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Inflation Uncertainty and Relative Price Variability in WAEMU Countries

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Abstract

Using a consistent dataset and methodology for all eight member countries of the West African Economic and Monetary Union (WAEMU) from 1994 to 2009, this paper provides evidence of the two major channels for real effects of inflation: inflation uncertainty and relative price variability. In line with theory and most evidence for advanced and emerging market economies, higher inflation increases inflation uncertainty and relative price variability in all WAEMU countries. However, the pattern, magnitude and timing of these two channels vary considerably by country. The findings raise several policy issues for future research.

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I. INTRODUCTION

Economists and policymakers need a clear understanding of the major channels through which inflation may affect the real economy, if they aim to minimize the adverse economic consequences and welfare costs of increases in the price level. Two well known channels come from the effects that higher inflation has on inflation uncertainty and relative price variability (RPV). Theoretically, the first arises from the public's perception of erratic policy responses by the monetary authority to price level changes (Ball, 1992). In contrast, the second originates from the existence of menu costs (Sheshinsky & Weiss, 1977 or Rotemberg, 1983) or incomplete information (Lucas, 1973 or Barro, 1976). Both reduce the efficiency of market prices as a coordinator of economic activity (Friedman, 1977) and negatively affect investment (Caballero, 1991). As shown by a large literature,[2] these effects ultimately lead to a growth-dampening resource misallocation, even where inflation is low.

Several studies present empirical evidence of inflation's significant impact on inflation uncertainty and RPV.[3, 4] This finding may pose a special challenge to monetary unions where a single monetary policy deprives countries of the flexibility to respond to their own needs. In particular, although a common monetary policy may be instrumental in reducing inflation and

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[2] Karanasos and Kim (2005) survey the early empirical literature on the real impact of inflation uncertainty. Newer evidence comes from, e.g., Chang and He (2010), Conrad and Karanasos (2008), and Grier et al. (2004) on the US; Fountas and Karanasos (2007) on the G7; Apergis (2005) on OECD countries; Wilson (2006) on Japan; Samimi and Shahryar (2009) on Iran; and Grier and Grier (2006) on Mexico. Moreover, empirical work on the real impact of RPV peaked in the 1980/90s (see, e.g., Blejer & Leiderman 1980, Golob 1993; and Sauer & Bohara, 1995) and was recently revived by, e.g., Nautz and Scharff (2005) on Germany and Catik, Martin, and Őnder. (2008) on Turkey. Both channels for the real effects of inflation have been predominant in recent macroeconomics, particularly in New Keynesian dynamic stochastic general equilibrium (DSGE) models.

3 While Davis and Kanago (2000) survey the early evidence on the impact of inflation on inflation uncertainty, for more recent studies on advanced countries, see, e.g., Caporale, Onorante, and Paesani (2009) or Fountas, Ioannidis, and Karanasos (2004) on the euro area; Cogley, Primiceri, and Sargent (2010), William and Vijverberg (2009), or Benati and Surico (2008) on the US; Conrad and Karanasos (2005) on the US, the UK, and Japan; Binetti [Binette in the refs.; please check] and Martel (2005) on Canada; and Berument and Dincer (2005) or Bhar and Hamori (2004) on G7 countries. For emerging market countries, see, e.g., Thornton (2007a) or Daal,.Naka, and Sanchez. (2005); Keskek and Orhan (2008) on Turkey; Thornton (2007b) on Argentina; or Gomes (2007) on Brazil. Finally, for developing countries, see, e.g., Payne (2008) on Caribbean countries; Rizvi, Abbas, and Naqvi (2008) on Pakistan; Entezarkheir (2006) on Iran; or Thornton (2006) on South Africa.

4 For recent studies on the impact of inflation on RPV for the US, see, e.g., Choi (2010) (who also covers Japan), Bick and Nautz (2008), Fielding and Mizen (2008), Lastrapes (2006), Nath (2004), Chang and Cheng (2002), or Jaramillo (1999). For European countries, see e.g. Konieczny and Skrzypacz (2005), Nautz and Scharff (2005), Fielding and Mizen (2002), Silver and Ioannidis (2001) or Wozniak (1998). Threshold effects are added in, e.g., Nautz and Scharff (2007) for the euro area, Caraballo, Dabus, and Usabiaga. (2006) for Spain and Argentina, and Caglayan and Filiztekin (2003) for Turkey.

its first-round (or direct) effects on the real economy across all countries, it may not be sufficient to dampen second-round (or indirect) real effects arising from higher inflation uncertainty and RPV. This is especially true if the transmission mechanism from inflation to both variables is not homogeneous across all countries.

This paper therefore extends the empirical literature to the eight member countries of the WAEMU area: Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo. We use a unique consistently defined dataset (from the establishment of the WAEMU in January 1994 through December 2009) and common methodology, which allows us to check potential heterogeneous effects across countries of inflation on inflation uncertainty and RPV. Following recent empirical studies, we first derive a measure of inflation uncertainty from a GARCH model of inflation (accounting also for lagged, seasonal, regional, and global effects) and study the nexus between inflation and inflation uncertainty in a bi-variate VAR context. We then construct a measure of RPV from the harmonized consumer price index (HCPI), which we use to examine the nexus between inflation and RPV in a variety of empirical models.

Overall, we find strong statistical evidence for both transmission channels of inflation in WAEMU countries: inflation raises not only inflation uncertainty, but also RPV. However, the pattern, magnitude, and timing of both transmission channels vary substantially by country.[5] This result is plausible considering the persistent and sizeable structural differences in the economies, insufficient macroeconomic convergence, and uneven (bilateral, regional, and global) integration.

Our results have some important policy implications. Above all, they point to the benefits of keeping inflation low, stable, and predictable. For this purpose, as inflation shocks are highly correlated across countries, a common monetary policy is a sensible instrument to keep inflation under control in the whole region. However, as second-round effects of inflation on output are likely to be different across countries, enhance macroeconomic convergence, closer integration, more domestic policy coordination, and adequate use of national monetary policy instruments

5 Such heterogeneities are found in similar studies of countries in the euro zone (see e.g. Caporale and Kontonikas (2009) or Berument et al. (2005) on inflation uncertainty or Silver and Ioannidis (2001) on RPV.

may help homogenize the transmission mechanisms of inflation. Other proposals mainly pertain to the central bank's information and communication policy.

In what follows, based on background information on the WAEMU given in Section II, Section III analyzes recent regional inflation. Section IV describes the empirical analysis and presents the results. From these, Section V deduces some policy implications, and Section VI draws conclusions.

II. Background

A. The West African Economic and Monetary Union

The West African Economic and Monetary Union (WAEMU) was created as a custom and monetary union in January 1994 by Benin (BEN), Burkina Faso (BFA), Côte d'Ivoire (CIV), Mali (MLI), Niger (NER), Senegal (SEN), and Togo (TGO). Initially, it was established in response to the sharp devaluation of their common currency, the CFA Franc (CFAF).[6] Guinea-Bissau (GNB) joined in May 1997.

WAEMU member countries are quite heterogeneous in both size and economic structure (see Table 1). Côte d'Ivoire dominates the WAEMU, accounting for more than 34 percent of its GDP and 23 percent of its population. Senegal is second in terms of GDP, while Burkina Faso is second in terms of population. In both aspects, Guinea-Bissau is the smallest member. The WAEMU includes both semi-industrialized economies with a high share of manufacturing and industry value-added (Côte d'Ivoire and Senegal) and some of the world's poorest economies with a high share of agriculture value-added (especially Guinea-Bissau, Togo, and Niger). In terms of trade openness, the range is from a low 35 percent of GDP in Burkina Faso to 89 percent in Togo.

6 The CFAF was created in 1945 as a colonial currency and retained after independence with a peg of 100:1 against the French Franc. In the 1980s, many CFAF countries suffered persistent balance of payments deficits and registered high public and private borrowing from the central bank. In 1994 after a 50 percent devaluation and reform of the rules on central bank lending, the CFAF was pegged against the euro at 10:0.152449.

Table 1. Characteristics of WAEMU Countries in 2009

Country	Nominal GDP		Population		Per capita	Value added (% of GDP) 1/			Trade
	bil. US$	*%-share*	mio.	*%-share*	GDP (US$)	agriculture	manufacturing	industry	openness
WAEMU	**67.0**	***100.0***	**93.4**	***100.0***	**628.7**	**35.0**	**23.0**	**15.8**	**63.5**
Benin	6.4	*9.6*	8.4	*9.0*	765.0	32.2	7.5	13.4	41.2
Burkina Faso	7.8	*11.6*	14.4	*15.4*	541.6	33.3	14.6	22.7	35.2
Côte d'Ivoire	22.9	*34.2*	21.4	*22.9*	1071.3	22.8	19.3	25.9	77.2
Guinea-Bissau	0.4	*0.7*	1.8	*1.9*	244.0	54.9	11.4	14.3	80.5
Mali	8.8	*13.1*	13.7	*14.6*	640.8	36.6	3.2	24.2	58.3
Niger	5.3	*7.9*	14.2	*15.2*	375.1	40.0	6.4	17.3	60.9
Senegal	12.6	*18.8*	12.8	*13.7*	983.7	16.7	15.2	23.8	66.2
Togo	2.8	*4.1*	6.8	*7.3*	407.9	43.7	10.1	24.0	88.8

Note: 1/ Data from 2005 (except from 2003 for Benin), provided by World Bank.
Source: IMF's WEO.

B. The Central Bank

The common central bank for WAEMU members is the Banque Centrale des Etats de l'Afrique de l'Ouest (BCEAO). Its monetary policy goal is to maintain price stability (defined as inflation at or below 2 percent) and an appropriate level of foreign reserves (the pooled foreign exchange reserves of the member states). The French treasury, which holds at least 65 percent of WAEMU reserves, guarantees the convertibility of the CFAF into Euros but has rules limiting CFA government borrowing.

Conceptually, monetary policy in the WAEMU is thus more constrained by rules limiting domestic credit creation (even if they are sometimes lax) than by the need to maintain the exchange rate peg. More importantly, capital controls open up room for autonomous monetary policy and the BCEAO actively exploits this benefit by responding to changes in prices or output in the region.[7] Yet, because of the substantial macroeconomic differences among its members, the challenge for the BCEAO is that no single monetary policy may be suitable for all

[7] According to the *Impossible Trinity*, a country can only implement two out of the three following policy goals: a fixed exchange rate, monetary independence, and open capital markets. Acknowledging the classic trilemma, the WAEMU restricts capital mobility to gain some monetary independence while keeping a fixed exchange rate. Thus, in the WAEMU the path of neither inflation nor interest rates mirrors what is happening in the euro zone in the short run. Shortland and Stasavage (2004a, 2004b) confirm this by showing that the BCEAO retains the freedom to react to domestic economic variables (above all inflation, output gap, foreign exchange position, and government borrowing). Veyrune (2007) further confirms the BCEAO's autonomous monetary stance by failing to detect a link between foreign reserves and base money supply.

its members at once.[8] The benefits, especially in terms of price stability and trade integration, also carry substantial costs because there is little macroeconomic convergence among members.[9]

III. Data

After presenting the data sources, we will review the regional and domestic inflation experience, analyzing especially global, regional and cross-country inflation shock interdependencies.

A. Data Sources

To investigate the link between inflation and inflation uncertainty, we use WAEMU countries' monthly domestic consumer price index (CPI), taken from the IMF's International Financial Statistics (IFS). CPI data generally has been available since January 1981, but only since February 1986 for Guinea-Bissau, July 1987 for Mali, and January 1991 for Benin.

On the other hand, to scrutinize the link between inflation and RPV, we employ WAEMU countries' monthly price data and weights for the various subcategories of a cross-country comparable harmonized consumer price index (HCPI). Provided by member country authorities, the HCPIs are generally available from January 1997 (but only since December 1997 for Niger and Togo, January 1998 for Senegal, and July 2002 for Guinea-Bissau). Recorded prices for each country are for 12 product groups, which have different weights (see Table 2). Food items are the dominant component in all countries' HCPI, ranging from 32.1 percent in Burkina Faso to 59.7 percent in Guinea-Bissau.

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[8] At the regional level, the BCEAO uses a mix of policy instruments (money market operations in the form of tenders for repo operations and standing refinance facilities, including discount operations for liquidity provision up to 360 days and repo operations for liquidity provision up to 30 days). Also, for each member the BCEAO can set different reserve requirements.

[9] Indeed, convergence is limited in both nominal and real terms. Bamba (2004) reviews the mixed performance in terms of the nominal criteria fixed in the 1999 regional Convergence, Stability, Growth and Solidarity Pact: (i) fiscal balance zero of in surplus; (ii) public debt/ GDP close to 60 percent; (iii) nonaccumulation of payment arrears; (iv) inflation rate of 3 percent or lower; (iv) wage bill/tax revenue of at most 35 percent; (v) domestically financed investment/tax revenue of at least 20 percent; (vi) external current account deficit/GDP of at most 5

(continued…)

Table 2. Subcategories and Weights in WAEMU Countries' HCPI

(Percent as of 2009)

HCPI Subcategory		*WAEMU average*	Countries: BEN	BFA	CIV	GNB	MLI	NER	SEN	TGO
(i)	Food and non-alcoholic beverages	*41.4*	38.2	32.1	32.2	59.7	48.3	43.6	40.3	36.7
(ii)	Alcoholic beverages and tobacco	*1.3*	0.8	1.8	0.0	1.8	1.7	1.6	1.2	1.3
(iii)	Clothing and footwear	*7.1*	6.9	6.4	7.4	7.6	5.3	5.8	11.4	6.0
(iv)	Housing, water, electricity, gas and other fuels	*12.8*	9.5	10.5	13.9	13.6	11.7	13.9	16.9	12.4
(v)	Furniture and household appliances	*6.2*	5.9	6.7	5.7	4.4	7.0	7.7	6.6	5.6
(vi)	Health	*3.1*	4.3	4.2	4.6	2.3	2.0	1.7	1.9	4.0
(vii)	Transport	*10.1*	10.1	15.6	9.6	5.6	10.9	12.1	8.3	8.5
(viii)	Communications	*1.0*	1.4	1.1	0.0	1.0	1.0	0.9	2.1	0.9
(ix)	Recreation and culture	*3.6*	3.8	4.9	4.2	1.9	4.2	2.6	4.0	3.2
(x)	Education	*1.7*	2.0	2.4	3.0	0.7	1.3	1.1	1.4	1.8
(xi)	Resaurants and hotels	*6.7*	9.8	10.0	12.3	0.5	2.0	4.8	1.7	12.9
(xii)	Other goods and services	*5.0*	7.2	4.4	7.1	1.0	4.6	4.4	4.4	6.7

Source: Respective country authorities.

B. Recent Inflation Experience

In recent decades, regional and domestic inflation in the WAEMU has been lower, less volatile and more aligned than in most other developing countries, especially those in Latin America.

Regional Inflation

Whether based on a simple or a weighted aggregation of member domestic inflation rates, the regional WAEMU inflation rate has recently become lower and less volatile except during two events: the devaluation of the CFAF by 50 percent in 1994 and the fuel and food price crisis in 2008 (see Figure 1). Guinea-Bissau, however, had trouble controlling monetary developments until having adopted the CFAF franc in May 1997. Another burst on inflation in this country occurred during the civil war in 1998-99.

percent; and (vii) tax revenue/GDP of at least 17 percent. Likewise, Fielding, Lee, and Shields. (2004) find that although price asymmetries slowly smooth out in WAEMU countries, output asymmetries persist indefinitely.

Figure 1. WAEMU Regional Twelve-Month Inflation Rates, 1980-2009

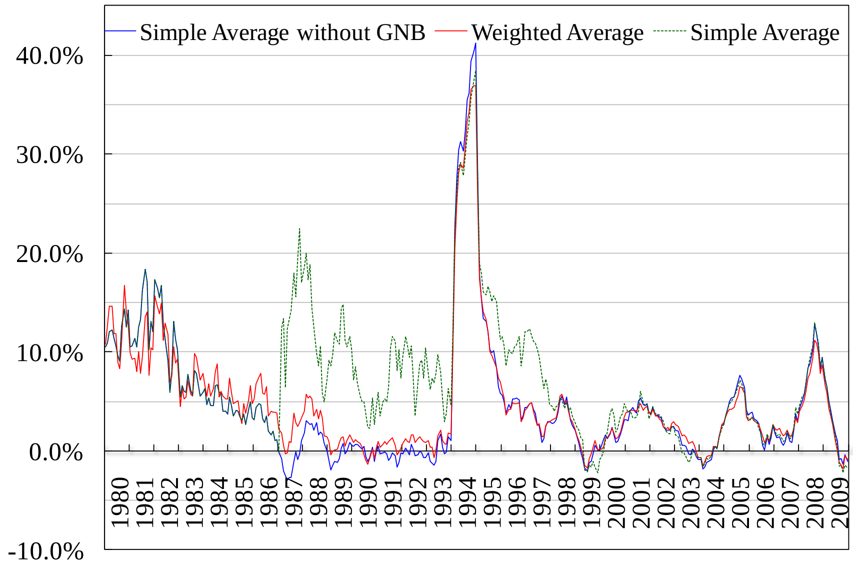

Table 3. Statistics Describing the WAEMU Regional Inflation Rate

(Percent based on the 12-month simple average)

	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09
WAEMU						
Mean	9.73	1.42	11.42	8.01	1.95	3.93
Standard deviation	3.94	2.23	9.88	6.27	2.03	3.45
Median	10.24	1.68	7.61	8.58	2.13	3.33
WAEMU without GNB						
Mean	9.73	1.42	6.18	4.77	1.85	3.95
Standard deviation	3.94	2.23	13.30	5.15	1.85	3.36
Median	10.24	1.68	0.01	4.08	2.01	3.55

The statistics for the 12 -month average inflation rate using five-year periods confirm the graphic picture in Figure 1 (see Table 3). After dropping from almost 20 percent in the early 1980s, average inflation (without Guinea-Bissau) remained benign except during the two events mentioned. This is true for the simple as well as the weighted average (using 2009 GDPs taken from the IMF's *World Economic Outlook*). Moreover, inflation volatility (measured by the standard deviation) was lowest when average inflation remained low. Including Guinea-Bissau does not change the main conclusions.

Domestic Inflation

Domestic inflation rates have become quite synchronized since the WAEMU began in 1994, including Guinea-Bissau's since its WAEMU accession in 1997 (see Figure 2). There is increasing convergence of WAEMU countries' mean and median (see Table 4). Inflation has also become less volatile, as reflected in the lower standard deviation of inflation in recent years.

Figure 2. WAEMU Member Domestic 12-Month Inflation, 1991-2009

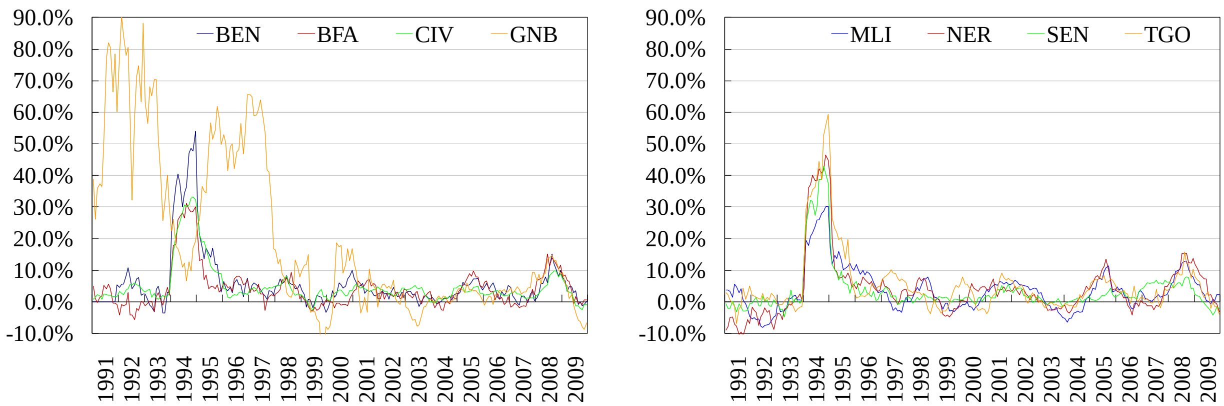

Table 4: Descriptive Statistics of Domestic and Regional Year-on-Year Inflation Rates

(In percent)

	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09
Benin 1/						
Mean	…	…	14.73	5.88	2.62	4.19
Standard deviation	…	…	17.83	5.84	2.33	3.43
Median	…	…	5.55	4.97	2.37	4.18
Burkina Faso						
Mean	9.09	1.13	5.09	4.05	1.71	4.40
Standard deviation	6.15	5.01	10.71	4.25	2.38	4.56
Median	9.18	0.45	0.50	4.02	1.47	3.79
Côte d'Ivoire						
Mean	8.29	5.32	6.67	5.34	2.93	3.15
Standard deviation	5.05	4.01	10.46	5.71	1.52	2.68
Median	7.65	5.35	2.23	3.92	3.31	2.75
Guinea-Bissau 2/						
Mean	…	81.15	45.67	30.67	2.69	3.79
Standard deviation	…	23.52	24.15	25.09	6.65	5.06
Median	…	80.54	39.09	35.70	1.16	3.57
Mali 3/						
Mean	…	1.93	3.86	4.56	1.03	4.18
Standard deviation	…	4.12	10.73	5.66	3.87	3.88
Median	…	0.47	0.61	3.27	0.96	3.13
Niger						
Mean	10.35	-2.96	4.37	4.38	1.65	4.75
Standard deviation	10.70	3.81	17.03	6.27	2.73	5.43
Median	10.21	-3.01	-2.19	4.02	2.08	4.47
Senegal						
Mean	11.10	2.80	6.03	2.91	1.31	2.89
Standard deviation	4.89	6.75	13.78	3.55	1.63	2.95
Median	11.26	0.75	-0.02	1.60	1.13	2.67
Togo						
Mean	9.85	0.31	8.22	6.28	1.70	4.10
Standard deviation	8.35	3.15	16.71	8.66	3.36	3.98
Median	11.09	0.44	0.97	3.98	1.11	3.90
WAEMU 4/						
Mean	9.39	3.36	6.38	4.81	2.05	3.65
Standard deviation	3.22	2.21	12.00	4.85	1.66	2.95
Median	9.15	3.58	0.93	3.99	2.12	2.96
WAEMU without GNB 4/						
Mean	9.39	2.99	6.11	4.64	2.05	3.65
Standard deviation	3.22	2.42	12.18	4.84	1.66	2.94
Median	9.15	3.20	0.62	3.66	2.14	2.97

1/ Sample starts in 1991:12. 2/ Sample starts in 1987:02. 3/ Sample starts in 1988:07. 4/ Regional inflation calculated as weighted average.

Interdependence of Inflation Rates

Next, we investigate the dynamic interdependence of national price levels in WAEMU countries. With fixed exchange rates, as in common currency areas, price shocks in one country are likely to be transmitted to other countries.[10] Trade linkages, which were stimulated in the WAEMU area by the establishment of the free trade area, are also important in transmitting price shocks.[11] Thus, this part of the paper tries to answer the following question: how much of a country's domestic inflation dynamics can be attributable to foreign-originating inflation? With this aim, shocks to inflation in a given country are classified into global, regional and country-specific. Global shocks affect economies both inside and outside the regional boundary, while regional shocks are common only to the economies within the region. Country specific shocks (also called domestic shocks or local shocks) are unique to the individual economy.[12]

Consider a three-variable model with global, regional and local price levels: p^g, p^r, and p^d. They are subject to three types of inflation shocks u^g, u^r and u^d): global (affecting economies both inside and outside the region); regional (common to all economies within the region); and domestic (unique to a single economy):[13]

$$\begin{pmatrix} \Delta p_t^g \\ \Delta p_t^r \\ \Delta p_t^d \end{pmatrix} = \begin{pmatrix} A_{11}(L) & A_{12}(L) & A_{13}(L) \\ A_{21}(L) & A_{22}(L) & A_{23}(L) \\ A_{31}(L) & A_{32}(L) & A_{33}(L) \end{pmatrix} \begin{pmatrix} u_t^g \\ u_t^r \\ u_t^d \end{pmatrix} \Leftrightarrow \Delta p_t = A(L) u_t$$

where $A_{ij}(L) = a_{ij}^0 + a_{ij}^1 L + a_{ij}^2 L^2 + ...$ is a polynomial function of the lag operator L.[14] We capture inflation by the monthly percentage change in the global, regional and domestic CPIs.

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[10] See for example Bordo (1993).

[11] In fact, intraregional trade is higher in the WAEMU than in any other region in Africa (see Goretti and Weisfeld (2007)).

[12] As an example, oils shocks may be termed global shocks. The 1994 exchange rate devaluation of the CFAF was a regional shock, while domestic shocks may arise from disturbances on aggregate demand in a particular country (i.e. fiscal policies).

[13] While a global shock was, e.g., the oil shock and a regional shock, e.g., the 1994 CFAF devaluation, a domestic shock may arise from disturbances on aggregate demand in a particular country (e.g., precipitated by fiscal policies).

[14] Following standard structural VAR analysis, we also apply the following identifying restrictions to recover unobserved structural shocks from reduced-form innovations: (1) neither regional nor domestic inflation shocks

(continued…)

Global inflation is represented by US inflation (and alternatively euro zone inflation, to account for the peg of the CFAF to the euro). In contrast to Figure 1, we derive a regional inflation rate for each WAEMU country from the weighted average (using 2009 GDPs) of monthly inflation rates in WAEMU countries excluding the country for which the rate is being calculated.

Table 5. Variance Decomposition of Domestic Inflation

(Sample 1994:01–2009:12, based on a *VAR(12)* model, reported is 24-months horizon)

Country	Specification I			Specification II		
	Global (US)	Regional	Domestic	Global (Euro zone)	Regional	Domestic
1994:01-2009:12						
Benin	5.7	52.7	41.7	9.5	47.7	42.8
Burkina Faso	7.6	36.2	56.2	13.8	32.0	54.1
Côte d'Ivoire	4.4	48.4	47.2	9.9	43.3	46.8
Guinea-Bissau	9.1	6.8	84.2	9.3	5.8	84.8
Mali	9.2	38.4	52.4	11.3	36.4	52.3
Niger	8.1	57.4	34.5	11.6	51.5	36.9
Senegal	4.9	49.9	45.2	7.2	50.5	42.3
Togo	5.4	57.1	37.4	12.3	51.0	36.7

For each WAEMU country, the variance decomposition of forecast errors from a seasonality-controlling VAR(12) model shows that global shocks are surprisingly unimportant in all countries (see Table 5), but regional shocks matter about as much as domestic shocks. Regional shocks typically explain 50 to 60 percent of the total variation in domestic inflation. However, they represent less than 40 percent in Burkina Faso and Mali and as little as less than 10 percent in Guinea-Bissau. The relatively equal magnitude of global shocks when using US and euro zone inflation (see Specification I versus II) also refutes suspicions that global shocks might be largely picked up by regional shocks because of the fixed exchange rate between the CFAF and euro. In fact, the weight of price-volatile HCPI subcategories is much higher in WAEMU countries than in the US or the euro zone. For instance, the share of food items is on average 41.4 percent in the WAEMU but only about 15 percent in the US and the euro zone. That is how high food prices get imported from international markets without really showing up in global

have contemporaneous effects on global inflation; (2) domestic inflation shocks have no contemporaneous effects on regional inflation. That is, we use the Cholesky factorization to recover the unobserved innovations.

inflation. Moreover, CPI data in WAEMU countries are biased toward import prices because data are collected in urban areas, where the share of imports is higher than the national average.

On the other hand, even though domestic inflation shocks have a central role in the WAEMU region, they transmit across borders within the region quite heterogeneously (see Table 6).[15] The correlation coefficients of domestic inflation shocks are all positive (except for Guinea-Bissau). However, they range widely, from 0.07 in the pair Niger-Senegal to 0.76 in the pair Burkina Faso-Mali or Côte d'Ivoire-Benin. Importantly, this pattern closely resembles established trade pairings.[16]

Table 6. Correlation of Inflation Shocks

(Sample 1994:01–2009:12)

	BEN	**BFA**	**CIV**	**GNB**	**MLI**	**NER**	**SEN**	**TGO**
BEN	1	0.66	0.76	-0.28	0.46	0.15	0.49	0.71
BFA	0.66	1	0.67	-0.10	0.76	0.46	0.51	0.59
CIV	0.76	0.67	1	-0.29	0.51	0.24	0.47	0.76
GNB	-0.28	-0.10	-0.29	1	-0.01	0.20	-0.25	-0.21
GNB 1/	0.59	0.45	0.45	1	0.41	0.53	0.31	0.32
MLI	0.46	0.76	0.51	-0.01	1	0.42	0.54	0.35
NER	0.15	0.46	0.24	0.20	0.42	1	0.07	0.18
SEN	0.49	0.51	0.47	-0.25	0.54	0.07	1	0.38
TGO	0.71	0.59	0.76	-0.21	0.35	0.18	0.38	1

1/ Excluding times before the Guinea-Bissauan civil war (June 1998 to May 1999) and WAEMU accession (May 1997).

IV. Analysis

Our country-by-country analysis of the transmission channel from inflation to inflation uncertainty and RPV proceeds in two steps: we assess the impact of inflation first on inflation uncertainty and second on RPV.

[15] We apply the Hodrick-Prescott filter to estimate a trend component for the (log) price level. Short-term deviations (differences) from this trend represent inflation shocks in a given period.

[16] Guinea-Bissau also fits the picture when excluding times before its civil war (June 1998 to May 1999) and its WAEMU accession (May 1997). This raises correlation coefficients quite substantially.

A. Inflation and Inflation Uncertainty

There are two conflicting views on the nexus between inflation and inflation uncertainty. The Friedman-Ball hypothesis posits that inflation has a positive impact on inflation uncertainty. Building on the seminal work of Friedman (1977), Ball (1992) formalizes a model with two types of policymakers, tough and soft, who stochastically alternate in power. The public knows that only the tough type is willing to bear the economic costs of disinflation. When inflation is already low, both types of policy makers will try to keep it low, and uncertainty about future inflation will be low. However, when inflation is high, the public can only speculate about how long it will take until a tough type is in power to push disinflation. Uncertainty about future inflation will therefore be higher. Cuckierman (1992), however, posits that causality operates in the opposite direction. He based this conclusion on the time-inconsistency problem of monetary policy in a Barro-Gordon framework, which makes the public's inflation uncertainty fuel the central bank's optimal rate of inflation.

Yet, does either of these hypotheses hold for WAEMU countries? To find out we derive the variance of unpredictable innovations in the inflation rate as a measure of inflation uncertainty using a generalized autoregressive conditional heteroscedasticity (GARCH) model for each country.[17] A Granger test then helps identify the direction of causality between inflation and inflation uncertainty. Finally, impulse reaction functions help quantify effects.

Measure of Inflation Uncertainty

Accounting for lagged, seasonal, regional, and global inflation effects (see Table 5 and 6) and ARCH test results (see Appendix A.1), we use the following GARCH model to obtain the time-varying conditional variance of the error term as our measure of inflation uncertainty:[18]

---

[17] Earlier studies often use an alternative measure of inflation variability (most often the standard deviation of inflation) which is not a good proxy for inflation uncertainty. This measure is an ex post concept related to past fluctuation around a historical mean that cannot capture Ball's (1992) ex ante and subjective inflation concept, which is stochastic. Evans (1991) also notices that predictable fluctuations show up in standard deviation measures but do not truly increase uncertainty.

[18] A GARCH model allows simultaneously estimation of the mean and conditional variance equations. In contrast, ordinary least squares (OLS) regressions of (3.1) are unable to account for the strong pattern in the conditional variance of the residuals. A GARCH(p,q) model also allows for both autoregressive and moving average

(continued…)

$$INF_t = c + \sum_{j=1,2,3,4} \beta_j INF_{t-i} + \sum_{s=6,9,12} \lambda_s INF_{t-s} + \sum_{i=0,1,2,3,4} \gamma_i REG_{t-i} + \sum_{k=0,1,2,3} \varphi_k DEP_{t-k} + u_t \qquad (3.1)$$

$$\text{with } u_t \sim N\left(0, \sigma_t^2\right) \text{ and } \sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i u_{t-i}^2 + \sum_{i=1}^{q} \delta_i \sigma_{t-i}^2$$

where INF_t is the time *t* monthly domestic inflation rate; *c* a constant term, and REG_t the country's time *t* monthly regional inflation rate (calculated as the weighted average regional inflation rate, using 2009 GDPs, excluding data for that particular country in the calculation). Also, DEP_t represents the time *t* monthly depreciation rate of the nominal exchange rate (domestic currency per US dollar, taken from the IFS), u_t labels the stochastic error, and σ^2_t the variance of the error. We also include several lags of the explanatory variables and autoregressive terms at lags six, nine, and twelve to account for seasonality in the data. Finally, we add two dummy variables to account for the sharp currency depreciations at the start of the WAEMU (for Guinea Bissau, the sharp deprecation occurred before its accession to the monetary union). The first takes a value of one in January 1994 (for Guinea-Bissau May 1997) and the second takes a value of one in February 1994 (for Guinea-Bissau June 1997) and zero otherwise. All variables are stationary, as shown in Appendix A.1.

Overall, *GARCH(p,q)* models prove to fit well not only the mean, but also the variance process of inflation in all WAEMU countries (see Table 7).[19] The Ljung-Box Q^2-statistics (LBQ^2) confirm that including *GARCH* parameters is sufficient to remove any heteroscedasticity in the residuals. In addition, the individual z-statistics indicate that at least one coefficient in a country's variance equation is highly significant (however, only the constant is significant when using data from Côte d'Ivoire). As the sum of *p* and *q* coefficients is very close to one for Benin, Guinea-Bissau, Mali, Senegal, and Togo, we can also conclude that volatility shocks are especially persistent there.

components in the heteroscedastic variance of the error term: the conditional variance of a series depends on p lags of the residual and q lags of the error term's variance. In every period, the variance is approximated by the square residuals. The model thus assumes that the conditional variance of the errors follows an ARMA(p,q) process.

[19] In Table 7, we present only the "best" models. For every country several GARCH(p,q) models were tested and compared based on the significance of the coefficients in the variance equation and various information criteria (i.e., the Akaike and Schwarz criterion). The reported GARCH models, however, proved to be robust against the choice of p and q, the inclusion of a GNB civil war dummy, the exclusion of the depreciation rate for fear of multicollinearity, and the replacement of the depreciation rate by global inflation.

Lagged and seasonal domestic inflation are significant everywhere, even if chronology and sign are different. Likewise, a significant regional impact is present throughout. Except for Senegal, countries see a significant and contemporaneous regional inflation effect. Benin, Côte d'Ivoire, Mali, Niger, and Senegal also incur significant regional inflation lags. Again, the magnitude and timing differ. While a significant contemporaneous depreciation effect appears only in Côte d'Ivoire, a significant lagged effect occurs in Benin, Burkina Faso, Mali, and Niger. Finally, one dummy or another is always significant, except for Burkina Faso, Mali, and Niger.[20]

Figure 3. Inflation Uncertainty in WAEMU Countries

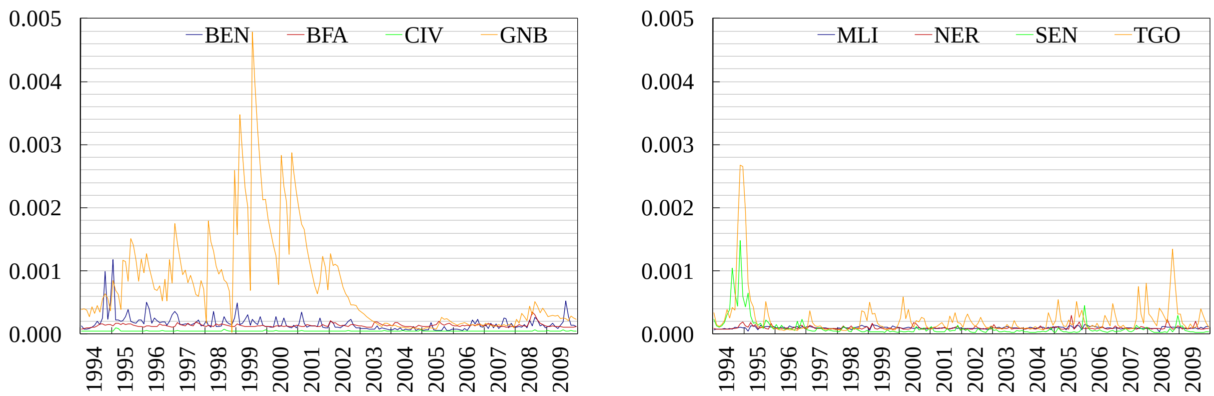


Figure 3 plots the time dynamics of the error term conditional variance from the GARCH models in Table 7. It shows that inflation uncertainty was mildly cyclical at quite a low level in all countries. The main exceptions result from three events: establishment of the WAEMU in January 1994; the food and fuel and food price crisis in 2008; and, the civil war in Guinea-Bissau from June 1998 to May 1999.

[20] Note that using a measure of core inflation (i.e. HPCI excluding category 1, "food and non-alcoholic beverages") significantly reduced the explanatory power of our GARCH models (adjusted R^2 below 10 percent). This shows that inflation uncertainty is mainly driven by food price volatility. This result is not surprising either, as adjusted inflation is much lower, missing high-inflation episodes, which usually increase inflation uncertainty significantly.

Table 7. GARCH Results for WAEMU Countries

Country	**Benin**		**Burkina Faso**		**Côte d'Ivoire**		**Guinea-Bissau**	
	GARCH(1,2)		*GARCH(1,1)*		*GARCH(0,1)*		*GARCH(1,2)*	
	Coeff.	*z-Stat.*	Coeff.	*z-Stat.*	Coeff.	*z-Stat.*	Coeff.	*z-Stat.*
Mean Inflation								
Constant	**0.003**	***3.85***	0.000	*0.29*	0.001	*1.52*	0.001	*0.98*
INF_{t-1}	**-0.161**	***-2.25***	**-0.314**	***-3.97***	**0.240**	***3.03***	-0.012	*-0.23*
INF_{t-2}	**-0.222**	***-3.18***	**-0.157**	***-2.19***	0.116	*1.63*	0.035	*0.50*
INF_{t-3}	**-0.144**	***-1.84***	**-0.165**	***-2.17***	-0.104	*-1.45*	**0.265**	***3.38***
INF_{t-4}	-0.046	*-0.85*	-0.090	*-1.29*	-0.040	*-0.62*	0.072	*1.03*
INF_{t-6}	**-0.103**	***-2.00***	**-0.104**	***-1.79***	**-0.134**	***-2.37***	**-0.132**	***-1.88***
INF_{t-9}	0.033	*0.69*	-0.085	*-1.39*	-0.014	*-0.41*	0.059	*0.84*
INF_{t-12}	0.045	*0.86*	**0.108**	***1.79***	**0.231**	***1.99***	**0.163**	***2.59***
REG_{t}	**0.542**	***4.18***	**0.939**	***5.83***	**0.153**	***2.01***	**0.713**	***2.84***
REG_{t-1}	**0.275**	***1.65***	0.168	*0.89*	0.065	*0.79*	0.172	*0.65*
REG_{t-2}	0.209	*1.35*	0.155	*1.12*	0.045	*0.59*	-0.277	*-1.36*
REG_{t-3}	-0.214	*-1.33*	0.271	*1.62*	-0.079	*-0.99*	0.189	*1.29*
REG_{t-4}	0.066	*0.59*	0.082	*0.60*	**0.169**	***2.67***	-0.258	*-1.62*
DEP_{t}	-0.050	*-1.54*	-0.013	*-0.35*	**-0.041**	***-1.82***	0.057	*1.14*
DEP_{t-1}	0.017	*0.49*	-0.015	*-0.38*	0.004	*0.17*	0.024	*0.43*
DEP_{t-2}	0.021	*1.33*	-0.017	*-1.12*	0.007	*0.67*	0.024	*0.47*
DEP_{t-3}	**0.064**	***4.57***	**0.029**	***1.94***	-0.001	*-0.14*	0.033	*0.72*
DUM-Jan94	**0.189**	***5.10***	-0.014	*-0.29*	**0.099**	***3.92***	**-0.150**	***-5.39***
DUM-Feb94	0.004	*0.10*	0.016	*0.33*	0.017	*0.66*	-0.029	*-0.89*
DUM-May97	---	---	---	---	---	---	0.018	*0.59*
DUM-Jun97	---	---	---	---	---	---	**0.033**	***2.00***
Variance								
Constant	0.000	*0.61*	**0.000**	***1.12***	**0.000**	***5.10***	0.000	*0.89*
u^{2}_{t-1}	**0.940**	***18.36***	**0.57**	***1.62***	---	---	**0.817**	***12.41***
u^{2}_{t-2}	---	---	---	---	---	---	---	---
σ^{2}_{ut-1}	**0.413**	***2.92***	*0.10*	*0.84*	*0.08*	*0.73*	**-0.058**	***-1.96***
σ^{2}_{ut-2}	**-0.360**	***-2.75***	---	---	---	---	**0.224**	***3.83***
Summary Statistics								
Adj. R-squared	0.55		0.41		0.59		0.13	
Akaike criterion	-5.81		-5.83		-6.92		-4.56	
Schwarz criterion	-5.42		-5.46		-6.56		-4.13	
LBQ^{2} *[1]*	0.02		0.71		0.11		0.02	
LBQ^{2} *[3]*	2.58		2.15		0.89		0.64	
LBQ^{2} *[6]*	3.80		3.13		4.22		2.01	

Note: All coefficients are estimated using the Berndt-Hall-Hall-Hausman algorithm for maximization. Bold indicates significance at the 5 and 10 percent level (calculated using the Bollerslev-Wooldridge robust QM standard errors). The critical values for the LBQ^2-statistic for lags 1, 3, and 6 at the 5 percent (resp. 10 percent) level are 3.84, 7.81 and 12.59 (resp. 2.71, 6.25 and 10.64).

Table 7 (cont.): GARCH Results for WAEMU Countries

Country	**Mali**		**Niger**		**Senegal**		**Togo**	
	GARCH(1,2)		*GARCH(0,1)*		*GARCH(2,2)*		*GARCH(1,1)*	
	Coeff.	*z-Stat.*	Coeff.	*z-Stat.*	Coeff.	*z-Stat.*	Coeff.	*z-Stat.*
Mean Inflation								
Constant	-0.001	*-0.71*	**-0.002**	***-2.08***	0.000	*-0.19*	0.001	*0.80*
INF_{t-1}	**0.139**	***1.96***	-0.022	*-0.31*	**0.179**	***2.38***	**0.196**	***2.25***
INF_{t-2}	0.049	*0.72*	-0.068	*-1.13*	-0.027	*-0.41*	**-0.151**	***-2.18***
INF_{t-3}	-0.045	*-0.60*	**-0.207**	***-2.78***	**-0.154**	***-2.63***	-0.036	*-0.56*
INF_{t-4}	-0.072	*-1.08*	**-0.110**	***-2.81***	0.046	*0.84*	-0.001	*-0.03*
INF_{t-6}	**-0.219**	***-3.83***	**-0.131**	***-3.88***	-0.036	*-0.66*	-0.086	*-1.23*
INF_{t-9}	0.010	*0.24*	-0.050	*-0.86*	**-0.096**	***-1.66***	0.008	*0.12*
INF_{t-12}	**0.164**	***2.43***	0.075	*1.27*	**0.183**	***3.43***	**0.101**	***2.01***
REG_{t}	**0.553**	***3.86***	**0.898**	***5.14***	-0.094	*-1.11*	**0.688**	***4.88***
REG_{t-1}	**0.296**	***1.87***	**0.565**	***3.38***	0.120	*1.23*	-0.197	*-1.18*
REG_{t-2}	-0.027	*-0.21*	0.054	*0.40*	**0.178**	***1.85***	0.030	*0.19*
REG_{t-3}	0.066	*0.46*	0.068	*0.47*	**0.455**	***5.46***	-0.095	*-0.54*
REG_{t-4}	0.169	*1.53*	**0.502**	***4.76***	-0.105	*-1.00*	0.047	*0.36*
DEP_{t}	0.016	*0.53*	0.013	*0.35*	0.021	*0.77*	-0.063	*-1.46*
DEP_{t-1}	-0.014	*-0.43*	**0.057**	***1.72***	0.011	*0.46*	-0.004	*-0.11*
DEP_{t-2}	**-0.072**	***-5.16***	**0.034**	***2.71***	0.000	*0.03*	0.010	*0.53*
DEP_{t-3}	0.001	*0.09*	-0.020	*-1.49*	-0.017	*-1.17*	0.021	*1.14*
DUM-Jan.94	0.040	*1.10*	-0.058	*-1.27*	**0.116**	***3.94***	**0.119**	***2.45***
DUM-Feb.94	0.004	*0.11*	-0.025	*-0.64*	0.037	*1.32*	**0.107**	***2.36***
Variance								
Constant	0.000	*0.96*	**0.000**	***4.96***	0.000	*1.19*	**0.000**	***2.93***
u^2_{t-1}	**0.734**	***3.11***	---	---	**1.178**	***6.64***	**0.338**	***2.67***
u^2_{t-2}	---	---	---	---	-0.213	*-1.33*	---	---
σ^2_{ut-1}	-0.070	*-1.23*	**0.163**	***1.70***	**0.454**	***2.50***	**0.570**	***3.04***
σ^2_{ut-2}	**0.121**	***1.76***	---	---	**-0.432**	***-2.38***	---	---
Summary Statistics								
Adj. R-squared	0.59		0.68		0.54		0.41	
Akaike criterion	-6.20		-6.08		-6.56		-5.66	
Schwarz criterion	-5.81		-5.72		-6.15		-5.28	
LBQ^2 *[1]*	0.23		0.22		0.00		0.06	
LBQ^2 *[3]*	0.50		1.53		0.52		1.79	
LBQ^2 *[6]*	6.91		2.71		2.39		3.73	

Note: All coefficients are estimated using the Berndt-Hall-Hall-Hausman algorithm for maximization. Bold indicates significance at the 5 and 10 percent level (calculated using the Bollerslev-Wooldridge robust QM standard errors). The critical values for the LBQ^2 -statistic for lags 1, 3, and 6 at the 5 percent (resp. 10 percent) level are 3.84, 7.81 and 12.59 (resp. 2.71, 6.25 and 10.64).

Granger Causality Tests

To determine the direction of causality between inflation and our measure of inflation uncertainty, we apply Granger tests in two steps.[21] These tests are based on regressions in which the explanatory variables of Y are not only past values of Y itself but also past values of X (and vice versa):

$$UNC_t = c_1 + \sum_{j=1}^{n} \beta_j UNC_{t-i} + \sum_{j=1}^{n} \gamma_j INF_{t-i} + u_{1t} \tag{3.2}$$

$$INF_t = c_2 + \sum_{j=1}^{n} \lambda_j UNC_{t-i} + \sum_{j=1}^{n} \varphi_j INF_{t-i} + u_{2t} \tag{3.3}$$

where INF_t is the time t monthly domestic inflation rate;[22] UNC_t our measure of inflation uncertainty at time t; c_1 and c_2 constant terms; and u_{1t} and u_{2t} error terms. Granger tests assesses whether the estimated coefficients on lagged *INF* in equation (3.2) and *UNC* in equation (3.3) are statistically significant as a group. Recognizing that the choice of lag length may affect conclusions, we report test results for different lag lengths.

Our Granger test results support the Friedman-Ball hypothesis for all WAEMU countries (see Table 8): average inflation has a positive and statistically significant impact on inflation uncertainty. We can reject the null hypothesis that inflation does not Granger-cause inflation uncertainty at conventional levels of significance in all countries, even if at different lag lengths. Besides confirming the direction of causality, we also find that the overall effect of inflation on inflation uncertainty is indeed positive, as the sum of the coefficients on lagged inflation is positive. However, there is some evidence for the Cuckierman hypothesis, because we can reject the null hypothesis that inflation uncertainty does not Granger-cause inflation for Benin, Senegal, and Togo at a few lags. Therefore, with Granger causality running two ways, there is certainly a feedback process between inflation and inflation uncertainty, so that the Friedman-Ball and Cuckierman hypotheses hold simultaneously in these three countries at few lag lengths.

[21] The logic of the Granger test is simple: if X causes Y, then changes in X should precede changes in Y. Earlier studies instead often used a *GARCH* model with lagged inflation in the conditional variance equation. This procedure directly allows testing if this month's inflation rate significantly and positively affects next month's inflation variance. Yet it would not be reasonable to restrict our effects to those occurring within a month. In addition, putting lagged inflation in the variance equation can jeopardize the non-negativity of the variance.

To quantify the impact of inflation on inflation uncertainty we employ the *VAR(12)* regressions behind the 12-lag Granger causality tests in equation (3.2) (see Table 8) and use the Cholesky decomposition to calculate the impulse-reaction functions of inflation uncertainty to inflation (see Figure 4). Indeed, the response of inflation uncertainty to a rise in inflation from its sample mean to one standard deviation above is quite substantial in all WAEMU countries. Following an inflation shock, a country's uncertainty quickly rises from its mean, erratically fluctuates at high levels, and then steadily falls back to the mean usually after periods 10 to 15. Yet, the magnitude, volatility, timing and persistence of country responses in inflation uncertainty differ widely. In Guinea-Bissau, for instance, the effect does not die down even after 50 periods.

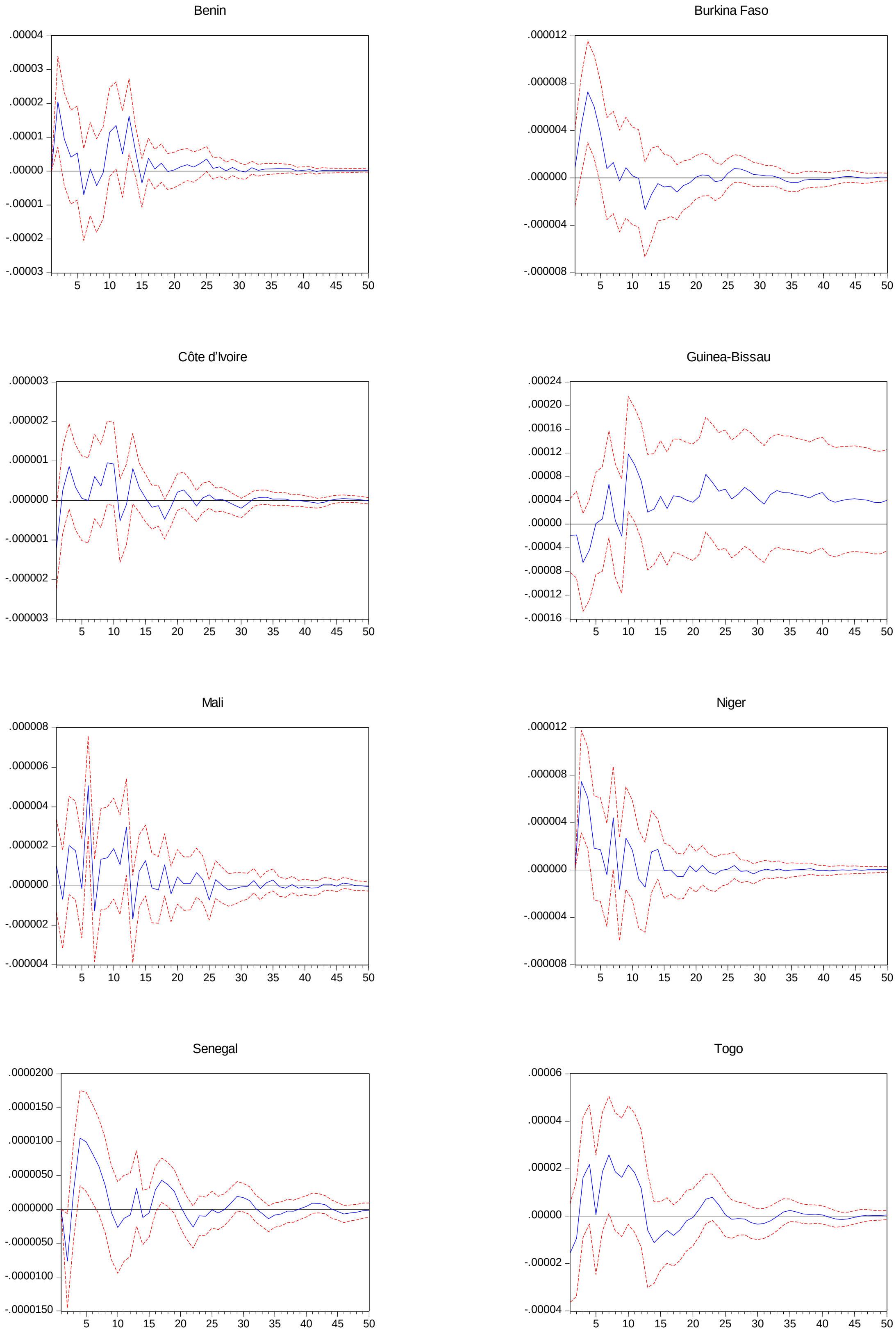
[22] Employing core instead of headline inflation does not change our results (see Appendix A.2.A). The same is true for using seasonally adjusted monthly domestic inflation rates.

Table 8. Granger Causality Tests for Inflation and Inflation Uncertainty

Country	H0: Inflation does not Granger cause inflation uncertainty			H0: Inflation uncertainty does not Granger cause inflation		
	***F*-statistic**	**Significance**	**Lagged *INF***	***F*-statistic**	**Significance**	**Lagged *UNC***
Benin						
3 lags	6.25	***	(+)	1.89		
6 lags	5.57	***	(+)	2.16	**	(+)
9 lags	8.86	***	(+)	1.63		(+)
12 lags	3.73	***	(+)	1.27		(+)
Burkina Faso						
3 lags	2.14	*	(+)	1.27		
6 lags	1.92	*	(+)	1.61		(-)
9 lags	1.50		(+)	1.11		(+)
12 lags	1.60	*	(+)	0.88		(-)
Côte d'Ivoire						
3 lags	1.50		(+)	1.04		
6 lags	1.10		(+)	0.32		
9 lags	0.65		(+)	0.66		
12 lags	2.74	***	(+)	0.63		
Guinea-Bissau						
3 lags	1.17			0.15		
6 lags	2.60	**	(+)	0.91		(+)
9 lags	3.39	***	(+)	0.93		(+)
12 lags	2.97	***	(+)	1.33		(+)
Mali						
3 lags	0.51			1.79		
6 lags	2.90	***	(+)	0.80		
9 lags	2.41	**	(+)	0.78		(-)
12 lags	2.55	***	(+)	1.22		(-)
Niger						
3 lags	2.91	**	(+)	2.06		(-)
6 lags	2.67	**	(+)	0.65		(-)
9 lags	4.75	***	(+)	0.51		(-)
12 lags	3.11	***	(+)	0.74		(-)
Senegal						
3 lags	13.86	***	(+)	0.54		
6 lags	14.29	***	(+)	2.73	**	(-)
9 lags	6.17	***	(+)	3.73	***	(+)
12 lags	2.89	**	(+)	1.48		(-)
Togo						
3 lags	20.02	***	(+)	2.92	**	(+)
6 lags	11.21	***	(+)	1.67		
9 lags	27.14	***	(+)	1.36		(-)
12 lags	1.49		(+)	0.82		(+)

Note: ***, ** and * indicate significance at the 1, 5 and 10 percent level. (+) and (-) indicate the sign of the sum of the coefficients of lagged inflation in equation (3.2) (resp. lagged uncertainty in equation (3.3)), if at least one of the lagged coefficients is significant at the 10 percent level. If no coefficient is significant, there is no entry.

Figure 4. Impulse Response Functions—Inflation and Inflation Uncertainty



B. Inflation and Relative Price Variability (RPV)

A body of theories pioneered by Friedman (1977) predicts that inflation has a positive and causal impact on RPV. The drivers of this impact differ, however, depending on the theoretical model specification. There are two main lines of explanation: first, menu cost and consumer search cost models, and second, signal-extraction models.

Both menu cost and costly consumer search models postulate that expected inflation increases RPV. Given inflation, menu or price adjustment costs make heterogeneous firms optimally change their prices only rarely, even if their real prices erode (see Sheshinsky and Weiss, 1977 or Rotemberg, 1983). This is because firms increase the nominal price when the real price hits a lower boundary. The magnitude of the increase thus reflects the expected severity of inflation. Similarly, in an inflationary environment search costs make heterogeneous consumers reduce their optimal stock of price information (see Baye, Morgan, & Scholten, 2006). This increases a firm’s market power and enables it to ask for higher prices, even for the same product.

Signal-extraction models, on the other hand, predict that only unexpected inflation (i.e., ex ante inflation uncertainty) raises RPV. If information is incomplete, noisy price information leads to misperceptions of absolute and relative price changes, causing confusion between aggregate and relative shocks. This makes price-setting behavior and supply inefficient (see Lucas, 1973 or Barro, 1976). Extended signal-extraction models also assume that firms are heterogeneous (see Hercowitz, 1981 or Cukierman, 1983). Their different elasticity of supply makes them respond even more differently not only to noisy price information but also to unexpected aggregate demand shocks.

Yet, do any of these hypotheses hold for WAEMU countries? To find out, we first develop a measure of RPV and then examine how it varies with inflation. We also disentangle the impact of expected and unanticipated inflation.

Measure of RPV

By default, following Parks (1978), we derive a measure of RPV from the weighted variance of individual HCPI subcategories around the HCPI average:[23]

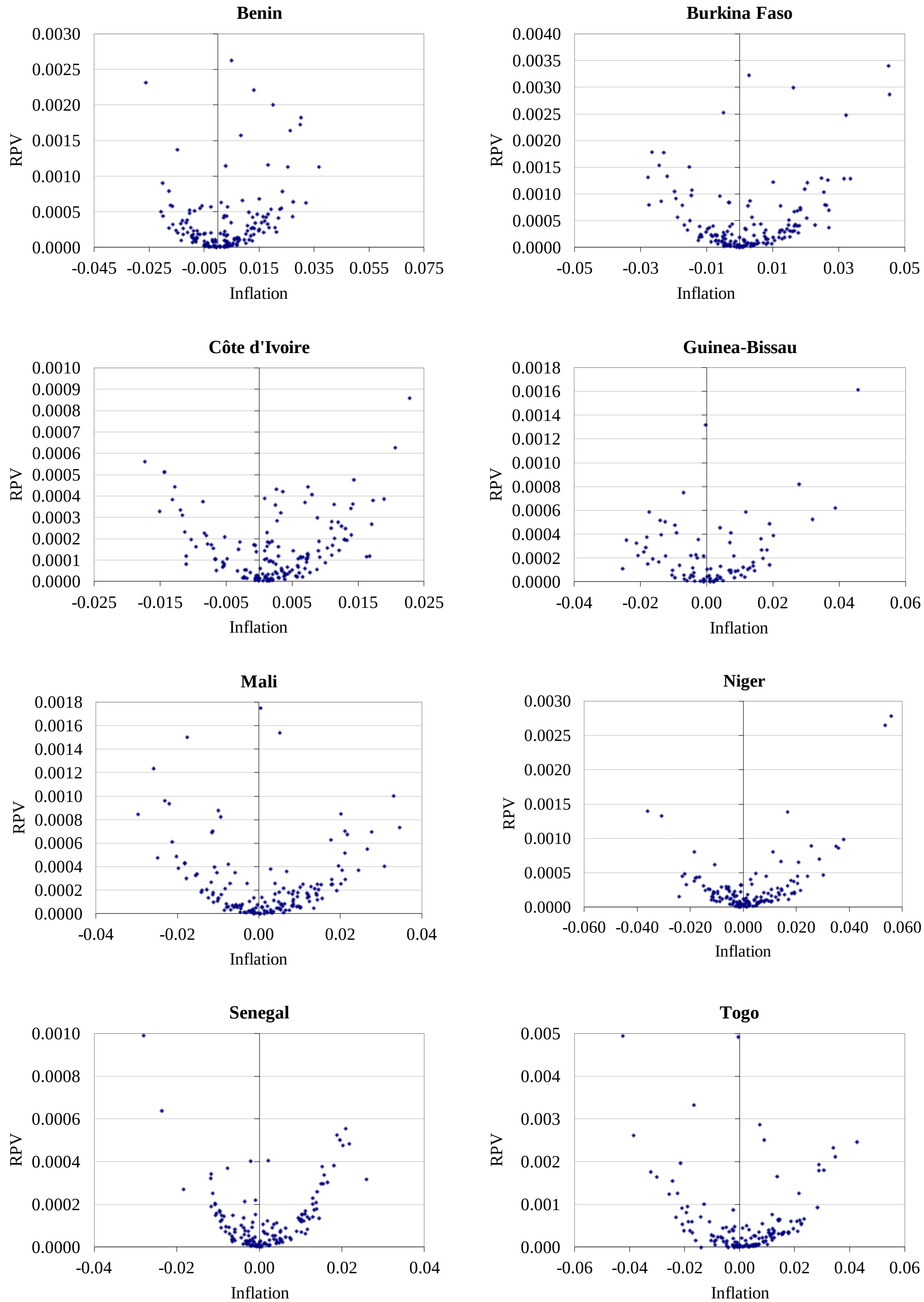
$$RVP_t = \sum_{i=1}^{n} w_i \left(\Pi_{it} - \Pi_t\right)^2 \tag{3.4}$$

where w_i is the expenditure weight of subcategory $i=1,\ldots n$; Π_{it} the monthly rate of inflation for subcategory i , and $\Pi_t = \sum_{i=1}^{n} w_i \Pi_{it}$ the monthly average (across subcategories) rate of inflation. For WAEMU countries whose HCPI has 12 subcategories (see Table 2), n=12 produces headline inflation and RPV.

Visual inspection of the plot of average HCPI inflation against our RPV measure gives a first indication of the large volatility of relative prices accompanying an inflationary process (see Figure 5). All WAEMU countries exhibit a clear joint fluctuation of inflation rates and RPV, though to different extents.

[23] RVP_t monotonically increases in the difference between individual price movements. Its lower bound is zero, when all prices change proportionally. As an alternative measure of RPV, Silver and Ioannidis (2001) propose a coefficient of variation, but this methodology is not applicable here as our sample includes negative inflation rates.

Figure 5. Monthly Rates—Inflation and RPV in WAEMU Countries



Specifications and Empirical Results

To verify the validity of the various theories on the impact of inflation on RPV, we study several models. Following a (i) linear specification, we run a number of nonlinear specifications to test (ii) the relevance of inflation, (iii) the asymmetric impact of inflation and deflation, (iv) the relevance of unexpected inflation, and (v) the asymmetric impact of unexpected inflation and deflation.[24]

Linear specification

We begin our analysis with a simple linear ordinary least squares (*OLS*) regression of RVP_t on average headline inflation Π_t:

$$RPV_t = \alpha_1 + \beta_1 \Pi_t + \varepsilon_t \qquad (OLS\text{-}I)$$

As in most empirical studies, the data do not support a simple linear relation between inflation and RPV in WAEMU countries other than in Benin, Guinea-Bissau, and Niger (see, *OLS-I*). In these countries the coefficient of inflation β_1 takes a value of around 0.01 at quite high levels of confidence only.

[24] There are three main ways to increase the explanatory power of our tests. First, we could follow Silver and Ioannidis (2001) in including other macroeconomic variables along with inflation, such as GDP growth or exports. Second, we could follow Nautz and Scharff (2006) or Choi (2010) and apply a threshold approach. Third, we could follow Carballo and Dabus (2008) and add lagged inflation and lagged RPV as explanatory variables. We refrain from doing so because none would change the essence of our results but would rather distract from it.

Table 9. Linear Impact of Inflation on RPV

Country	OLS I			
	α_1	β_1	R^2	*DW*
Benin	0.00 ***	0.01 **	0.05	1.79
	8.76	*2.06*		
Burkina Faso	0.00 ***	0.01	0.05	1.44
	9.49	*1.58*		
Côte d'Ivoire	0.00 ***	0.00	0.01	1.49
	8.56	*0.75*		
Guinea-Bissau	0.00 ***	0.01	0.07	1.87
	8.07	*1.43*		
Mali	0.00 ***	0.00	0.01	1.86
	9.66	*-0.69*		
Niger	0.00 ***	0.01 *	0.15	1.81
	8.63	*1.86*		
Senegal	0.00 ***	0.00	0.01	1.89
	8.77	*0.56*		
Togo	0.00 ***	-0.01	0.01	1.66
	7.70	*-0.69*		

Note: In italics, the table reports robust *t*-statistics using White heteroscedasticity-consistent standard errors and covariance. ***, ** and * indicates significance at the 1, 5 and 10 percent level.

Relevance of inflation

To better account for the presence of some negative inflation rates (see Figure 2), we run another widely used robust *OLS* regression of the square root of RVP_t on the absolute value of average headline inflation $|\Pi_t|$:

$$\sqrt{RPV}_t = \alpha_2 + \beta_2 |\Pi_t| + \varepsilon_t \qquad (OLS\text{-}II)$$

The results confirm that a nonlinear specification of the relation between inflation and RPV better fits the data for all WAEMU countries (see Table 10, *OLS-II*) than the linear specification presented in Table 9. The coefficient of inflation β_2 is highly significant; it ranges from 0.55 in Guinea-Bissau to 1.03 in Togo.[25]

[25] Appendix A.2 shows that the volatility and seasonality of food prices does not bias the link between inflation, inflation uncertainty and RPV. Seasonally adjusting all other subcategories in the HCPI basket (see Table 2) does not pay off because seasonality in WAEMU countries predominantly arises from the agricultural sector.

Table 10. Symmetric and Asymmetric Impact of Inflation on RPV

Country	OLS-II				OLS-III				
	α_2	β_2	R^2	DW	α_3	β_3	γ_3	R^2	DW
Benin	0.01 ***	0.85 ***	0.41	1.96	0.01 ***	0.85 ***	0.00	0.41	1.96
	7.00	*9.69*			*6.40*	*9.83*	*0.06*		
Burkina Faso	0.01 ***	0.93 ***	0.50	1.66	0.01 ***	0.90 ***	0.15 *	0.51	1.73
	7.95	*13.48*			*7.47*	*12.23*	*1.73*		
Côte d'Ivoire	0.01 ***	0.78 ***	0.47	1.72	0.01 ***	0.74 ***	0.17 **	0.48	1.78
	10.45	*11.51*			*10.30*	*10.20*	*2.34*		
Guinea-Bissau	0.01 ***	0.55 ***	0.38	2.22	0.01 ***	0.56 ***	-0.01	0.38	2.22
	6.10	*6.97*			*6.04*	*6.80*	*-0.16*		
Mali	0.01 ***	0.74 ***	0.45	1.80	0.01 ***	0.66 ***	0.24 ***	0.48	1.82
	6.50	*11.17*			*6.26*	*10.73*	*3.44*		
Niger	0.01 ***	0.71 ***	0.69	1.70	0.01 ***	0.70 ***	0.03	0.69	1.71
	12.73	*15.90*			*12.03*	*14.74*	*0.44*		
Senegal	0.00 ***	0.78 ***	0.66	2.10	0.00 ***	0.75 ***	0.12 **	0.67	2.11
	8.54	*14.73*			*8.51*	*14.29*	*2.26*		
Togo	0.01 ***	1.03 ***	0.50	1.63	0.01 ***	0.97 ***	0.15	0.51	1.62
	5.32	*12.03*			*5.43*	*11.49*	*1.56*		

Note: In italics, the table reports robust *t*-statistics using White heteroscedasticity-consistent standard errors and covariance. ***, ** and * indicates significance at the 1, 5 and 10 percent level.

Asymmetric impact of inflation and deflation

Owing to potential price stickiness and thus downward price rigidity, the simple nonlinear specification might be mis-specified.[26] As a refinement, we therefore challenge the symmetric impact of positive and negative inflation rates on RPV by extending equation (OLS-II):

$$\sqrt{RPV_t} = \alpha_3 + \beta_3 |\Pi_t| + \gamma_3 |\Pi_t| * DUM_t^- + \varepsilon_t \qquad (OLS\text{-}III)$$

where DUM_t^- is a dummy variable that takes a value of one if $\Pi_t < 0$ and 0 otherwise to allow for a different slope of price level changes during deflationary periods.[27]

[26] This is illustrated by Jaramillo (1999) for a two-sector economy in which sector 1 exhibits perfect price flexibility and sector 2 some degree of downward price rigidity. Positive and negative aggregate demand shocks will then translate into symmetric price changes in sector 1 but asymmetric changes in sector 2. In these circumstances, a negative shock produces an increased new aggregate level of RPV and a decreased absolute value of inflation, reinforcing the fact that negative inflation rates will be associated with higher RPV levels.
[27] The periods registering a monthly deflation rate in our sample range from 41 in Guinea-Bissau up to 71 in Burkina Faso and Senegal.

The estimation results, however, corroborate the existence of an asymmetrical impact of inflation and deflation on RPV in half of the WAEMU countries (see Table 10, *OLS-III*). While the coefficient of absolute aggregate inflation β_3 remains highly significant in all WAEMU countries (between 0.56 in Guinea-Bissau and 0.97 in Togo), the coefficient of deflation γ_3 is significantly different from zero in Burkina Faso, Côte d'Ivoire, Mali and Senegal (ranging from 0.12 to 0.24).

Relevance of unexpected inflation

Moreover, in order to corroborate the prediction of signal-extraction models that only unexpected inflation has an impact on RPV, we test the following equation:

$$\sqrt{RPV_t} = \alpha_4 + \beta_4 \left|\Pi_t^e\right| + \mu_4 \left|\Pi_t - \Pi_t^e\right| + \varepsilon_t \qquad (OLS\text{-}IV)$$

where $|\Pi^e|$ is absolute expected headline inflation and $|\Pi-\Pi^e|$ absolute unexpected headline inflation. As a proxy for the latter, we use the absolute value of the residuals from the GARCH regressions in Section III.A. This way, we also implicitly account for seasonal effects.

Table 11. Symmetric and Asymmetric Impact of Unexpected Inflation on RPV

Country	***OLS-IV***					***OLS-V***						
	α_4	β_4	μ_4	R^2	*DW*	α_5	β_5	η_5	ψ_5	R^2	*DW*	*W*
Benin	0.01 ***	0.08	0.64 ***	0.18	1.86	0.01 ***	0.10	0.86 ***	0.36 ***	0.25	1.93	0.00
	6.96	*0.57*	*5.67*			*7.77*	*0.91*	*7.50*	*2.68*			
Burkina Faso	0.01 ***	0.15	0.74 ***	0.26	1.65	0.01 ***	0.20	0.85 ***	0.56 ***	0.28	1.64	0.00
	5.99	*0.71*	*6.37*			*6.39*	*0.98*	*7.90*	*3.75*			
Côte d'Ivoire	0.01 ***	0.28 **	0.63 ***	0.24	1.73	0.01 ***	0.27 **	0.80 ***	0.47 ***	0.27	1.67	0.00
	7.98	*2.02*	*6.02*			*8.29*	*2.03*	*7.15*	*3.99*			
Guinea-Bissau	0.01 ***	0.23	0.64 ***	0.41	2.18	0.01 ***	0.28 *	0.74 ***	0.51 ***	0.44	2.14	0.01
	4.56	*1.64*	*7.40*			*4.76*	*1.98*	*7.20*	*5.94*			
Mali	0.01 ***	0.43 ***	0.66 ***	0.29	1.95	0.01 ***	0.43 ***	0.67 ***	0.66 ***	0.29	1.94	0.13
	5.06	*3.63*	*6.72*			*5.04*	*3.63*	*6.09*	*5.04*			
Niger	0.01 ***	0.64 ***	0.56 ***	0.40	1.94	0.01 ***	0.62 ***	0.58 ***	0.51 ***	0.41	1.93	0.85
	4.01	*4.59*	*5.25*			*4.20*	*4.35*	*4.73*	*4.10*			
Senegal	0.01 ***	0.40 ***	0.51 ***	0.27	2.33	0.01 ***	0.40 ***	0.53 ***	0.50 ***	0.27	2.33	0.42
	6.32	*3.64*	*4.20*			*6.28*	*3.61*	*3.85*	*3.29*			
Togo	0.01 ***	0.32	1.09 ***	0.42	1.90	0.01 ***	0.32	1.09 ***	1.09 ***	0.42	1.90	0.00
	4.07	*1.33*	*11.60*			*4.06*	*1.33*	*10.47*	*8.58*			

Note: In italics, the table reports robust *t*-statistics using White heteroscedasticity-consistent standard errors and covariance. ***, ** and * indicates significance at the 1, 5 and 10 percent level. The last column is the estimated probability for the Wald test (*W*) of equality of coefficients between positive and negative unexpected inflation.

Our estimation results generally confirm the relevance of unexpected inflation for WAEMU countries (see Table 11, *OLS-IV*). Indeed, there is solid evidence in favor of signal-extraction models, even if their impact varies across WAEMU countries. While the coefficient of unexpected inflation μ_4 is generally about 0.51 to 0.74, it is again much higher in Togo at 1.09. On the other hand, there is also evidence in favor of menu cost and consumer search cost models in half of the WAEMU countries. The coefficient of expected inflation β_4 is significant and between 0.28 in Côte d'Ivoire and 0.64 in Niger, with Mali and Senegal falling in between. Except for Niger, β_4 is also always lower than the coefficient of unexpected inflation, μ_4.[28]

Asymmetric impact of unexpected inflation and deflation

As a last refinement, we scrutinize the impact of signal-extraction models. To determine whether an increase in RPV follows whatever the sign of unexpected inflation, we allow for asymmetrical responses of RPV to unexpected inflation and deflation:[29]

$$\sqrt{RPV_t} = \alpha_5 + \beta_5 \left|\Pi_t^e\right| + \eta_5 \left|\Pi_t - \Pi_t^e\right| * D_t^+ + \psi_5 \left|\Pi_t - \Pi_t^e\right| * D_t^- + \varepsilon_t \qquad (OLS\text{-}V)$$

where D_t^+ (or D_t^-) is a dummy variable that takes the value of one if $\Pi_t - \Pi_t^e > 0$ (or $\Pi_t - \Pi_t^e < 0$) and 0 otherwise.

Our results support an asymmetric impact of unexpected inflation on RPV in most WAEMU countries (see Table 11, *OLS-V*).[30] Indeed, the estimated probability for the Wald test (*W*) allows rejecting the null hypothesis of coefficient equality of positive and negative unexpected inflation at the 10 percent level of significance in all WAEMU countries but Mali, Niger and Senegal. In the other five countries, the coefficient of unexpected deflation, ψ_5, varies between 0.36 in Benin and 1.09 in Togo. These parameter values also fall short of the coefficients on unexpected

[28] For the euro zone for 1995 to 2003, Nautz and Scharff (2006) found a significant coefficient of expected inflation of 0.26 and of unexpected inflation of 1.13. Similarly, for 1996 to 2006 Nautz and Scharff (2007) obtain 0.35 for expected and 1.02 for unexpected inflation.

[29] Some studies using US data found that RPV's response to inflation is more pronounced when inflation is unexpectedly (rather than expectedly) high, see e.g. Aarstol (1999), Jaramillo (1999) or Parsley and Popper (2002).

[30] Unlike Aarstol (1999) for the US, Nautz and Scharff (2007) can also not confirm an asymmetric impact of unexpected inflation on RPV for the Euro zone.

inflation, η_5, that vary between 0.53 in Senegal and 1.09 in Togo.[31] Following Nautz and Scharff (2005) and Konieczny and Skrzypacz (2005), the fact that the influence of expected inflation decreases shows that credible monetary policy stabilized inflation expectations at a low level. Meanwhile, the coefficients for expected inflation, β_5, remain almost unchanged compared to the regression output for specification *OLS-IV*. It, however, become significant for Guinea-Bissau.

V. POLICY IMPLICATIONS

Our results have some important policy implications. Above all, they point to the benefits of keeping inflation low, stable, and predictable.[32] In particular, the evidence of interdependent inflation shocks across WAEMU countries (see Table 5 and Table 6) makes a common monetary policy seem to be an adequate instrument to keep inflation under control in the whole region. However, second-round effects of inflation on output are likely to be different across countries considering the heterogeneity on the transmission mechanism from inflation to inflation uncertainty and RPV. Thus, the results imply the need to minimize and homogenize the impact of inflation on these two variables. To achieve that goal:

- Fostering macroeconomic convergence and regional integration may reduce heterogeneity.
- Implementing swift policy responses to inflation developments may reduce inflation uncertainty and -where Cuckierman's predictions hold- also persistence (see also Soderstrom, 2002).[33]

[31] Nautz and Scharf (2006) report similar results for the euro zone, Nautz and Scharff (2005) for Germany, and Aarstol (1999) for the US.
[32] The goal should be to minimize the marginal effect of inflation on inflation uncertainty and RPV, which does not imply keeping inflation close to zero. Otherwise, difficulties might arise, e.g., from the zero bound for nominal interest rates (see Adam and Billi, 2006) or from the need for relative price changes in accordance with fundamentals (see Woodford, 2003).
[33] Caporale, Onorante, and Paesani (2009) confirm that a tough anti-inflation stance even reduces long-run uncertainty in the euro zone, where the ECB, like the BCEAO, has an inflation mandate only and a clear quantitative definition of price stability. The opposite holds for the US, where the Fed's mandate also includes full employment but there is no quantitative definition of price stability.

- Publishing information on all major drivers of domestic inflation may help rationalize and align inflation as well as RPV expectations.[34] Such information might include the exchange rate, the regional inflation rate and that of the most important regional trading partners, and projections of important import and export prices (above all, for food and fuel products). In fact, food and fuel product prices may act as supply-side factors for inflation, in turn driving inflation uncertainty and RPV, irrespective of any monetary policy.[35] Likewise, the BCEAO should also publish news on potential idiosyncratic inflation drivers in the region (such as droughts or locust invasions).
- Better explaining current inflation developments and forecasts to the general public may also facilitate the communication of monetary policy, anchor inflation expectations, and increase the central bank's transparency and accountability.[36] To this aim and despite the exchange rate peg, the BCEAO already follows the ECB in explicitly announcing an inflation target below or close to 2 percent. Yet, in line with our findings, the BCEAO might consider adding core to headline inflation as a reference measure, particularly in times of especially volatile international energy and food prices. For this purpose, the BCEAO would first have to design and compile a regionally comparable index of domestic core inflation that precludes volatile energy and food prices.
- Enhancing the coordination of national fiscal policies and capacity building may foster the ability to react effectively to idiosyncratic shocks. Similarly, gearing national reserve requirements toward countering cyclical fluctuations in individual WAEMU countries might help fine-tune monetary policy.[37]

[34] This is the more important. Rogoff (2007) even warns that the turbulence of recent years (such as the bursting of the tech stock and housing bubbles, the 9/11 terrorist attacks, wars, and volatile energy prices) may raise inflation uncertainty and thus global inflation in coming years.
[35] Among the twelve subcategories of the CPI index (see Table 2), food prices have dominant and different weights across countries (i.e., between 32 and 60 percent) and naturally change the most with international prices that are traditionally quite volatile. The same is true for energy prices, which affect several categories with different weights. Both therefore account for much of RPV. That is how there can even be situations in which higher average inflation correlates with higher RPV owing to exogenous factors only (i.e., not due to monetary policy).
[36] Mishkin and Westelius (2008) find that inflation targeting can be interpreted as an inflation contract mitigating the inflation bias of discretionary policy. Also, see the evidence reviewed in Berument and Yuksel (2007).
[37] However, monetary policy tools also affect prices and thus RPV. For instance, Sahin, Saracoglu, and Berument (2009) find that policies using a mix of instruments increase RPV less than pure policies using the interbank market or exchange rate only.

- Eliminating national differences in laws relating to administered prices, customs exemptions, and tax rates would align firms' price-setting behavior throughout the region.

VI. Conclusions

Implementing a country-by-country approach, this paper provides ample evidence for two channels through which higher inflation could have real effects in the economy. We not only detect a significant and positive impact of inflation on inflation uncertainty, but also show how expected and unexpected inflation increases RPV in the economy. The empirical exercise comprises all eight members of the WAEMU from its start in January 1994 through December 2009. However, our findings indicate that the pattern, magnitude, and timing of both channels are quite heterogeneous within the region. This fact poses particular challenges to the implementation of a common monetary policy.

Our findings have a number of valuable implications for economic policy. They corroborate the benefit of keeping inflation low, stable and predictable, as increases in the price level could be costly for individuals in two ways. First, high inflation produces direct negative effects in the economy and among individuals through different channels (it, e.g., reduces growth, changes the distribution of wealth among individuals, increases poverty, etc.). Second, inflation triggers uncertainty about future inflation and raises relative price variability, which have further welfare consequences. To restrain these effects, a common monetary policy is a sensible instrument to keep inflation under control in the WAEMU region given that inflation shocks are highly correlated across countries. However, as second-round real effects of inflation are likely to be different across countries, enhanced macroeconomic convergence; closer integration; more domestic policy coordination; and adequate and harmonized use of national monetary policy instruments (such as administered prices and customs exemptions) will be needed to homogenize the transmission mechanism of inflation and tame its heterogeneous output effects.

There are many avenues for future research. For instance, distinguishing short- from long-term inflation uncertainty (as in Caporale et al. 2009) would help separate the uncertainty associated with differences between member states or commodity price shocks from structural uncertainty related to unanticipated monetary policy changes. Also, micro data evidence on firms' pricing behavior (see, Klenow and Kryvtsov, 2008, or Golosov and Lucas 2007); remittances (see, Balderas & Garcia-Contreras, 2009); and the impact of monetary instrument would help better understand observed RPV. Threshold models or endogenous break-point tests could be useful to identify critical inflation thresholds above which the impact is particularly detrimental. Finally, studies of the implications of inflation in the WAEMU area could explore the real output and welfare consequences of inflation-induced increases in inflation uncertainty and RPV.

APPENDIX

A.1. STATIONARITY AND HETEROSCEDASTICITY TEST

Despite capturing well any pattern in the mean of inflation in WAEMU countries, *OLS* regressions of equation (3.1) in Section IV.1 are unable to account for the strong pattern in the conditional variance of the residuals.

Indeed, although the monthly inflation rate appears to be stationary, its residual variance does not appear to be constant in most countries over time (see Table A.1). The first follows from rejecting the null hypothesis of a unit root at the 1 percent level for all countries, based on the augmented Dickey-Fuller (*ADF*) test statistic.[38] The second follows from rejecting the null hypothesis of serial correlation in the squared *OLS* residuals with quite high levels of significance based on the Ljung-Box Q^2-statistic (LBQ^2) at lags 1, 3, or 6 for all countries except Niger. This suggests the presence of autoregressive conditional heteroscedasticity (*ARCH)* in all countries' OLS residuals other than Niger's.

Table A.1. Stationarity and Heteroscedasticity Tests

Country	***Unit Root Test 1/***	***ARCH Test 2/***		
	ADF	***LBQ² [1]***	***LBQ² [3]***	***LBQ² [6]***
Benin	**-12.14**	**3.33**	**16.89**	**18.02**
Burkina Faso	**-8.70**	**6.80**	**7.89**	8.88
Côte d'Ivoire	**-6.60**	**6.41**	**6.79**	8.59
Guinea-Bissau	**-12.46**	0.23	2.15	**11.55**
Mali	**-9.58**	1.04	2.52	**11.54**
Niger	**-8.83**	1.14	3.16	3.70
Senegal	**-9.60**	**11.67**	**71.47**	**85.85**
Togo	**-10.30**	**14.73**	**15.60**	**16.52**

Note: Bold indicates significance at the 10 percent level. 1/ Given the sample size, the ADF test employs 14 lags (but 13 for Guinea-Bissau). The choice of the lag number follows Schwert (1989). All cases include a constant and the lag lenght is 0 (but 1 for Burkina Faso and Côte d'Ivoire). The critical value at the 1 percent level is -3.47. 2/ The critical values for lags 1, 3, and 6 at the 5 percent level are 3.84, 7.81 and 12.59.

[38] The same conclusion follows from ADF tests for regional inflation rates and the depreciation rate.

A.2. ROBUSTNESS OF INFLATION-RPV LINK TO CORE INFLATION

We first recalculate core average inflation and a measure of core RPV by excluding from equation (3.4) subcategory (i) “food and non-alcoholic beverages” and then rerun equations *OLS-II* and *OLS-III*. The evidence not only on the impact of inflation but also on price rigidities is quite robust to the use of core inflation and RPV (see Table A.2 and Table 10). Coefficients on core inflation are just a little bit higher than those on headline inflation.[39] As for general price rigidities, we find support for nonfood price rigidities in Benin only. Thus, comparing the outcome with core inflation to that with headline inflation shows that while food prices seem to be downward sticky in Burkina Faso, Côte d’Ivoire, Mali and Senegal, the same is not true for all other prices. The opposite holds for Benin.

Table A.2: Impact of Core Inflation on Core RPV

Country	*OLS-II'*					*OLS-III'*							
	α'_2		β'_2		R^2	DW	α'_3		β'_3		γ'_3		R^2	DW
Benin	0.01	***	1.12	***	0.59	2.01	0.00	***	1.08	***	0.47	*	0.61	2.09
	7.06		*8.90*				*6.80*		*9.34*		*1.88*			
Burkina Faso	0.01	***	1.40	***	0.43	1.88	0.01	***	1.39	***	0.03		0.43	1.88
	6.28		*7.74*				*6.46*		*7.06*		*0.17*			
Côte d’Ivoire	0.00	***	1.11	***	0.60	1.55	0.00	***	1.09	***	0.11		0.60	1.54
	8.16		*10.69*				*8.26*		*8.63*		*0.84*			
Guinea-Bissau	0.01	***	1.00	***	0.59	2.05	0.01	***	1.04	***	-0.23		0.59	1.98
	6.62		*9.25*				*6.4*		*7.69*		*-1.33*			
Mali	0.00	***	1.45	***	0.46	1.99	0.00	***	1.38	***	0.41		0.47	2.00
	5.42		*6.43*				*5.46*		*5.57*		*1.24*			
Niger	0.01	***	0.88	***	0.37	1.50	0.01	***	0.85	***	0.07		0.37	1.51
	11.35		*7.58*				*11.02*		*7.93*		*0.35*			
Senegal	0.00	***	1.22	***	0.54	2.03	0.00	***	1.18	***	0.19		0.54	2.04
	9.37		*9.27*				*9.43*		*8.35*		*0.80*			
Togo	0.00	***	1.34	***	0.76	1.92	0.00	***	1.34	***	-0.09		0.76	1.94
	8.72		*13.42*				*8.24*		*12.98*		*-0.36*			

Note: In italics, the table reports robust *t*-statistics using White heteroscedasticity-consistent standard errors and covariance. ***, ** and * indicates significance at the 1, 5 and 10 percent level.

[39] Similar results arise for the Euro area. For instance, for 1995 to 2003 Nautz and Scharff (2006) obtain coefficients for headline inflation amounting to 0.46 and for core inflation 0.59. Similarly, for 1996 to 2006 Nautz and Scharff (2007) find coefficients of 0.61 for headline and 0.67 for core inflation.

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