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Implications of Food Subsistence for Monetary Policy and Inflation

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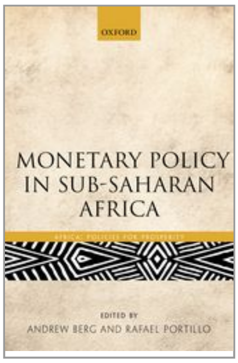

Monetary Policy in Sub-Saharan Africa
Andrew Berg and Rafael Portillo

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Implications of Food Subsistence for Monetary Policy and Inflation

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Luis-Felipe Zanna
Stephen O'Connell
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Abstract and Keywords

The chapter introduces subsistence requirements in food consumption into a simple New Keynesian model with flexible food and sticky non-food prices. It shows how the endogenous structural transformation that results from subsistence affects the dynamics of the economy, the design of monetary policy, and the properties of inflation at different levels of development. A calibrated version of the model encompasses both rich and poor countries and broadly replicates the properties of inflation across the development spectrum, including the dominant role played by changes in the relative price of food in poor countries. The authors derive a welfare-based loss function for the monetary authority and show that optimal policy calls for complete (in some cases near-complete) stabilization of sticky-price non-food inflation, despite the presence of a food-subsistence threshold. Subsistence amplifies the welfare losses of policy mistakes, however, raising the stakes for monetary policy at earlier stages of development.

Keywords: Subsistence, food prices, monetary policy, inflation, low-income countries, developing countries, structural transformation, sub-Saharan Africa

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1 Introduction

Central banks in low-income countries (LICs) have been adopting elements of inflation targeting since the mid-1990s, including an elevated focus on price stability and a commitment to transparency in the conduct of policy (Chapter 1).[1] In concert with a move to market-determined exchange rates and interest rates, these developments have narrowed the gap between the monetary policy frameworks in use among LICs and those employed by emerging-market and high-income economies.

This convergence at the level of policy frameworks coexists with sharp differences in the structure of the economy by income level. In this chapter we focus on the disproportionate size of the food-producing sector in many low-income countries. We trace this phenomenon to subsistence requirements in food consumption, a time-honoured source of what Chenery and Syrquin (1975) called the *structural transformation*. As we document, a large agricultural sector can help account for some striking differences between business cycle patterns in LICs and in richer countries, including the greater volatility of inflation and the real economy in LICs, the larger share of relative food prices in inflation volatility, and the negative business-cycle correlation in LICs between inflation and economy-wide output. The question we then address is: what are the implications of a large food sector for the conduct of monetary policy?

In this chapter, we summarize the results of Portillo et al. (2016), who use a two-sector version of the New Keynesian model to study monetary policy at different stages of development. The subsistence requirement in food gives rise to Engel's Law, which drives a demand-side version of the structural transformation as long as food is imperfectly tradable (we assume a closed economy). **(p.187)** Consumer budgets and sectoral employment levels shift away from the food sector as aggregate productivity rises, and the non-food sector—comprised of manufacturing and services—correspondingly expands. Key demand parameters also change as development proceeds, because proximity to subsistence reduces the income and price elasticities of demand in the food sector (while increasing them in the non-food sector), reduces the inter-temporal elasticity of substitution, and diminishes the effects of changes in food prices on household consumption. These features amplify the impact of food-sector productivity shocks on the relative price of food and therefore on inflation, at earlier stages of development. But the structural transformation also alters the relative importance of sticky prices, a core preoccupation of monetary policy. Consistent with item-level evidence on price flexibility, we model the food sector as a flex-price sector and the non-food sector as subject to sticky prices. A key corollary to the structural transformation is then an increase in the prevalence of sticky prices in the economy.

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The New Keynesian literature suggests that if sticky prices are the only distortion in the economy, monetary policy should focus on keeping these prices stable. In a two-sector setting without subsistence, this means that the central bank should target non-food inflation rather than overall (headline) inflation, as shown by Aoki (2001). We show that this result continues to hold in the presence of a subsistence requirement in food. We also show, however, that despite the increased prevalence of sticky prices as income rises, the welfare stakes in choosing the appropriate inflation target are higher in poor countries than in rich countries. A policy of targeting headline inflation, in particular, leads to greater welfare losses in countries at lower levels of development.

These results follow from the impact of the subsistence requirement on the structure of the economy and (therefore) on the objective function of the monetary authority. In the presence of supply shocks, a policy of stabilizing headline inflation requires larger adjustments in non-food inflation and non-food production in poor countries. Output volatility increases considerably as a result, which is welfare-reducing. This effect is not solely due to the larger share of food in poor economies; it also depends on the limited economy-wide substitutability that prevails in the presence of subsistence. The central bank's welfare-based loss function, in turn, places weight on the variances of non-food inflation, the aggregate output gap, and the gap of the relative price of food. Yet as we show, a policy that stabilizes only the first of these components succeeds in perfectly stabilizing the other two—thereby keeping both aggregate output and the relative price of food around their efficient levels, as in the Aoki (2001) model without subsistence.

A modified version of the 'divine coincidence' of Blanchard and Gali (2007) therefore holds in our model with subsistence: stabilizing the appropriate concept of inflation is sufficient to stabilize the real economy. At face value this result seems at odds with Anand, Prasad, and Zhang (APZ, 2015), who find that headline inflation performs better than core inflation within a class of Taylor-type interest-rate rules applied to similar low-income economies. The resolution of this puzzle turns on the distinction between instrument rules, which govern the settings of variables the central bank directly controls like the short-term interest rate, and targeting rules, which govern (through unspecified means) one or **(p.188)** more of the economic outcomes the central bank may care about (Svensson, 2003). This distinction proves crucial because our analysis of targeting rules reveals that a version of the divine coincidence is very close to holding under the conditions studied by APZ. The APZ model incorporates not only subsistence but also limited asset-market participation and segmented labour markets, two distortions that in combination invalidate the strict Aoki result, as we show using a version of their model.[2] But the optimal weight on food inflation in the APZ model—within the class of targeting rules that fully stabilize some measure of inflation—remains close to zero for a low-income country, and therefore far below its weight in the CPI. Core inflation is therefore

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close to being the single appropriate objective of monetary policy, even when these additional distortions are present. A headline-targeting instrument rule *can* outperform a core-targeting instrument rule in this setting, but only when conditions are such that a moderately aggressive response to headline inflation ends stabilizing core inflation more successfully than the same moderately aggressive response to core inflation. We discuss the intuition behind this result and argue against drawing definitive conclusions on policy objectives from the analysis of simple instrument rules.

2 Related Literature

Engel's Law is sufficient to drive the structural transformation in our model. To keep the analysis simple, we eliminate alternative drivers, including sectoral differences in factor intensity. We also follow the bulk of the structural transformation literature in assuming a closed economy (Herrendorf et al., 2014), an assumption that is not as restrictive as it first appears. Evidence from Gilbert (2011), for example, suggests that domestic grain markets in LICs (particularly for rice) are not strongly integrated with world markets. FAO et al. (2011) attribute this to a combination of restrictive trade policies and high transport and transaction costs. Gollin and Rogerson (2010, 2014) document the high costs of overland trade in Africa and argue that these costs can explain why the vast majority of the food consumed in many African countries does not enter international trade. If food is non-traded, then of course domestic demand plays a major role in determining its relative price regardless of whether or not non-food is traded. Our treatment of differential price flexibility in the food and non-food sectors draws on a recent micro-empirical literature (cited below).

(p.189) 3 Stylized Facts about Developed and Developing Countries

Figure 11.1 documents a set of key characteristics of developed and developing countries. The data cover part or all of the period 1995–2011 and comprise twenty-eight OECD countries, twenty-three sub-Saharan African countries, and fifteen non-OECD countries (the latter mostly emerging market countries).[3]

3.1 The Share of Food in the Consumer Price Index Falls as Income Rises

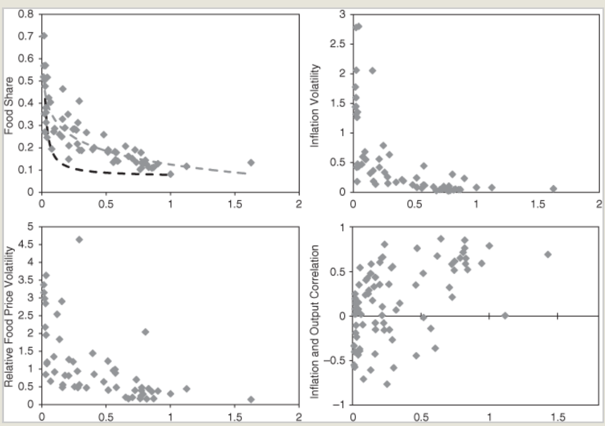

Figure 11.1. Stylized Facts

The upper-left panel in Figure 11.1 plots the weight of food in the consumer price index against average income per capita in PPP dollars over the period 2001–10.[4] Income per capita for the US has been normalized to one. The relationship appears to be convex: the food share increases by more as income

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per capita decreases. This is captured by the good least-squares fit of the food shares to the log of GDP (the grey dashed line). We also show the relation between income per capita and the share of food implied by the model (the black dashed line), which we derive below.

3.2 Food Prices are More Flexible than Non-Food Prices

In Table A.1 of the online appendix to Portillo et al. (2016), we summarize a substantial micro-empirical literature that follows the Bils and Klenow (2004) approach of tracking item-level changes in the prices used to compute the monthly consumer price index. For each country we report the average frequency of price changes for food products, raw food products (where reported), and all products. These data show that food prices change more frequently than average, and that unprocessed food prices change with markedly higher frequency than overall food prices. The difference in flexibility between food prices and overall prices is most pronounced in LICs, probably because a greater share of the food category is unprocessed in these countries. Our assumptions about price flexibility are therefore highly appropriate for LICs.[5]

3.3 Inflation Volatility Falls as Income Rises

The upper-right panel in Figure 11.1 shows the standard deviation of headline inflation (quarter-on-quarter) against income per capita. The focus here is on **(p. 190)** business-cycle frequency, so we use a band-pass filter that retains frequencies between six and thirty-two quarters.[6] There is a decidedly negative relationship with real GDP per capita: countries with lower income per capita have inflation rates that are considerably more volatile. The bottom-left panel shows that there is also a negative relationship between the volatility of changes in the relative price of food (in relation to the CPI) and income per capita.

3.4 The Correlation Between Headline Inflation and Output Increases with Income

The bottom-right panel in Figure 11.1 plots the correlation between headline inflation and output against income per capita at a business-cycle frequency. It reveals that there is a positive relationship between this variable and income per capita, starting from a negative value representing most of the LICs.

We now present a model consistent with these features.[7] **(p.191)**

4 The Model

4.1 Consumers and Producers

The representative consumer chooses a consumption aggregate c_t*, labour effort n_t and holdings of a nominal bond to maximize lifetime utility, which is given by:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[ln\left(c_t*\right) - \frac{\left(n_t\right)^{1+\psi}}{1+\psi} \right].$$

The composition of c_t* is:

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$$c_t{}^* = Z(c_{F,t} - \bar{c}_F)^{\alpha_F} c_{N,t}^{1-\alpha_F}.$$

(1)

The pair $(c_{F,t}, c_{N,t})$ denotes consumption of food and non-food, with the parameter $\bar{c}_F$ indicating the subsistence level of food consumption, a threshold below which food consumption cannot decline. Z is a scaling parameter that takes the value $(\alpha_F)^{-\alpha_F}(1-\alpha_F)^{-(1-\alpha_F)}$ to simplify notation. In Figure 11.2, the Cobb-Douglas consumption aggregator generates indifference curves for food and non-food consumption that are homothetic starting from the displaced origin point $(\bar{c}_F, 0)$.

The food sector features perfect competition and flexible prices. Food production is given by:

(p.192)

$$y_{F,t} = A_{F,t}(An_{F,t})^{\alpha} K_F^{1-\alpha},$$

(2)

where K_F is the equilibrium level of capital in the sector given an economy-wide level of labour augmenting productivity A, $n_{F,t}$ is the demand for labour in the food sector, α is the labour share, and $A_{F,t}$ is a productivity shock in agriculture. Our short-run analysis takes place around long-run equilibria (steady states) that correspond to different values for A.

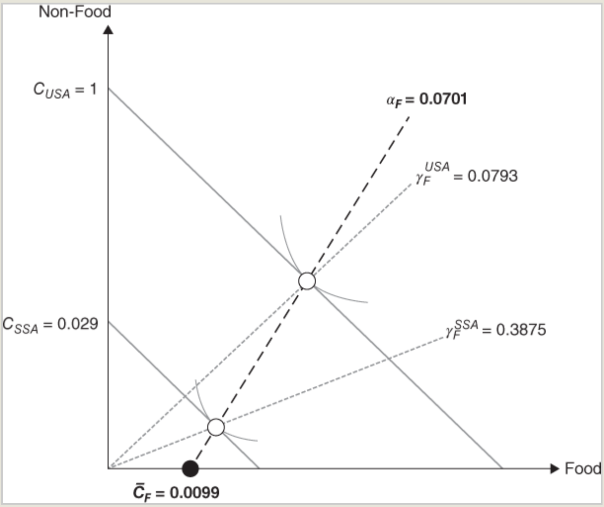

Figure 11.2. Calibration

The non-food sector is composed of a continuum of monopolistic competitors, each providing a variety $y_{N,t}(i)$, with $i \epsilon [0, 1]$. Varieties are combined by consumers into a Dixit-Stiglitz aggregate, $y_{N,t}$, giving rise to the sectoral price index

$$P_{N,t} = \left[\int P_{N,t}(i)^{1-\epsilon} di\right]^{\frac{1}{1-\epsilon}}$$

(3)

where ε is the elasticity of substitution between varieties. Production of non-food varieties is given by:

$$y_{N,t}(i) = [An_{N,t}(i)]^{\alpha} K_N^{1-\alpha},$$

(4)

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where K_N, again is the equilibrium level of capital corresponding to aggregate productivity A. We assume Calvo (1983) pricing in the non-food sector. Each period's aggregate price index for non-food items is therefore a weighted average of the previous period's prices, for firms unable to make any price adjustment, and the forward-looking price that maximizes the discounted stream of expected profits, for the fraction $(1-\theta)$ of firms that are randomly given the opportunity to reset their prices.

Along with market-clearing conditions for food, non-food, and labour markets,[8] the model requires a description of the stochastic environment. Food-sector productivity shocks are crucial to our analysis, and we specify these using an autoregressive process of order 2:

$$\widehat{A}_{F,t} = (1+\rho_A)\,\widehat{A}_{F,t-1} - (\rho_A + \varrho)\,\widehat{A}_{F,t-2} + \varepsilon_{A_F,t},$$

where a hat on top of a variable $\left(\hat{*}\right)$ denotes a per cent deviation from steady state. This process differs from a persistent AR(1) in allowing food-productivity shocks to have a persistent effect on food inflation. To parameterize the AR(2), we rely on the observed behaviour of both international relative food prices and relative food prices in a sample of low-income countries in sub-Saharan Africa. Estimates of the persistence of relative food prices are reported in Table 11.1. These variables are well characterized by AR(2) processes with values of ρ_A between 0.5 and 1 and positive but small values of ϱ.

The model also features shocks to nominal aggregate demand, which we discuss below.

Table 11.1. Relative Price of Food: Estimated AR(2)

Dependent Variable:	(1)	(2)
ln(Relative Price of Food)	Coef.	Std. Error
1st lag	1.631	(0.012)***
2nd lag	−0.736	(0.012)***
Constant	−0.001	(0.000)***

Notes: $R^2 = 0.975$. Estimates are based on quarterly data from 23 sub-Saharan African countries (1,319 time-country observations). The time series are the natural logarithm of the ratio of food prices to non-food prices, filtered with a band-pass filter to retain frequencies between six and thirty-two quarters.

(***) p<0.01, ** p<0.05, * p<0.1

(p.193)

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4.2 The Structural Transformation

The structural transformation emerges across steady states that correspond to different values for economy-wide productivity, A. With mobile labour and capital and identical factor proportions in the two sectors, the steady-state relative price of food is 1 and the values of capital equate the marginal products of capital in each sector with the steady-state rental rate $1/\beta - 1$.

The presence of a subsistence threshold for food consumption $\bar{c}_F$ makes the relationship between aggregate consumption (output) and economy-wide productivity non-linear, with an elasticity that is below one but approaches one as labour productivity increases. When consumption is close to subsistence, income effects dominate substitution effects in the supply of labour and agents work more in order to satisfy their subsistence needs. As productivity and income increase, agents reduce their labour supply and enjoy more leisure at the cost of a smaller increase in total consumption.

We use γ_F to denote the share of expenditure and labour that is allocated to the food sector in a steady state. This key parameter is a function of the level of aggregate productivity, through the influence of the latter on aggregate consumption. When $\bar{c}_F > 0$, γ_F converges to α_F from above as steady-state consumption increases. Four new parameters depend on the value of γ_F and will play a role in the log-linearized version of the model:

$$\xi = \frac{\gamma_F}{1-\gamma_F} \geq \frac{\alpha_F}{1-\alpha_F},\ \phi = \xi\left(1-\alpha_F\right) - \alpha_F \geq 0, \delta = \frac{\alpha_F}{\gamma_F} \leq 1,\ \text{and}\ \sigma = \frac{1-\alpha_F}{1-\gamma_F} \geq 1.$$

In the presence of subsistence, as steady-state consumption increases, ξ converges toward $\alpha_F/\left(1-\alpha_F\right)$ from above, ϕ converges toward zero from above, and δ and σ converge toward one, the former from below and the latter from above.

4.3 Log-Linearization

We focus here on how food subsistence modifies the standard three-equation New Keynesian model that emerges after log-linearization. The existence of a **(p.194)** subsistence threshold is captured by $\gamma_F > \alpha_F$ and the values of the related parameters (ξ, ϕ, δ, and σ), all of which are specific to the economy's level of aggregate productivity.

The forward-looking IS equation takes the form

$$\hat{y}_t = -\sigma^{-1} E_t\left(\widehat{R}_t - \widehat{\pi}_{t+1} + \phi \Delta \hat{p}_{F,t+1}\right) + E_t \hat{y}_{t+1}.$$

(5)

Subsistence introduces two modifications into this equation. First, the inter-temporal elasticity of substitution for output is given by σ^{-1}, which is less than one—the value that would be obtained if $\bar{c} = 0$—when $\gamma_F > \alpha_F$ ($\bar{c}_F > 0$). This

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modification is related to the difference between the consumption aggregate that matters for private sector decisions (c_t*) and measured consumption (c_t), with the former always smaller than the latter. The second difference concerns the presence of the expected change in relative food prices ($\Delta\hat{p}_{F,t+1}$). When $\gamma_F > \alpha_F$, the inflation rate that matters for private sector decisions ($\widehat{\pi}_t^*$) differs from the measured headline inflation rate ($\widehat{\pi}_t$) by the quantity $\phi\Delta\hat{p}_{F,t}$. As the economy develops, this term disappears and changes in the expected relative price of food no longer exert a direct effect on inter-temporal decisions.

Second, inflation in the non-food sector is determined by the New Keynesian Phillips curve

$$\widehat{\pi}_{N,t} = \beta E_t \widehat{\pi}_{N,t+1} - \kappa\widehat{\mu}_{N,t},$$

(6)

where $\widehat{\mu}_{N,t}$ denotes changes in markups in the non-food sector, and κ is defined as:

$$\kappa = \frac{(1-\theta\beta)(1-\theta)\alpha}{\theta\alpha + \epsilon(1-\alpha)}.$$

Overall inflation is given by:

$$\widehat{\pi}_t = \widehat{\pi}_{N,t} + \xi\Delta\hat{p}_{F,t},$$

(7)

and the definition of aggregate GDP and the relation between aggregate employment and output can be expressed as:

$$\hat{y}_t = \gamma_F\hat{y}_{F,t} + (1-\gamma_F)\hat{y}_{N,t} = \alpha\widehat{n}_t + \gamma_F\widehat{A}_{F,t}.$$

(8)

For purposes of welfare-based analysis it is helpful to distinguish between movements in output that would hold if prices were flexible—the potential output component—and movements in output due to the presence of nominal rigidities—the output gap component $\tilde{y}_t$. The latter is directly related to inflationary pressures in the sticky-price sector:[9]

$$\hat{y}_t = \hat{y}_t^{\text{flex}} + \tilde{y}_t.$$

(9)

Written as a function of the aggregate output gap and the inflation rate of non-food prices, the IS curve and New Keynesian Phillips curve in this two-sector setting take the form

(p.195)

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$$\tilde{y}_t = -\Theta E_t \left(\widehat{R}_t - \widehat{\pi}_{N,t+1} - \hat{r}_t^{\text{flex}}\right) + E_t \tilde{y}_{t+1},$$

(10)

$$\widehat{\pi}_{N,t} = \beta E_t \widehat{\pi}_{N,t+1} + \kappa_y \tilde{y}_t,$$

(11)
where the coefficients Θ and κ_y are functions of the model parameters and where $(\sim)$ denotes a percentage difference relative to the short-run equilibrium under flexible prices.

Finally, we must define a monetary policy rule. For model simulations designed to generate business-cycle patterns at alternative levels of development, we describe monetary policy as the following rule:

$$\widehat{R}_t = \left(\hat{r}_t^{\text{flex}} + \xi E_t \Delta \hat{p}_{F,t+1}^{\text{flex}}\right) + \varsigma \widehat{\pi}_{N,t} + u_{MP,t},$$

(12)
where

$$u_{MP,t} = \rho_{MP} u_{MP,t-1} + \varepsilon_{MP,t}.$$

Here, $\hat{r}_t^{\text{flex}}$ is the natural rate of interest, the interest rate that would hold under flexible prices, and $\hat{p}_{F,t}^{\text{flex}}$ is what the relative price of food would be if non-food prices were flexible. When $u_{MP,t} = 0$, this rule ensures that core inflation is perfectly stabilized. Instead, a negative shock to $\varepsilon_{MP,t}$ will generate a monetary policy loosening, which can be thought of as an expansionary shock to aggregate demand, and affects core (and headline) inflation. This policy specification therefore generates a simple dichotomy between supply and demand shocks.

For the welfare analysis, we will focus on targeting rules rather than instrument rules because our interest is in understanding the optimal target of monetary policy. In particular, we consider the welfare implications of policies that succeed in stabilizing a weighted sum of food and non-food inflation. These take the form

$$\widehat{\pi}_t^{\omega} = \omega \widehat{\pi}_{F,t} + (1-\omega)\,\widehat{\pi}_{N,t} = 0, \;\; \text{with} \omega \in [0,\ 1]\,,$$

(13)
which embeds the specific cases of non-food-inflation targeting ($\omega = 0$), food-inflation targeting ($\omega = 1$), and (iii) headline-inflation targeting ($\omega = \gamma_F$).

4.4 Calibration

The calibration is presented in Table 11.2. Most of our parameter choices are standard in the new-Keynesian literature; for details see Portillo et al. (2016). Figure 11.2 shows how we calibrate the structural transformation, the trajectory

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of which depends on the food-subsistence floor $\bar{c}_F$ and the marginal budget share devoted to food, α_F. Our aim is to encompass the disparate situations of high- and low-income economies—say, the US economy and the economy of a typical country in sub-Saharan Africa. In our model, the sole difference between high- and low-income economies is the level of aggregate productivity, which drives not only the level of aggregate consumption but also its distribution between food and non-food. Setting aggregate consumption per capita in the USA to 1, the median average consumption level in the set of sixteen low-income countries in **(p.196)** sub-Saharan Africa for which we have data is 0.029. In Figure 11.2, these numbers tie down the positions of the linear transformation curves for consumption in each location. To locate actual consumption we use the observed values of γ_F—the budget shares devoted to food in the USA and the median low-income African country—to pin down the slopes of the rays through the origin in Figure 11.2. A straight line drawn through the two intersection points between food shares and transformation curves then jointly determines both the marginal budget share devoted to food and the value of the subsistence floor.

Table 11.2. Calibration

Parameter	Definition	Value
$\bar{c}_F$	Subsistence level of food consumption	0.0099
α_F	Non-subsistence food consumption share	0.0701
α	Labour income share	0.7
β	Discount factor	0.99
θ	Probability of not being able to reset price	0.75
ς	Response coefficient to non-food inflation in the rule	1.5
ψ	Inverse of Frisch elasticity of labour supply	5
ϵ	Elasticity of substitution between different varieties	6
ρ_A	Parameter in the AR(2) process for food productivity shocks	0.631
ϱ	Parameter in the AR(2) process for food productivity shocks	0.105
σ_{A_f}	Standard deviation of food productivity shocks	0.6
ρ_{MP}	Persistence in the AR(1) process for monetary policy shocks	0.8
σ_{MP}	Standard deviation of monetary policy shocks	0.6

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The upper-left panel of Figure 11.1 shows the cross-country relationship between food share and income generated by our calibration. The model does a reasonably good job of replicating the relationship in the data, though it tends to under-predict the food share for middle-income countries.

4.5 Impulse Response Analysis

4.5.1 An Exogenous Monetary Policy Loosening ($\varepsilon_{MP,t} < 0$)

Figure 11.3 shows the effect of an exogenous monetary policy loosening, captured by a negative shock to $\varepsilon_{MP,t}$. Food prices are flexible and therefore rise by more than non-food prices. The relative price of food rises by roughly 11 per cent more in the poor country, however, while the increase in non-food inflation is slightly smaller. Given the large size of its food sector, headline inflation increases by more than twice as much in the poor country. Overall output expands in both countries due to the presence of sticky non-food prices, and the food sector shrinks in response to demand-side substitution generated by the increased relative price of food. Sectoral impacts differ by income, with the non-food sector expanding by more and the food sector contracting by less in the low-income country.[10] **(p.197)** **(p.198)** The overall expansion is larger in the rich country, however, because its sticky-price (non-food) sector is larger.

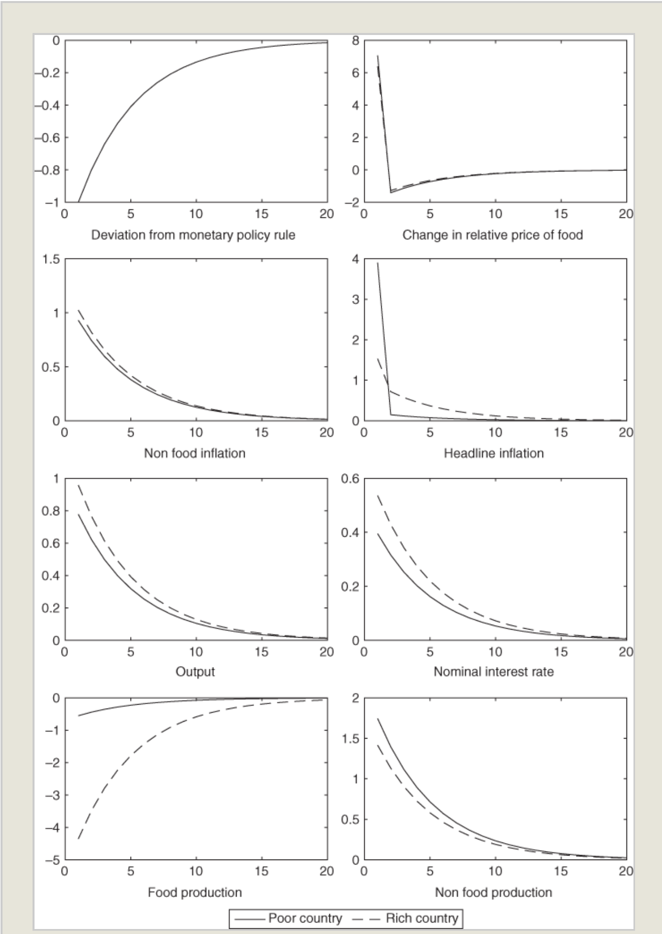

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Figure 11.3. A Monetary Policy Shock, $\varepsilon_{MP} < 0$

4.5.2 A Negative Shock to Food Production ($\varepsilon_{A_F,t} < 0$)

Figure 11.4 shows the impact of a 1 per cent decline in productivity in the food sector $\varepsilon_{A_F,t}$ Note that the productivity decline initially amplifies before correcting itself during the second year. Given the reduced substitutability in the economy—because of subsistence—the relative price of food increases by more in the poor country. For the same reason food production contracts by less in the poor country, at the cost of a larger contraction in the non-food sector. The specification of the monetary policy rule prevents non-food inflation from increasing in either location. But headline inflation increases by more in the poor country, reflecting its large food share. Note that inflation goes from positive to negative after one year, as the recovery in productivity during the second year creates deflationary pressure. Again, these effects are more pronounced in the poor country given the larger share of food in the consumer price index.

4.5.3 A Negative Shock to Food Production ($\varepsilon_{A_F,t} < 0$) under Headline Inflation Targeting

If monetary policy targets headline inflation ($\widehat{\pi}_t = 0$, Figure A.1 in the online appendix to Portillo et al., 2016), then the increase in the relative price of food described above must be compensated by a decrease in non-food inflation. In the presence of sticky prices, this can only come about through a demand-driven contraction in non-food production that exacerbates the contraction in overall output.

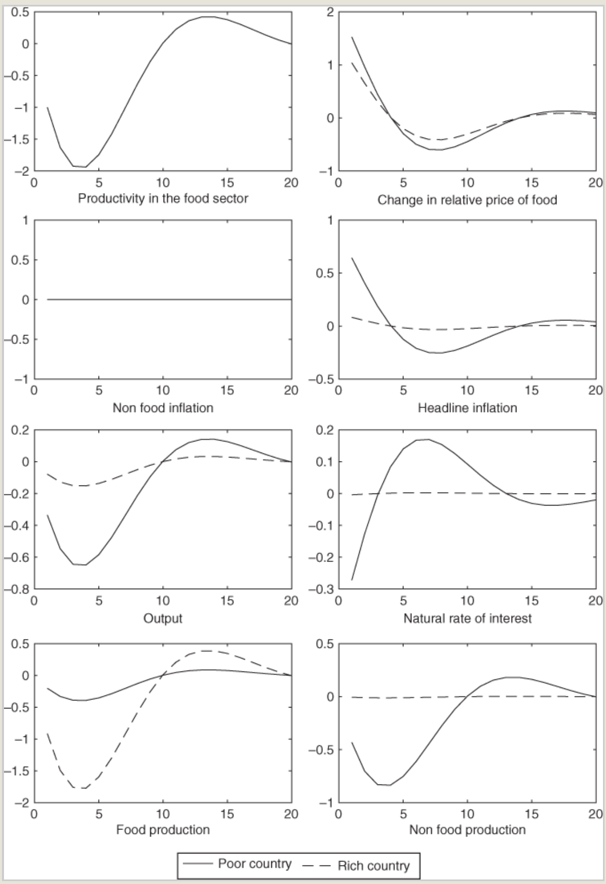

Figure 11.4. A Shock to Food Sector Productivity, $\varepsilon_{A_F} < 0$

This effect is barely noticeable in a high-income country because the food sector is so small. Only a very small decrease in non-food inflation is needed, implying a tiny contraction of non-food output. The poor country, by contrast, requires a large decline in non-food prices to control headline inflation in the face of a food supply shock—

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which in turn means a sharp recession in the non-food sector. The effect on aggregate output is therefore larger.

The choice of inflation target is therefore more important for output in the poor country than in the rich country, even though price stickiness is more relevant in the latter case because it affects a larger share of goods. In Section 6 we show analytically that the welfare losses associated with targeting headline inflation are inversely related to development level.

4.6 Second-Order Moments

In Portillo et al. (2016), we simulate the model and compare the model-generated second-order moments to those observed for the US and the median observation **(p.199)** in our group of African countries. Our model replicates several stylized facts of inflation across levels of development. The relative price of food accounts for about 50 per cent of the volatility of inflation in LICs (79 per cent in the model), compared with 3 per cent in the US (16 per cent in the model). The model broadly **(p.200)** generates the right comovement between inflation and output: as shown in Figure 11.1, LICs tend to have negative (or zero) inflation/output correlations, while the correlation becomes increasingly positive at higher levels of development. The model generates inflation volatility in LICs that is about 160 per cent higher than the volatility in the US economy, short of the roughly 300 per cent difference observed in the data. We note, however, that the model, under-predicts the volatility of changes in the relative price of food in LICs and over-predicts this volatility in the US.

5 Welfare Analysis

5.1 Optimal Monetary Policy Under Subsistence

Despite the presence of food subsistence, optimal monetary policy requires complete stabilization of sticky-price non-food inflation. Doing so is sufficient to stabilize both aggregate output and the relative price of food around their efficient levels. To obtain these analytical results, we derive a loss function in Portillo et al. (2016), using a second-order approximation to the utility losses faced by the representative agent due to deviations from the efficient equilibrium. The following proposition makes this loss function explicit.

Proposition 1 Consider the model with food subsistence, described above, and assume that $\alpha = 1$. The average welfare loss per period is given by the following linear function:

$$\mathbb{L} = \frac{1}{2}\sigma\left[(1-\gamma_F)\,\frac{\epsilon}{\kappa} var\left(\widehat{\pi}_{N,t}\right) + (\psi+\sigma)\, var\left(\tilde{y}_t\right) + \frac{\alpha_F}{1-\gamma_F} var\left(\tilde{p}_{F,t}\right)\right],$$

(14)

where $\sigma = \frac{1-\alpha_F}{1-\gamma_F}$ and $\kappa = \frac{(1-\theta\beta)(1-\theta)}{\theta}$.

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Thus the welfare loss can be expressed as the weighted sum of the variances of sticky-price non-food inflation ($\widehat{\pi}_{N,t}$), the aggregate output gap ($\tilde{y}_t$), and the gap of the relative price of food ($\tilde{p}_{F,t}$). Note that the weights are functions not only of the preference parameters (α_F, ψ,ϵ,β) and the degree of price stickiness (θ), but also of the share of expenditures allocated to food (γ_F) and the related parameter σ. The latter parameters reflect subsistence and play an important role in determining the *relative* weights that the central bank gives to the variances of the aggregate output gap and the gap of the relative price of food, relative to sticky-price non-food inflation.

Online appendix Figure A.2 plots these relative weights for the loss function (14) —i.e., $\frac{(\psi+\sigma)\kappa}{(1-\gamma_F)\varepsilon}$ and $\frac{\alpha_F\kappa}{(1-\gamma_F)^2\epsilon}$—and shows that both relative weights are increasing in the degree of subsistence. The slope of the relative weight on the output gap is much steeper than that on the relative price of food. In particular, holding everything else constant, a poor country ($\gamma_F = 0.42$) should assign almost twice the weight a rich country should to the objective of stabilizing the output gap ($\gamma_F = 0.08$).

Although stabilizing aggregate output and the relative price of food around their efficient levels are appropriate goals for monetary policy, optimal policy is **(p. 201)** still characterized as a strict inflation-targeting regime. More specifically, despite food subsistence, optimal monetary policy corresponds to the complete stabilization of a core inflation measure, as in Aoki (2001). The appropriate core measure in our model is sticky-price non-food inflation. The following corollary formalizes this result.

Corollary 1 The welfare loss (14) can be rewritten as

$$\mathbb{L} = \frac{1}{2}\sigma\left\{(1-\gamma_F)\frac{\varepsilon}{\kappa}var\left(\widehat{\pi}_{N,t}\right) + \frac{1}{\kappa\kappa_y}\left[(\psi+\sigma) + \frac{\alpha_F}{1-\gamma_F}\left(\frac{\psi+\sigma}{\sigma}\right)^2\right]var\left(\widehat{\pi}_{N,t} - \beta E_t\widehat{\pi}_{N,t+1}\right)\right\},$$

(15)

and therefore optimal monetary policy corresponds to strict targeting of sticky-price non-food inflation, as implemented by setting $\widehat{\pi}_{N,t} = 0$ for every t.

Corollary 1 implies that *strict* targeting of sticky-price non-food inflation maximizes social welfare. This approach completely stabilizes aggregate output and the relative price of food around their efficient levels. The ‘divine coincidence’ of Blanchard and Gali (2007) therefore holds in our model: stabilizing (the appropriate concept of) inflation is equivalent to stabilizing the welfare-relevant output gap.

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While food subsistence does not overturn the optimal policy result of strictly targeting core (sticky-price) inflation, it does raise the stakes for monetary stabilization policy. In particular, targeting headline inflation instead of core inflation is more costly in terms of welfare losses for countries that are closer to the subsistence threshold. Table 11.3 calculates the welfare losses for poor and rich countries of targeting headline versus core inflation, when the economies experience a negative shock to productivity in the food sector.[11] The table also shows the standard deviations of sticky-price non-food inflation ($\widehat{\pi}_{N,t}$), the aggregate output gap ($\tilde{y}_t$), and the gap of the relative price of food ($\tilde{p}_{F,t}$) associated with these policies.

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Table 11.3. Welfare Losses from Alternative Targeting Rules, Rich and Poor Countries

	Targeting Rules			
	Poor Country[a]		Rich Country[a]	
	Headline Inflation[b]	Non-Food Inflation[c]	Headline Inflation[b]	Non-Food Inflation[c]
$\sqrt{var\left(\widehat{\pi}_{N,t}\right)}$	0.374	0	0.079	0
$\sqrt{var\left(\tilde{y}_{t}\right)}$	0.103	0	0.028	0
$\sqrt{var\left(\tilde{p}_{F,t}\right)}$	0.425	0	0.167	0
Welfare Loss	4.630	0	0.206	0

[a] For a poor country $\gamma_F = 0.42$, while for a rich country $\gamma_F = 0.08$.

[b] Headline inflation targeting: $\gamma_F \widehat{\pi}_{F,t} + (1-\gamma_F)\,\widehat{\pi}_{N,t} = 0$.

[c] Core (non-food) inflation targeting: $\widehat{\pi}_{N,t} = 0$.

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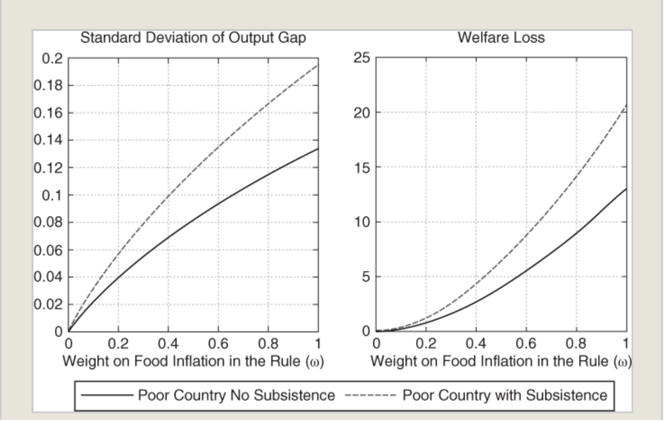
(p.202) When both countries implement the optimal policy of targeting core inflation, standard deviations and welfare losses are equal to zero. Adopting headline inflation targeting increases the volatility of these economies and reduces welfare; and the welfare loss for the poor country is much greater than that of the rich country.[12] In a poor country that faces a negative productivity shock in the food sector (which increases the relative price of food), keeping broad measures of inflation stable implies engineering large decreases in non-food inflation. These decreases are bigger in poor countries than in rich countries, given the larger weight of food in the poor economy. And, because of sticky prices in the non-food sector, these drops are also accompanied by bigger contractions in non-food output and overall output in a poor country.

5.2 Subsistence is More Than a Higher Food Share

It is tempting to conclude that the importance of subsistence stems simply from generating a higher food share at lower levels of development. An argument could then be made that all that is necessary to analyse developing countries is the standard model without subsistence but with higher food share, i.e., $\alpha_F = \gamma_F \approx large$. To show that this is not the case we compare the welfare costs of targeting various measures of inflation (according to equation (13)) in a poor economy with food subsistence ($\alpha_F = 0.07$, $\gamma_F = 0.42$) to those costs in the same economy without subsistence ($\alpha_F = \gamma_F = 0.42$).

Figure 11.5 shows the standard deviation of the output gap and the welfare loss as ω, which is the weight on food inflation in the measure of inflation that is targeted by the central bank, goes from zero (no weight on food inflation) to one (only food inflation is stabilized), for the two economies mentioned above.[13] For any positive weight on food inflation ($\omega > 0$), both the volatility of aggregate output and the welfare losses are bigger for the poor country with subsistence, and are increasing in that weight. The volatilities of non-food inflation and the gap of the relative price of food (not shown) are broadly similar, so most of the variations in welfare stem from the impact on output. But what accounts for the higher output volatility and higher welfare costs?



A poor economy with subsistence is an economy in which reallocation away from agriculture is hampered by the need to maintain a certain level of food consumption. The limited economy-wide factor reallocation implies that supply-side shocks have bigger aggregate effects. The corollary is that equilibrium relative food

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Figure 11.5. Standard Deviation of Output Gap and Welfare Loss, With and Without Subsistence

prices will be more volatile under subsistence. In this context, targeting the wrong price level is particularly costly because the associated real adjustment (shown in Figure A.2 in the online appendix to Portillo et al., 2016) increases with the level of relative food price volatility.

In addition to generating a more volatile output gap if policy is suboptimal, the economy with subsistence assigns a larger weight to output volatility in its loss function. **(p.203)** This can be seen by allowing the subsistence floor to approach zero in equation (14) so that subsistence concerns disappear. The coefficient on output volatility, $\frac{1}{2}\sigma\left(\psi+\sigma\right)$ with $\sigma \geq 1$, reduces to $\frac{1}{2}(\psi+1)$ when the subsistence floor is zero. In sum, this exercise reinforces our view that subsistence raises the stakes for monetary policy at earlier stages of development.

6 Model Extension

The finding that subsistence does not overturn the divine coincidence result of Blanchard and Gali (2007) is at odds with recent findings by Anand and Prasad (2012) and Anand et al. (2015) (APZ).[14] These authors study a model that features limited asset market participation (LAMP) and segmented labour markets (SLM) in addition to subsistence, and they conclude that targeting headline inflation is superior to targeting core inflation from a welfare perspective. To reconcile our findings with theirs, we extend our model to include LAMP and SLM and reconsider the design of monetary policy through the lens of optimal targeting rules (the model is presented in more detail in the online appendix to Portillo et al., 2016). For simplicity we continue to assume here that the labour share (α) is 1.

We extend our model to include two types of agent. One type provides labour services exclusively to the non-food sector (urban agents, which make up a share λ^* of the population), and the second type provides labour exclusively to the food **(p.204)** sector (rural agents, with share $(1-\lambda^*)$). Because labour is immobile across the two sectors, wages in each sector are not necessarily equal. Furthermore, as in Anand and Prasad, rural agents do not have access to financial assets so interest rate movements do not affect their consumption.[15]

The interaction of subsistence, LAMP, and SLM dramatically changes the economy's response to food productivity shocks. Consider a negative shock to food productivity. First, SLM prevents the reallocation of labour across sectors, which amplifies the effects of the shock on sectoral production and leads to a larger increase in relative food prices. Second, food productivity shocks have large and opposing effects on the incomes of the two types of agent. Subsistence lowers the price elasticity in the food sector. The increase in relative food prices

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more than compensates for the decrease in food production, so the negative shock to food sector productivity has *positive* effects on real income for households that work in the food sector. Furthermore, rural agents respond to this income increase by consuming more leisure and decreasing their labour supply, which adds further to the contraction in food production. The opposite effects occur in the non-food sector, so that negative food productivity shock lowers the level of income of urban agents, and they increase their labour supply to compensate, contributing to an expansion in the non-food sector. If the economy is close to subsistence, the latter effect can dominate, to the extent that total output increases in response to a negative food supply shock. This is the case in our model, when calibrated to data from African countries.

To investigate how these features change the nature of optimal monetary policy, we derive the welfare-based loss function for this version of the model, focusing on the case in which $\lambda^* = (1 - \gamma_F)$.[16]

Proposition 2 Consider the model with food subsistence, limited asset market participation and segmented labour markets, and assume that $\alpha = 1$ and $\lambda^* = (1 - \gamma_F)$. We use a weighted sum of urban and rural agents' utility to derive the average welfare loss per period, given by the following function:

$$\mathbb{L} = \frac{1}{2}\sigma \left[(1 - \gamma_F) \frac{\epsilon}{\kappa} var\left(\widehat{\pi}_{N,t}\right) + \frac{(\psi + \sigma)}{(1 - \gamma_F)} var\left(\tilde{\tilde{y}}_t\right) \right],$$

(16)

where $\tilde{\tilde{y}}_t = \hat{y}_t - \hat{y}_t^{alt}$, where $\hat{y}_t^{alt} \neq \hat{y}_t^{flex}$.

As in the baseline model without LAMP and SLM, welfare depends on the volatility of core (and not headline) inflation, although it no longer depends on the volatility of the gap in relative food prices. Instead, it now depends on an alternative measure of the output gap ($\tilde{\tilde{y}}_t$), which reflects the fact that the economy's response to food productivity shocks is inefficiently low (because of **(p.205)** **(p.206)** the offsetting effect coming from non-food production) due to the interaction of the three features mentioned above (subsistence, LAMP, and SLM).[17]

Because of this new inefficiency, a trade-off between non-food inflation and output stabilization exists. The divine coincidence therefore breaks down: it is no longer optimal simply to stabilize non-food inflation. Specifically, when there is a negative food supply shock, optimal policy now calls for a policy tightening, so that the economy approaches the more efficient level of output. But this movement implies that a decline in non-food inflation is part of the efficient response. Including food prices in the measure of inflation that is targeted is an

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indirect way of approaching the optimal policy prescription, as it elicits the required policy tightening.

To assess whether this matters quantitatively, we evaluate targeting rules as in equation (13). These are shown in Figure 11.6, with each of the three panels showing results for a different degree of persistence in food productivity.[18] Although perfect core (non-food) inflation stabilization is no longer optimal because of the trade-off mentioned above, it is still very close to optimal. In all three cases considered, the optimal weight on food inflation (indicated by the black vertical line) is minimal, between zero and 2 per cent. This is much lower than the weight on food inflation in the CPI (at 0.42, as indicated by the dashed grey line), and it implies near-perfect core inflation stabilization.[19] Thus, (near-perfect) core inflation stabilization remains the main objective of policy even in the presence of these additional features.

How can we reconcile these findings with those of APZ? The apparent contradiction results from the authors' focus on optimal interest rate rules of the form:

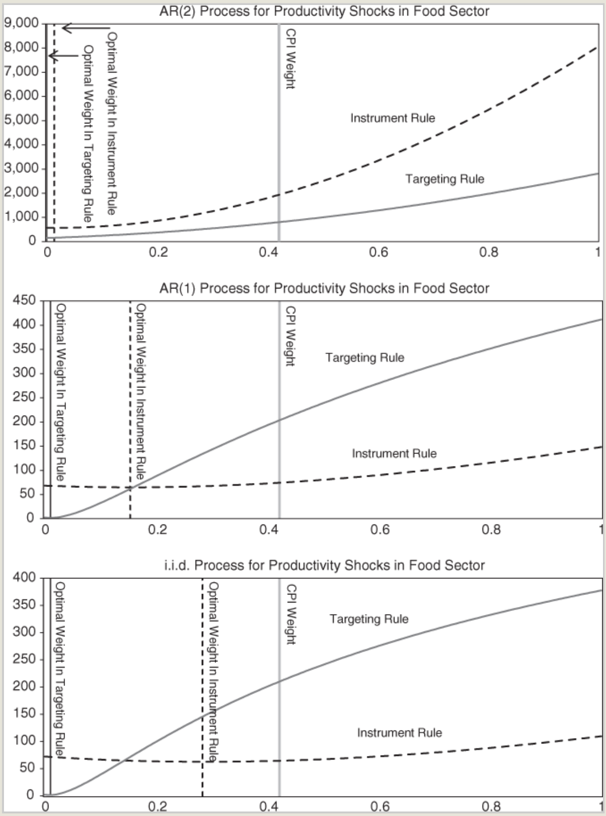

Figure 11.6. Welfare Losses at Alternative Food-Inflation Weights

$$\widehat{R}_t = \rho_R \widehat{R}_{t-1} + (1-\rho_R)\left(\phi_\pi \widehat{\pi}_t^\omega + \phi_y \hat{y}_t\right),$$

where $\widehat{\pi}_t^\omega$ is given by the first equality in equation (13). Figure 11.6 also includes a welfare evaluation of their rule, for the case in which $\rho_R = 0.67, \phi_\pi = 1.5, \phi_y = 0.5$. Unlike targeting rules, the optimal weight in their

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rule (given by the dashed black line) depends to a large extent on the assumed persistence of the shock.[20] Under a persistent AR(2) process like the one used throughout this chapter, the optimal weight on food inflation is near zero. As the persistence decreases, however, the optimal weight on food inflation in their instrument rule increases, and begins to approach the weight in the CPI. With the persistence used in their paper (the middle panel), the optimal weight jumps to 15 per cent; with i.i.d. shocks it increases further to 29 per cent, broadly consistent with the findings in APZ.

(p.207) The APZ finding is therefore contingent on the use of a particular instrument rule in a particular stochastic setting. Headline inflation wins in their setting because when productivity shocks are sufficiently transitory, a central bank that responds to headline inflation in its interest-rate rule ends up stabilizing core inflation more effectively than if it had responded to core inflation. It is nonetheless core inflation that the central bank ultimately cares about, as revealed by our analysis of target rules.

This divergence between optimal instrument rules and optimal targeting rules is a well-known issue in the design of monetary policy. As emphasized by Svensson (2003) and Svensson and Woodford (2005), targeting rules are more closely related to the objectives of monetary policy and are therefore more robust to model parameters. The welfare properties of interest rate rules, in particular, depend on how nearly they approximate movements in the natural rate of interest. As discussed further in the online appendix to Portillo et al. (2016), a negative shock to food productivity increases the equilibrium real interest rate in an economy with subsistence, LAMP, and SLM—and by more, the less persistent the productivity shock. In this case, assigning greater weight to food inflation can help generate the desired increase in real interest rates, but for reasons that are not robust to the stochastic environment and are unrelated to the deeper policy objectives of the monetary authority.

7 Conclusion

This chapter demonstrates that proximity to a subsistence requirement for consumption has far-reaching implications for macroeconomic dynamics, but it does not alter the appropriate objective of monetary policy when sticky prices are confined to the non-food sector. Despite the food sector's outsized role in the economy, the optimal targeting rule calls for the stabilization of core inflation only, as in higher-income countries. But subsistence raises the stakes: the welfare costs of mis-specifying the goals of the monetary authority are higher for LICs.

Subsistence is just one of many dimensions that differentiate low-income countries from the rich-country contexts for which New Keynesian models were developed. Our findings are robust to the inclusion of limited asset-market participation and segmented labour markets, despite the fact that when these

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features are present, headline inflation may outperform core inflation within a Taylor-type instrument rule. The reason is that while these features invalidate the divine coincidence they do so only very narrowly. The monetary authority continues to care almost exclusively about core inflation. When food productivity shocks display the kind of persistence we observe in real food prices, even a tightly-specified Taylor rule favours the use of core inflation rather than headline.

It remains to be seen whether our results are robust to additional features of the low-income environment. These include activities like private and/or public food storage that may help account for the observed persistence of relative food prices—something we have built in from the outside via persistent productivity shocks—and open-economy considerations that would drive a wedge between **(p.208)** food consumption and food output. We have also left aside some features of the structural transformation that may have implications for the conduct of monetary policy. These include the shrinkage of urban informal activity, which may alter the degree of wage and price flexibility in that sector, and the replacement of food staples with more processed varieties as development proceeds. Incorporating these structural features remains a crucial step in adapting the New Keynesian framework to the needs of low-income countries.

References

Bibliography references:

Anand, R., and E. Prasad (2012). ‘Core vs. Headline Inflation Targeting in Models with Incomplete Markets’, Manuscript, Cornell University.

Anand, R., E. Prasad, and B. Zhang (2015). What Measure of Inflation Should a Developing Country Central Bank Target? *Journal of Monetary Economics*, (74), 102–16.

Aoki, K. (2001). Optimal Monetary Policy Responses to Relative-Price Changes. *Journal of Monetary Economics*, 48(1), 55–80.

Bils, M., and P. Klenow (2004). Some Evidence on the Importance of Sticky Prices. *Journal of Political Economy*, 112, 947–85.

Blanchard, O. and J. Gali (2007). Real Wage Rigidities and the New Keynesian Model. *Journal of Money, Credit, and Banking*, 39(1), 35–66.

Calvo, G. A. (1983). Staggered Prices in a Utility-Maximizing Framework. *Journal of Monetary Economics*, 12(3), 383–98.

Chenery, H. and M. Syrquin (1975). *Patterns of Development (1950–1970)* Oxford: Oxford University Press for the World Bank.

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FAO et al. (2011). ‘Price Volatility in Food and Agricultural Markets: Policy Responses,’ (Policy Report including contributions by FAO, IFAD, IMF, OECD, UNCTAD, WFP, the World Bank, the WTO, IFPRI and the UN HLTF), http://documents.wfp.org/stellent/groups/public/documents/communications/wfp236530.pdf.

Fox, L. (2015). *Are African Households Heterogeneous Agents? Stylized Facts on Patterns of Consumption, Employment, Income and Earnings for Macroeconomic Modelers*, IMF Working Paper No. 15/102. Washington, DC.

Gilbert, C. (2011). Grains Price Pass-Through, in A. Prakash (Ed.) *Safeguarding Food Security in Volatile Global Markets*, Rome: Food and Agricultural Organization of the United Nations, 122–43.

Gollin, D., R. Jedwab, and D. Vollrath (2013). *Urbanization with and without Industrialization*, Working Papers 2013-290-26, Department of Economics, University of Houston.

Gollin, D., and R. Rogerson (2010). *Agriculture, Roads and Economic Development in Uganda*, National Bureau of Economic Research Working Paper No. 15863. Cambridge, MA.

Gollin, D. and R. Rogerson (2014). Productivity, Transport Costs, and Subsistence Agriculture. *Journal of Development Economics,* 107, 38–48.

Herrendorf, B., R. Rogerson, and A. Valentinyi (2014). Growth and Structural Transformation, in P. Aghion and S. Durlauf (Eds.). *Handbook of Economic Growth* Vol. 2, pp. 855–941.

IMF (2012). Structural Transformation in Sub-Saharan Africa, in *Regional Economic Outlook, Sub-Saharan Africa*, chapter 3. Washington, DC: International Monetary Fund.

Portillo, R., L. F. Zanna, S. O’Connell, and R. Peck (2016). Implications of food subsistence for monetary policy and inflation. *Oxford Economic Papers*, 68 (3), 782–810.

(p.209) Svensson, L. E. O. (2003). What Is Wrong with Taylor Rules? Using Judgment in Monetary Policy through Targeting Rules. *Journal of Economic Literature*, 41(2), 426–77.

Svensson, L. E. O. and M. Woodford (2005). ‘Implementing Optimal Policy through Inflation-Forecast Targeting,’ in B. S. Bernanke and M. Woodford (Eds.), *The Inflation-Targeting Debate*. Chicago: University of Chicago Press for the National Bureau of Economic Research, pp. 19–91.

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Notes:

([1]) This chapter summarizes our existing research. Figure 11.2 is new, but the model, simulations, and analytical propositions are drawn from Portillo et al. (2016), the material of which is reprinted here with permission from Oxford Economic Papers. See that paper and its online appendix for more detail.

([2]) While limited financial participation is a prominent feature of LIC economies, the assumption of segmented labour markets—implying complete labour immobility at business-cycle frequencies—is at odds with the informal and fluid nature of LIC labour markets (Fox, 2015) and with our reading of the evidence on structural transformation in LICs (Gollin et al., 2013 and IMF, 2012). We therefore allow for full labour mobility for the bulk of our analysis.

([3]) The data for some countries, especially LICs, start in 2000.

([4]) GDP data are from the World Bank. Price indices are from the IMF. Food weights in the CPI come from several sources: OECD Stat Extracts for OECD countries and Haver Analytics for non-OECD non-African countries. Food weights for African countries come from central bank websites, a list of which is available upon request.

([5]) However, our model will understate the change in relative price stickiness as structural transformation occurs, because we do not model the shift towards more highly processed foods as income rises.

([6]) Lower-frequency movements in inflation are usually interpreted as changes in the explicit or implicit inflation target of the country, the choice of which is beyond the scope of this chapter. We also drop higher-frequency movements in order to remove any noise or leftover seasonality.

([7]) For a complete presentation of the model, see Portillo et al. (2016) and the accompanying online appendix.

([8]) For simplicity we assume the depreciation rate is zero, which implies there is no investment to keep track of in the model (including in the market clearing conditions).

([9]) For a thorough discussion of the flexible-price equilibrium and the gap representation of the model, see the online appendix to Portillo et al. (2016).

([10]) Output in the food sector declines because it is priced out of the labour market as non-food output expands. This lack of sectoral comovement is typical of multisector New Keynesian models.

([11]) Similar results in terms of the ranking of policies can be found for Taylor rules that respond to non-food inflation versus Taylor rules that respond to headline inflation.

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([12]) This is consistent with the impulse response analysis of Figures 11.4 and A. 1.

([13]) Figure 11.5 is from Portillo et al. (2016) and uses a more persistent AR(2) for agricultural productivity (parameters $\rho_A = 0.8$ and $\varrho = 0.01$) than the one we estimated in Table 11.1.

([14]) APZ features an open economy model with imported goods, whereas Anand and Prasad's specification is closer to ours as it assumes a closed-economy setting.

([15]) Although one type of agent has access to financial assets and the other type does not, the consumption of each type is given by their income. This is because, in a closed-economy setting such as ours, the net supply of assets is zero so that access to financial markets does not result in consumption smoothing or risk sharing unless there is heterogeneity within the set of agents with access to financial markets. This point is often overlooked in the discussion of models with limited asset market participation.

([16]) This implies that the share of urban agents corresponds to the share of the non-food sector in the economy. This equality will arise endogenously if migration between sectors is allowed in the steady state.

([17]) Additional derivations confirm that no two of these three features are enough to generate this result.

([18]) Like Figure 11.5, Figure 11.6 uses the AR(2) employed by Portillo et al. (2016), with parameters $\rho_A = 0.8$ and $\varrho = 0.01$.

([19]) This is not surprising, as New Keynesian models with Calvo prices tend to favour inflation stabilization over output.

([20]) These calculations use the concept of unconditional welfare, which we have used throughout the chapter. Anand and Prasad (2012) and Anand et al. (2015), on the other hand, use the concept of conditional welfare. Results regarding the optimal weight, however, are very similar regardless of the welfare concept. Conditional welfare results are available upon request.

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