integrate various aspects of their monetary policy. It is therefore useful to understand how each of these steps contributes towards the integration of product markets.

In this paper, we identify the effect of a monetary union on product market integration using data from the emerging African economies of Botswana, South Africa (SA) and Lesotho. These countries (together with Namibia and Swaziland) are members of the Southern African Customs Union (SACU) and share a common external tariff with no internal trade restrictions. They are also, with the exception of Botswana, members of the Common Monetary Area (CMA), a *de facto* monetary union where member's currencies are pegged one-for-one to the South African Rand and South African monetary policy is adopted. This paper uses changes in the exchange rate and interest rate policy implemented by Botswana authorities (not a member of the CMA) to identify the impact on price integration between itself and South Africa, while controlling for changes in integration between South Africa and Lesotho (both members of CMA). These policy changes are similar to the process a country would follow to become a member of a monetary union.

The paper makes four specific contributions to the literature. Firstly, it extends the analysis of the relationship between monetary unions and product market integration to a set of Southern African countries – Botswana, Lesotho and South Africa, where there has been little of this type of work. Secondly, it uses highly disaggregated product price data that varies by location and time to precisely estimate the size of price border effects between member states. This data further allows for the estimation of heterogeneous effects of monetary unions on different product items. Thirdly, it applies a difference-in-differences approach that allows us to identify the effect of closer monetary integration relative to a control. Fourthly, because monetary integration in this region has experienced two distinct steps, namely closer alignment of exchange rate policies and then interest rate polices, the paper can investigate the cumulative importance of each of each of these steps in driving the desired outcomes.

An analysis of the data shows that product markets are not fully integrated between the three countries, despite their joint membership in SACU and, for Lesotho and South Africa, in the CMA. For example, retail prices of comparable products differ by on average 25–32% between SA and Lesotho and 32–37% between SA and Botswana. However, we find that the convergence of Botswana's monetary policy towards that of the CMA was effective in reducing price gaps between Botswana and South Africa (relative to South Africa and Lesotho). The adoption by Botswana of a crawling peg exchange policy that led to a convergence and stabilization of the Pula/Rand exchange rate reduced the South Africa-Botswana border effect by approximately 3.9 percentage points. Subsequent changes in the Botswana monetary policy regime to target the same 3–6 percent inflation band as South Africa further reduced the border-effect by 2.3 percentage points.

The remainder of this paper is divided into the following sections. Section 2 outlines the background on regional integration within the CMA region and discusses two policy events that translated into closer monetary integration in the SACU region. Section 3 develops the empirical method applied. Section 3 describes the data and the descriptive statistics while Section 4 presents the results. Robustness checks on the main results are presented in Section 4. Section 6 concludes the paper.

2. Botswana and the Common Monetary Area

The Southern African countries of Swaziland, Namibia, Botswana, Lesotho and South Africa share a long history of trade and monetary integration. They are all members of the Southern African Customs Union (SACU), one of the oldest customs unions in the world (McCarthy, 1994). Cross-border trade amongst SACU members is still subject to border controls, although, with the exception of a few infant industry barriers, import tariffs have been eliminated. The SACU countries of Botswana, Lesotho, Namibia and Swaziland are highly integrated into the South African economy and trade with South Africa accounts for over 50% of exports and imports of these countries.

With the exception of Botswana, the SACU countries are also members of the Common Monetary Area (CMA). The CMA was established between South Africa, Lesotho and Swaziland in 1986 with Namibia joining in 1992. Like the customs union, the CMA has deep historical roots. It emerged out of a *de facto* currency union whereby the South African currency became the sole medium of exchange in all the countries (including Botswana) after the establishment of the South African Reserve Bank in 1921 (Wang, Shirono, & Harris, 2007). The *de facto* currency union was formalized in 1974 with the signing of the Rand Monetary Area agreement. Botswana, however, withdrew two years later because it wished to retain and formulate its own monetary and exchange rate policies (Asonuma, Debrun, & Masson, 2012; Wang et al., 2007).

Under the CMA, each country has the right to issue their own national currency, although these currencies are pegged one-for-one to the South African Rand. There is a high mobility of capital between members as no restrictions are imposed on the transfer of funds between member countries, whether for current or capital transactions (Wang et al., 2007: 10). While the CMA is not a full monetary union with a common central bank and common pool of reserves, the South African Rand is the *de facto* common currency and is legal tender throughout the CMA and the central banks within the smaller CMA members essentially adopt the South African Reserve Bank interest rates. Since 2000, with the adoption of an inflation targeting monetary policy, the South African Rand has floated freely with little central bank intervention (Aron & Muellbauer, 2009; Aron, Elbadawi, & Kahn, 2000; Mtonga, 2011).

While Botswana is not a member of the CMA, two significant changes in Botswana's monetary policy and exchange rate framework between 2004 and 2008 mimic a process of convergence towards those policies adopted in the CMA. This paper uses these policy changes to identify the effect of closer monetary policy on product price integration.

The first major change, on 30 May 2005, involved the introduction of a new exchange rate regime. Prior to this date, the Bank of Botswana adopted a fixed peg regime whereby the national currency, the Pula, was pegged to a basket of currencies, of which the South Africa Rand constituted a large weight (60–70%) (Wang et al., 2007). However, given inflation differentials between Botswana and its

trading partners, this led to frequent sizeable discrete adjustments (usually devaluations) by the Bank to offset the appreciation of the real effective exchange rate. On 30 May 2005, the Bank unexpectedly introduced a crawling peg exchange rate regime involving the continuous adjustment of the trade-weighted Nominal Effective Exchange Rate (NEER) of the Pula at a rate of crawl based on the differential between the Bank's inflation objective and the forecast inflation of trading partner countries (Bank of Botswana, 2008: 129). During this process, the Bank also devalued the Pula by 12.5 percent against the basket of currencies.

This policy change resulted in a sudden convergence towards a one-to-one exchange with the Rand. The Pula/Rand exchange rate depreciated from 0.74 in the months prior to May to 0.82 in June. The next few months saw a further gradual devaluation of the Pula/Rand exchange rate reaching 0.89 by April 2006. This outcome is illustrated in Fig. 1 that displays the monthly average of the daily Botswana Pula/South African Rand exchange rate and its log change over the period June 2004 to January 2009.

The second major event, in January 2008, was a change in Botswana's monetary policy framework. Prior to 2008, the Bank of Botswana specified an annual inflation objective to be achieved over the forthcoming year, whereas South Africa had implemented an inflation targeting regime with a 3–6 percent inflation band. Beginning in 2008 the Bank of Botswana shifted from setting an annual inflation objective to an inflation objective of 3–6 percent over a medium-term horizon (Bank of Botswana, 2008). Although Botswana did not adopt an inflation targeting regime, this new inflation band corresponded exactly to that of South Africa's inflation targeting regime. Further, forecast inflation in Botswana, as opposed to the growth of commercial bank credit, became the signal for policy action. This too corresponds with the target variable for South Africa's monetary policy framework.

The immediate effect, as shown in Fig. 2, was a closer and stronger co-movement in the central bank policy rates of Botswana and South Africa. The central bank rate of Botswana has exceeded that of South Africa in all periods, but the difference declined from an average of 3 percentage points over the 12 months prior to January 2008, to 1 percentage points in the subsequent 12 months. Table 1 presents additional measures of interest rates, namely the commercial bank rate and the Treasury bill rate. In both cases, the 12-month mean interest rate difference between South Africa and Botswana declined in the post-January 2008 period.

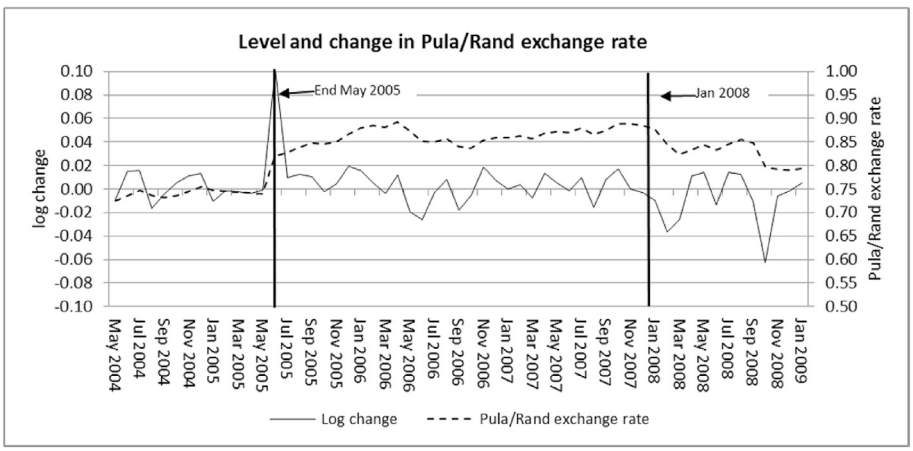
There has also been a convergence in the inflation rates between Botswana and the CMA countries (Fig. 3) associated with the implementation of new monetary policy framework. While inflation in rates had already converged by early 2007, what is noticeable is the coinciding of the downward turning point in inflation in both countries around July 2008. This contrasts starkly with the periods prior to 2007.

The synchronized movements of central bank rates between Botswana and South Africa suggest that from 2008, Botswana monetary policy became an approximation of a *de facto* single monetary policy operative throughout the CMA, which is in effect South Africa's monetary policy. Botswana's monetary policy thus converged towards that of the CMA.

3. Empirical method

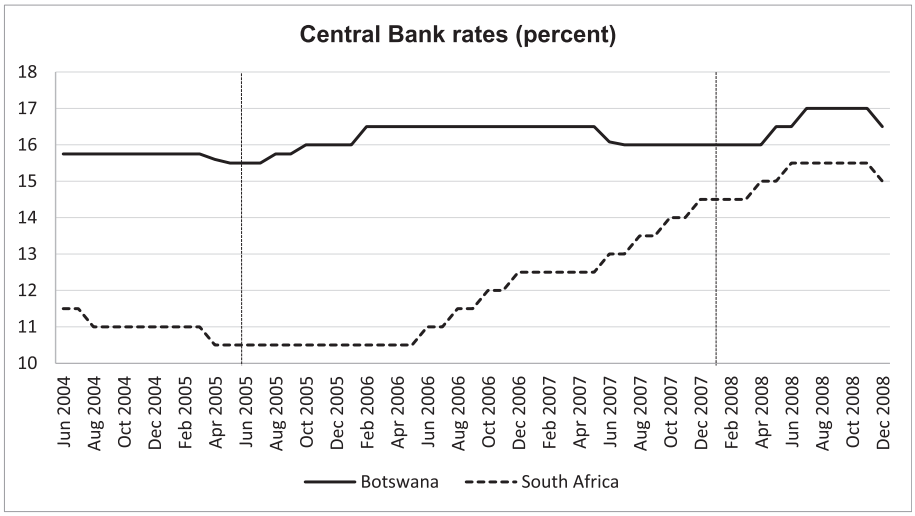
3.1. Conceptual framework

A challenge for studying the relationship between product market integration and monetary union is the establishment of a counterfactual for what would have occurred had the monetary union not occurred. Many studies use gravity models to provide the theoretical counterfactual from which to identify the effect of monetary unions on trade flows (Glick & Rose, 2002; Nitsch, 2002; Rose, 2000; Rose & van Wincoop, 2001) or product prices (Rose & Engel, 2002; Parsley & Wei, 2003; De Sousa & Lochard, 2005). One problem for these models is that the formation of the monetary union may itself be the outcome of unobserved similarities between the partner



Note: Own calculations using daily bilateral exchange rate data obtained from the South African Reserve Bank.

Fig. 1. Based on daily Pula/Rand exchange rate obtained from South Africa Reserve Bank (May2004-Jan2009). It displays the mean exchange rate on the right-hand sight and the coefficient of variation on the left-hand side. Note: Own calculations using daily bilateral exchange rate data obtained from the South African Reserve Bank.



Note: Monthly data on Central Bank lending rate obtained from the International Financial Statistics.

Fig. 2. Interest rates for CMA countries (June2004–Dec2008). The graph plots the annual averages of the central bank interest rates. Note: Monthly data on Central Bank lending rate obtained from the International Financial Statistics.

Table 1
Summary statistics of mean exchange rates, inflation and interest rates across countries, pre- and post-shocks (June 2004–Dec 2008).

Key variables	Period 1: Exchange rate shock		Period 2: Monetary policy shock	
	1 year pre-shock 2005	1 year post-shock 2005	1 year pre-shock 2008	1 year post-shock 2008
Exchange rates (Botswana-South Africa)				
Mean	0.74	0.86	0.89	0.83
Inflation rates				
Botswana	4.46	4.08	7.98	12.57
South Africa	2.29	3.37	7.08	11.53
Central bank rates				
Botswana	15.72	16.04	16.22	16.54
South Africa	11	10.50	13.17	16.13
Treasury bills rates				
Botswana	10	10.21	10.73	10.19
South Africa	7.29	6.74	9.12	10.81
Commercial bank rates				
Botswana	14.21	14.54	8.62	8.67
South Africa	6.23	6.27	7.15	8.61

Note: This table presents the summary statistics on mean the bilateral exchange rate, inflation rates and interest rates for South Africa and Botswana over 12 months before and after the exchange rate policy shock in 2005 and the monetary policy shock in 2008. The monthly data used was obtained from the International Financial Statistics database.

countries. Consequently, the coefficient on the monetary union dummy in these regressions is likely to be biased upwards in the case of trade flows and downwards in the case of price gaps. Further, member of the monetary unions are simultaneously members of customs unions implying that the monetary union coefficient also picks up the effect of the trade agreements.

Alternative studies attempt to control for these biases by estimating the pre-post effect around the date of formation of the monetary union on trade flows and prices (Cavallo, Neiman, & Rigobon, 2014; Engel and Rogers; 2004; Gil-Pareja & Sosvilla-Rivero, 2008; Goldberg & Verboven, 2005). However, the date of formation of a monetary union reflects the culmination of many macroeconomic convergence policies jointly implemented in preparation for the formation of the monetary union. Consequently, these studies still under-estimate the effect of the monetary union as many of the expected effects have already occurred by the date of formation. In addition, with the exception of Lutz (2004), Allington et al. (2005) and Martin and Mejean (2013), the effect of the monetary union is not generally evaluated relative to a control group that serves as a counterfactual from which to identify the impact.[2]

The innovation in this paper is to analyse the effect of monetary integration on product market integration between South Africa and Botswana using the monetary area of South Africa and Lesotho as a control or counterfactual. Further, by using the two policy shocks that mimic a shift towards a monetary union, namely Botswana's adoption of the crawling peg exchange rate and the subsequent

[2] Lutz (2004), Allington et al. (2005) and Martin and Mejean (2013) find that membership by advanced economies in a monetary union reduces price gaps between members relative to non-members, but they do not isolate the different channels (e.g. exchange rate, interest rate) through which this arises.

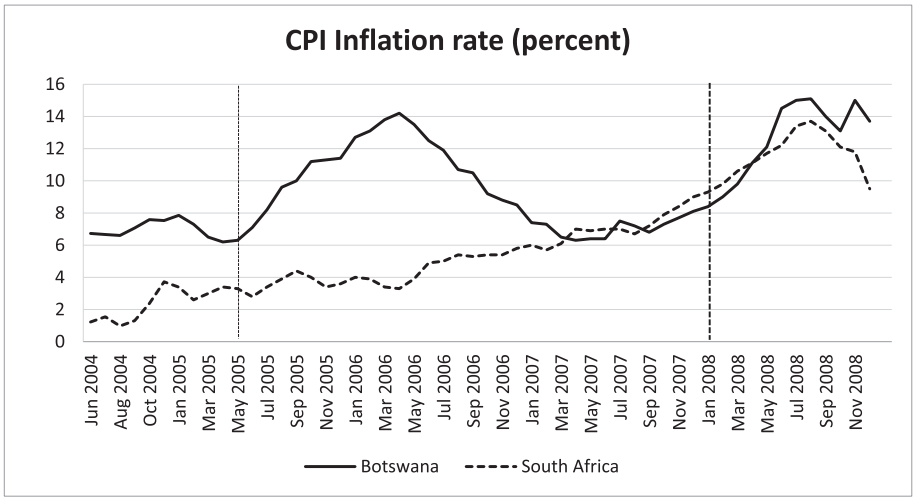


Fig. 3. Consumer price inflation for South Africa and Botswana (June 2004–December 2008). This graph plots the annual percentage changes in consumer price index for the two countries.

adoption of a new monetary policy framework, we are better able to isolate the various channels through which a monetary union affects product market integration. Finally, by using three countries that are already members of a long-standing customs union, our results are not tainted by tariff differences across countries, as is the case with the earlier gravity-based studies.

We measure product market integration using product prices at a disaggregate level. According to the Law of One Price (LOP), in competitive markets price gaps between regions will be arbitraged away until the difference is exactly equal to the trade costs. Within this framework, spatial price differentials can directly be used to measure trade costs, including border-effects associated with the trade of goods between countries.[3]

3.2. Data description and descriptive analysis

3.2.1. Data description

The core data used in the paper is a price database constructed from monthly product prices underlying the consumer price indices (CPI) of Lesotho, South Africa and Botswana, and collected by the statistical offices in the respective countries. The data is provided at the product level and varies across cities and across time (it is collected monthly). Each individual product has information on the date (month and year), city, product and unit codes, units of measurements and, in some cases, a brand name of that product.

To structure our analysis around the two policy shocks, we split the sample of monthly product prices into two periods: (i) June 2004 to May 2006 for the effect of the exchange rate policy change that took place at the end of May 2005, and (ii) January 2007 to December 2008 for the monetary policy change that took place in January 2008.

There are three important dimensions to the outcome variable of interest (price differences between cities). The first is the pair of cities (i and j) between which the price difference is calculated. The data for period 1 is comprised of 37 cities and towns across the three countries (7 from Lesotho, 11 from Botswana and 19 from South Africa). Period 2 comprises of 75 cities and towns (10 from Lesotho, 46 from Botswana and 19 from South Africa). Each period has different cities as statistical agencies, particularly Botswana, provided the data at different levels of aggregation in the different periods.

The second dimension over which price differences vary is at the product (k) level. We are able define a consistent set of 18 narrowly defined products that are common across the three countries.[4] The third dimension over which the outcome variable varies is time (t). The data consists of monthly observations for each product and city-pair.

3.2.2. Descriptive analysis

To analyse the degree of product market integration across the three countries, we calculate for each product and month the absolute value of the difference in log prices across city pairs in South Africa and Botswana (SA-BOTS) and South Africa and Lesotho (SA-LES). In Fig. 4 we present box plots using the average of this data over the two periods to illustrate price dispersion between Lesotho and South Africa and between South Africa and Botswana. The diagram highlights a wide dispersion in price gaps between cities in the different

[3] See Borazz et al. (2012), Anderson, Schaefer, and Smith (2013) and Atkin and Donaldson (2014) for more detailed discussions.
[4] Table A in the data appendix presents a list of the products in the sample.

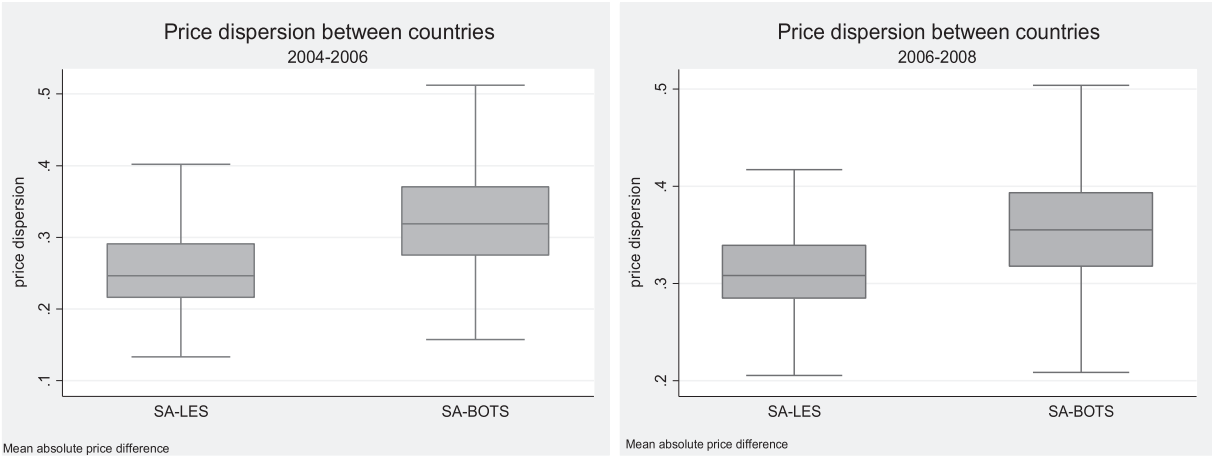


Fig. 4. Box plots for the individual product level price differences across city pairs over the two sub-periods. The diagram on the left-hand side presents box plots for the dependent variable (mean absolute log price difference) between the three countries during the period May2004–June2006 and the diagram on the right presents the box plots for the period January 2007–December 2008. BOTS denote Botswana, LES denotes Lesotho and SA denotes South Africa.[5]

Table 2
Summary statistics for price differences across countries (June2004-Dec2008).

Key variables	Period 1		Period 2	
	1 year pre- shock2005	1 year post-shock2005	1 year pre-shock2008	1 year post-shock2008
Price dispersion variables				
Mean absolute value				
SA-LESOTHO	0.253	0.271	0.316	0.308
SA-BOTSWANA	0.342	0.322	0.373	0.341
Standard deviation				
SA-LESOTHO	0.234	0.265	0.357	0.334
SA-BOTSWANA	0.312	0.333	0.348	0.295

countries. The price gaps tend to be larger for city-pairs between South Africa and Botswana than between South Africa and Lesotho, although there is substantial overlap. This holds for both periods.

Table 2 presents the mean and standard deviation of the log price differences (in absolute value) between South Africa and Lesotho and between South Africa and Botswana, over the 12 months before and after each policy shock. The mean price gap is larger between Botswana and South Africa than between Lesotho and South Africa in all sub-periods. The data also shows an increased integration of Botswana and South Africa relative to South Africa and Lesotho in response to both policy shocks. The mean deviation from LOP between Botswana and South Africa fell from 0.342 before the exchange rate shock in May 2005 to 0.322. In contrast, the mean deviation from LOP between Lesotho and South Africa rose from 0.253 to 0.271 over the two periods.

Note: This table presents the summary statistics on mean absolute values and standard deviation of absolute values of log price differences between South Africa and Lesotho and between South Africa and Botswana (the upper row), one year before and one year after the exchange rate policy shock in 2005 and monetary policy shock in 2008. We use monthly city-pairs at the product level.

Looking at the 2008 shock, while the mean deviation from LOP fell between Botswana and South Africa (0.373–0.341) as well as between Lesotho and South Africa (0.316–0.308), the change was stronger for the former. Both shocks led to closer integration of product markets between Botswana and South Africa compared to Lesotho and South Africa. A similar conclusion is drawn using the standard deviation of absolute price differences as presented in the last two rows of Table 2.[6]

On the face of it, this result provides evidence of the effectiveness of a monetary union in reducing price deviations between member countries. However, to test the robustness of this result, we need to control for distance and product, city and time specific effects. We do this in the next section.

[5] The upper and lower whiskers correspond to the maximum and minimum average price gaps respectively. The bottom and top of the boxes represent the first and third quantiles respectively while the bands represent the second quantile, which is the median. The y-axis corresponds to the mean absolute prices, across city pairs over the two sub-periods.

[6] This is calculated as the standard deviation across products, over time and city-pairs.

Table 3
Difference-in-difference regression results on price dispersion (June 2004–Dec 2008).

Dependent variable is the mean absolute log price difference	Policy change 1 (exchange rate)		Policy change 2 (inflation band)	
	(1)	(2)	(3)	(4)
Botswana-SA border effect, post-shock (D_{Bots}*D_{post})	−0.039***	−0.039***	−0.023***	−0.020***
	(0.005)	(0.006)	(0.004)	(0.004)
Constant and controls	Yes	No	Yes	No
Product*month dummies	No	Yes	No	Yes
Product dummies	Yes	No	Yes	No
City-pair dummies	Yes	Yes	Yes	Yes
Observations	81,508	81,508	382,296	382,296
Adj. R-squared	0.57	0.59	0.48	0.51

Notes: The first and third columns present the results based on regression specification (1) while the second and forth columns present the results for specification (2), for the sample June2004-May2006 and January2007-December2008 respectively. The dependent variable is computed at the product, month and city level. All regressions assume that; (i) there are common characteristics across time and across products respectively; (ii) the policy variable is strictly exogenous since policy assignment does not change in reaction to past outcomes on the dependent variable and; the errors are roughly uncorrelated. The controls in columns 1 and 3 include *Dpost*. The corresponding standard errors in parentheses are clustered at city-pair level. ***p < 0.01, **p < 0.05, *p < 0.1.

3.3. Empirical model specification

To precisely identify the impact of a monetary union on product market integration, we use the exchange rate and monetary policy shocks implemented by Botswana to identify how policy changes similar to those for the formation of a monetary union affect product market integration. We employ a difference-in-difference (DD) estimation technique, where Botswana is the treatment group, Lesotho is the control and the change in Botswana's policies is the treatment. The DD specification is as follows:

$$\left|p_{i,k,t} - p_{j,k,t}\right| = \eta_1 D_{Bots}{}^{*}D_{post} + \eta_2 D_{post} + \lambda_k + \lambda_{ij} + \varepsilon_{ij,k,t} \tag{1}$$

where:

- $\left|p_{i,k,t} - p_{j,k,t}\right|$ is the absolute value of the difference in log price of product *k*, measured in common currency (ZAR), for a given city-pair (*i* and *j*), in month *t*. Only South Africa-Botswana and South Africa-Lesotho city-pairs are included.
- D_{Bots} is a dummy variable equal to 1 if city *i* or *j* is located in Botswana.
- D_{post} is a dummy variable which takes the value of 1 for the period after the policy shock. [7]
- λ_k is a fixed effect for product *k*.
- λ_{ij} is a city-pair fixed effect for city *i* and *j*.

The dependent variable is a measure of the price gaps between cities across Botswana and South Africa and Lesotho and South Africa. The coefficient of interest is η_1 that captures the marginal effect of the policy shock on South Africa-Botswana price gaps (first difference), relative to the change in South Africa-Lesotho price gaps (second difference) captured by the coefficient, η_2. Our hypothesis is that $\eta_1 < 0$ reflecting a convergence in prices between South Africa and Botswana (relative to South Africa and Lesotho) in response to closer monetary integration. City-pair fixed effects (λ_{ij}) are included to control for transaction costs between city-pairs that is often correlated with distance (Atkin & Donaldson, 2014).

To account for possible heterogeneity across product and time-specific price trends that can affect the measurement of the price gaps, specification (1) is re-estimated with the interaction between product fixed effects and time fixed effects $\lambda_k{}^{*}\lambda_t$:

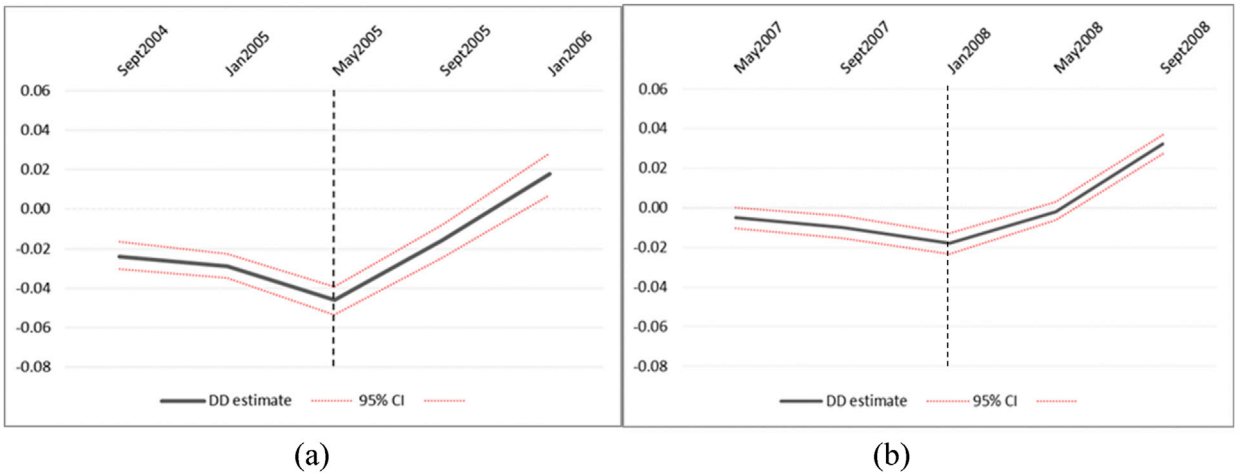
$$\left|p_{i,k,t} - p_{j,k,t}\right| = \eta_1 D_{SA-Bots}{}^{*}D_{post} + \lambda_k{}^{*}\lambda_t + \lambda_{ij} + \varepsilon_{ij,k,t} \tag{2}$$

We estimate the above specifications separately for the two different periods: June 2004 to May 2006 and January 2007 to December 2008. In each case, the policy shock occurs in the middle of the period ensuring a balanced 12-month interval pre- and post-the shock. We first estimate the relationship using monthly prices, but then test the robustness of the result using the annual average of the monthly prices as well as restricting the pre- and post-intervals to six months duration.

4. The impact of closer monetary union on retail prices

Table 3 presents the results of the two policy shocks. Our main interest is how the policy shock affected the Botswana-South Africa border effect relative to the change in the South Africa-Lesotho border effect. This result is given by the coefficient on the difference-in-difference interaction variable presented in the first row of the table. Looking at the first column, the results indicate a 3.9 percentage point decline in the Botswana-South Africa border effect (relative to the change in the South Africa-Lesotho border effect) in response to the end-May 2005 exchange rate policy shock.

[7] Note that the inclusion of month dummies results in this variable being dropped.



(a) (b)

Fig. 5. Line plots for the coefficient of the DD estimate for rolling window periods of 12 months with confidence intervals. Fig. 5(a) plots the DD estimate in the first period (June2004-May2006) and Fig. 5(b) plots the DD estimate in the second period (Jan2007-Dec2008).

This is an economically sizeable effect. The average price difference between South Africa and Botswana before the policy shock was 34.2%. The effect of the policy change on the SA-Botswana price gaps was thus equivalent to just below 10% of the prior price difference. Alternatively, prior to the policy change, mean price differences between South Africa and Botswana exceeded the mean price difference between South Africa and Lesotho by 8.9 percentage points (34.2–25.3, see Table 2). The policy shock was effective in reducing this by close to half.

The second column of Table 3 presents the effects associated with the change in monetary policy in January 2008. The results are similar to those estimated in period 1. The Botswana-South Africa border effect fell by 2.3 percentage points (column 1). These results suggest that both the adoption of the crawling peg exchange rate and the change in monetary policy framework by Botswana led to significant reductions in product price differences between South Africa and Botswana.

4.1. Robustness checks to the DD estimates: Pseudo treatment effects

The key assumption of the DD estimation is that in the absence of the treatment, the trends in the two groups of city-pairs would be the same. We therefore need to show that before the policy change (pre-treatment), trends in price differences were the same. One way to check the robustness of the DD estimate is to use a "pseudo" treatment analysis which considers the period of no treatment.

The pseudo treatment is a 'fake' policy shock that is imposed on the data to check if the true estimate presented in Table 3 is biased or not. We divide each period into several 'false' pre- and post-policy shock periods, each with a rolling window of six months where the 'false' shock occurs in the middle of the window period. We then re-estimate the difference-in-difference equation for each of these 'false' shock periods. Fig. 5 plots the coefficients of the DD estimates corresponding to the mid-period date in both periods. The expectation is that the largest impact will coincide with, or occur a few periods after, the actual policy shock. This will be the case even if price differences were declining throughout the entire period of analysis.

From Fig. 5(a), we see a drop in the DD estimate that coincides with the implementation of the policy providing support for our argument that it was the exchange rate policy change that led to a convergence in prices across South Africa and Botswana.

Similarly, Fig. 5(b) also displays the expected drop that coincides with the implementation of the policy, signifying that the effect of the monetary policy change led to a decline in price gaps between South Africa and Botswana in January 2008. The pseudo treatment analysis therefore provides further evidence in support of the argument that it was the policy shocks that led to greater product market integration as opposed to other shocks occurring during that period.

5. Further extensions

In this section, we test the robustness of the results to changes in the sample of product types, reduced time dimension and an alternative measure of product market integration, namely the standard deviation of log price differences.

5.1. Sensitivity analysis to sample of products

Despite our careful selection of a narrow range of comparable products and the inclusion of product fixed effects, there may nevertheless be important changes in the quality of the product purchased within each of the countries that could bias the results. For example, the devaluation of the Botswana Pula in May 2005 and the relatively sharp decrease in the Botswana Bank rate after January 2008 altered the purchasing power of consumers in Botswana relative to South Africa and Lesotho. To the extent that this altered

Table 4
Difference-in-difference regression results for different product samples (June2004-Dec2008).

Dependent variable is the mean absolute log price difference	South Africa branded goods		Perishable goods		Non-Perishable goods	
	Policy change 1	Policy change 2	Policy change 1	Policy change 2	Policy change 1	Policy change 2
	(1)	(2)	(3)	(4)	(5)	(6)
Botswana-SA border effect, post-shock	−0.053***	−0.033***	−0.084***	−0.053***	−0.066***	0.036***
	(0.004)	(0.003)	(0.008)	(0.006)	(0.004)	(0.003)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Product*month dummies	Yes	Yes	Yes	Yes	Yes	Yes
City-pair dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	67,647	315,493	12,549	71,066	43,268	166,651
Adj. R-squared	0.52	0.57	0.31	0.33	0.65	0.64

Notes: The results present the specification defined in equation (2) using samples in both periods. The first two columns in both samples present the results for branded products sourced from South Africa. Columns 3 and 4 present the results for perishable products while columns 5 and 6 present the results for non-perishable products. The dependent variable is computed at the product, month and city level. All regressions assume that; (i) there are common characteristics across time and across products respectively; (ii) the policy variable is strictly exogenous since policy assignment does not change in reaction to past outcomes on the dependent variable and; the errors are roughly uncorrelated. The corresponding standard errors in parentheses are clustered at city-pair level. ***p < 0.01, **p < 0.05, *p < 0.1.

consumers' relative choice of varieties, even within the narrowly defined product categories, the price changes associated with change in composition of varieties consumed will be erroneously attributed to the change in the border-effect associated with the policy shock.

To deal with this concern, we re-estimate the regressions for three different samples of products. Firstly, we select a narrower sample of 14 branded products sourced from South Africa.[8] These are identified in terms of brand names, product names and units of measurement. This sample includes mostly food products such as 700 ml All Gold tomato sauce, 750 ml (JIK) bleach, 340 ml Coca Cola, 500 g Kellogg's corn flakes, 420 g Koo canned peas, 750 ml JC Leroux white sparkling wine. Secondly, we split the sample of products into perishable and non-perishable goods. Prices of perishable products tend to be more volatile than non-perishable and may be more strongly influenced by border delays and exchange rate volatility than non-perishables (Versailles, 2012).[9] The estimate results for the various categories of products are presented in Table 4.

Looking first at branded goods sourced from South Africa, the effects of the two policy shocks are quantitatively larger than for the full sample of products. In response to the first policy shock, the border effect between Botswana and South Africa declines by 5.3 percentage points. In response to the second shock it declines by 3.3 percentage points. However, looking at the standard errors, the effect is not significantly statistically different from that when using the full sample (Table 3), despite the precision of the estimates.

Columns 3 to 4 of Table 4 present the results for perishable goods, while columns 5 and 6 present the results for non-perishables. The DD estimates show that the impact of monetary policy integration on average price differences between Botswana and South Africa is relatively stronger on perishable products than on non-perishable products in both periods, the difference is statistically significant. The results suggest that perishable goods may be more sensitive to exchange rate changes, which may explain some of the relatively high price volatility of these goods (Versailles, 2012). With this exception, the aggregate results appear to consistently hold across most product groupings. The effects of closer integration are thus experienced across a wide range of product categories.

5.2. Sensitivity analysis to reduced time dimension

The prior results are estimated using monthly data. While monthly data allows us to better control for the dynamics of adjustment, one concern is that this artificially multiplies the data points in the estimation. To test the robustness of the results to changes in the time dimension, we follow two approaches, the results of which are presented in Table 5.

Firstly, we aggregate the monthly data to the annual average for the period before and after the shocks (columns 1 and 3). The dependent variable thus has only one observation per product per city-pair pre and post shock. Secondly, we use the six-month average price before and after each policy shock (columns 2 and 4).

The DD estimates remain significant and of similar size to the estimates when using monthly data. Interestingly, there is no consistent trend in the size of the coefficient as one shift from the 6-month average to the full period average indicating that much of the effect of these policy shocks takes place within the first 6 months.

5.3. Sensitivity analysis to alternative measures of product market integration

Finally, we subject the data to an alternative approach to evaluating product market integration, namely whether there has been convergence towards a common set of internal relative prices (Knetter & Slaughter, 2001). This approach differs from that above in that product market integration is not measured by the mean absolute deviation in prices across cities, but is measured as the standard deviation across products k of city-pair log price differences $sdq_{ij,t} = sd_k(p_{i,k,t} - p_{j,k,t})$.

Conceptually, this approach looks at the extent to which the price of good w relative to good z (e.g. the price of peanut butter relative

[8] See Table A in the appendix of data article titled "Comparative retail price database for Botswana, Lesotho and South Africa" for the full list of these products.
[9] Table A also distinguishes between perishable and non-perishable products.

Table 5
Difference-in-difference regression results with reduced time dimension (2004–2008).

Dependent variable is the mean absolute log price difference	Policy change 1		Policy change 2	
	(1)	(2)	(1)	(2)
Botswana-SA border effect, post-shock	−0.039***	−0.037***	−0.042***	−0.033***
	(0.004)	(0.004)	(0.002)	(0.002)
Constant	Yes	Yes	Yes	Yes
Product*period dummies	(0.005)	Yes	Yes	Yes
City-pair dummies	Yes	Yes	Yes	Yes
Observations	17,197	16,964	156,547	152,642
Adj. R-squared	0.65	0.64	0.48	0.47

Notes: The results present the specification defined in equation (2) using samples in both periods. The first columns of each sample present the results where the data is averaged by the whole period (annual average) before and after the introduction of the shock. In second columns, the data is averaged by six-month intervals before and six months after the shock. The dependent variable is computed at the product, month and city level. All regressions assume that; (i) there are common characteristics across time and across products respectively; (ii) the policy variable is strictly exogenous since policy assignment does not change in reaction to past outcomes on the dependent variable and; the errors are roughly uncorrelated. The corresponding standard errors in parentheses are clustered at city-pair level. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 6
Difference-in-difference regression results on relative price dispersion (May2004-Dec2008).

Dependent variable is the mean absolute log price difference	Policy change 1	Policy change 1
	(1)	(2)
Botswana-SA border effect, post-shock	−0.032**	−0.035***
	(0.007)	(0.006)
Constant	Yes	Yes
Month dummies	Yes	Yes
City-pair dummies	Yes	Yes
Observations	13,325	51,024
Adj. R-squared	0.44	0.38

Notes: The results present the specification defined in equation (2) using samples in both periods. The dependent variable is computed at the month and city level. Both regressions assume that; (i) there are common characteristics across time; (ii) the policy variable is strictly exogenous since policy assignment does not change in reaction to past outcomes on the dependent variable and; the errors are roughly uncorrelated. The corresponding standard errors in parentheses are clustered at city-pair level. ***p < 0.01, **p < 0.05, *p < 0.1.

to the price of sugar) differs in city *i* from city *j*. The more similar are relative prices across products in city *i* and *j*, the lower is the standard deviation indicator. Closer integration is expected to both reduce the mean absolute price gap between countries, as well as the relative price gap. The latter would particularly occur if barriers to trade affect product prices differently.[10] The approach is at times referred as *relative* price integration and has been applied to a sample of African countries by Edwards and Rankin (2016).

The results presented in Table 6 confirm the findings using the mean absolute price difference: not only did the mean price gap decline in response to the two policy shocks, but the structure of relative prices across products also converged between cities in Botswana and South Africa (relative to between cities in South Africa and Lesotho) in response to the shocks. For example, the results show that the (across product) standard deviation of relative prices between city-pairs in South Africa and Botswana fell by 3.2 percentage points and 3.5 percentage points in response to the policy shocks in period 1 and period 2, respectively.

6. Conclusion

This study examines the impact of a closer monetary union on the integration of product markets across countries. It uses unique retail price data for 18 narrowly defined products that vary by region and month in Botswana, South Africa and Lesotho. These countries are all member of a customs union (SACU), but only South Africa and Lesotho are members of a monetary area. We exploit two policy shocks implemented by Botswana authorities that mimic a shift towards a monetary union, namely a change in exchange rate policy and a subsequent change in monetary policy. We use these shocks to identify the effect, through difference-in-difference estimation, that they have on price gaps between Botswana and South Africa, relative to price gaps between South Africa and Lesotho.

Our results reveal that the adoption by Botswana of a crawling peg exchange policy that led to a convergence and stabilization of the Pula/Rand exchange rate reduced the South Africa-Botswana average price gaps by 3.9 percentage points (approximately 9 percent of the initial price gap). We also find that the subsequent change in the Botswana monetary policy regime in January 2008 that targets the same 3–6 percent inflation band as South Africa led to a further reduction in the border-effect of 2.3 percentage points (5 percent of the

[10] For example, assume that barriers to integration between South Africa and Botswana raise prices of peanut butter in Botswana by 20% and sugar by 10%. The elimination of these barriers will result in a decrease in the absolute price difference between Botswana and South Africa, as well as the difference in the relative price of peanut butter to sugar. It is possible that the two policy shocks reduce (but not eliminate) the price gaps for both products proportionately, in which case there will be no change in the relative price of peanut butter to sugar.

initial price gap).

These results are shown to be robust to different specifications, such as the use of pseudo-treatments, restricting the data to shorter time periods and changes in the sample of products. An alternative indicator of product market integration that measures the convergence in the across product structure of relative prices between cities provides supporting results.

Taken together, these results suggest that the alignment of interest rate and exchange rate policies can be effective mechanisms to enhance the integration of product markets between countries. These alone, however, are not sufficient, the descriptive analysis reveals that price gaps between South Africa and Lesotho remain high (25–32 percent) despite their joint membership in a customs union and monetary area. Other complementary policies to reduce restrictions on the flow of goods between countries are required to fully integrate these product markets.

Acknowledgements

We thank participants of the Midwest International Trade Conference in Ohio State University, United States, the SALDRU seminar at the University of Cape Town and two anonymous referees for their valuable comments. This work was supported by the Private Enterprise Development in Low-Income Countries (PEDL) Exploratory Research Grant (grant number 223) provided by the research initiative of the Centre for Economic Policy Research (CEPR); the Carnegie foundation New York; and the African Economic Research Consortium (AERC). All views expressed in this article are those of the authors and do not necessarily represent the views of, and should not be attributed to, the funders.

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