CHAPTER 1

# COMMODITY SPECIAL FEATURE: ONLINE ANNEX

## Annex 1.SF.1.

### Food Insecurity and the Business Cycle

This appendix presents the econometric analysis behind 1) Figure 1.SF.3 (prevalence of undernourished); 2) the results about the effect of income shocks on the diet; and 3) Figure 1.SF.5 (transmission channels).

***Main Econometric Specification***. The share of households that falls below some hypothetical national food security line depends on average income, on distributional aspects related to the shape of income distribution (inequality), and on the general level of food prices. More formally,

$$\Delta y_{it} = \beta_0 + \theta ln y_0 + \beta_1 \Delta X_{it} + \beta_2 W_{it} + \beta_3 W_{it} \Delta X_{it} + \gamma_i + e_{it} \qquad (1)$$

where $y_{it}$ measures food insecurity for country $i$ at time $t$, proxied by two variables, namely, the (log) prevalence of undernourished and diet composition. The right-hand side includes country-specific unobserved changes, $\gamma_i$, while the matrix $X_{it}$ includes (log) GDP per capita, food CPI, and a redistribution measure proxied by per capita social protection expenditure. The initial (log) level of undernourishment has been introduced to investigate convergence among countries towards some "common level" of food insecurity. The Hausman test does not reject random effects, which are preferred being more efficient and necessary to identify the convergence coefficient. To investigate transmission channels, regressors are interacted with selected structural characteristics of the economy such as GDP per capita, the income share held by the bottom 20 percent, the level of social protection expenditure, and food import dependency ratio. Finally, to warn off concerns of endogeneity bias from contemporaneous reverse causality for $\Delta X_{it}$, we adopt an instrumental variables approach, whereby the instruments are given by lagged values of the right-hand side variables (Reed, 2015). The set of instruments for $W_{it}$ is sourced from the literature and includes the contemporaneous age dependency ratio in the population, the rainfall deviations from their long-term average and seasonal temperature levels.

**Annex Table 1.SF.1.1. Prevalence of Undernourished. GDP Growth by Far The Lasrgest Driver Globally**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| y0 | | -0.013*** | | -0.008** |
| | | (0.002) | | (0.003) |
| Δln GDP pc | -0.263*** | -0.283*** | -1.120* | -0.932*** |
| | (0.094) | (0.093) | (0.582) | (0.340) |
| Δ Food inflation | 0.031 | 0.030 | 0.171* | 0.151** |
| | (0.023) | (0.023) | (0.096) | (0.073) |
| Δln Social transfers | -0.009** | -0.010** | -0.023 | -0.028** |
| | (0.004) | (0.004) | (0.016) | (0.014) |
| _cons | -0.010*** | -0.043*** | | -0.013 |
| | (0.002) | (0.007) | | (0.016) |
| N | 2232 | 2232 | 1935 | 1937 |
| Estimation | FE | RE | FE-IV | RE-IV |
| Instruments | | | L.X, L2.X | L.X, L2.X, y0 |
| Instrumented | | | All ΔX | All ΔX |

Sources: UN' FAO, IMF data and IMF staff calculations.

Note: The standard deviation in the estimation sample of the covariates are 0.939, 0.037, 0.057 and 0.298, respectively.

***Prevalence of Undernourished***. Results are presented in Annex Table 1.SF.1.1. A 1 percentage point increase in economic growth leads to an approximately 1 percent reduction in the share of undernourished (Annex Table 1.SF.1.1).

The elasticity of undernourishment to inflation is close to 0.2 percent. In the absence of instruments, magnitudes decline.

***Diet Composition***. Economic growth is the only driver of changes in the share of energy derived from non-meat items. For a 1 percentage point increase in economic growth, the share of energy from cereals, roots and tubers decreases by 0.06 percent (Annex Table 1.SF.1.2). For every 1 percentage point increase in growth, average total protein intake increases by 0.55 percent, while an increase in food inflation of 1 percentage point reduces protein consumption by 0.1 percent.[1]

**Annex Table 1.SF.1.2. Diet (Re)composition Acts As Growth Shock Absorber**

| | (1) Cereal share | (2) Total protein | (3) Cereal share | (4) Total protein |
|---|---|---|---|---|
| ΔIn GDP pc | -0.066*** | 0.102*** | -0.265 | 0.551* |
| | (0.015) | (0.014) | (0.177) | (0.331) |
| Δ Food inflation | 0.001 | -0.006 | 0.053 | -0.104* |
| | (0.009) | (0.008) | (0.038) | (0.059) |
| ΔIn Social transfers | 0.001 | -0.001 | -0.008 | 0.006 |
| | (0.002) | (0.002) | (0.011) | (0.014) |
| _cons | -0.001 | 0.002*** | | |
| | (0.001) | (0.001) | | |
| N | 2139 | 2139 | 1810 | 1810 |
| Estimation | FE | FE | FE-IV | FE-IV |
| Instruments | | | L.X, L2.X | L.X, L2.X |
| Instrumented | | | All ΔX | All ΔX |

Sources: UN' FA O, IMF data and IMF staff calculations.

Note: The standard deviation in the estimation sample of the covariates are 0.040, 0.059 and 0.300, respectively.

***Transmission Channels***. Economic growth is interacted with the four variables in $W_{it}$ and similarly for food inflation and social transfer changes (Annex Table 1.SF.1.3). The coefficient on growth ranges from -1.1 towards zero as countries grow richer. Growth is more effective in reducing hunger in countries with more inclusive economic systems in which the bottom 20 percent of society holds larger shares of national income. Further, growth is complementary with social protection in reducing hunger, since while social protection spending reaches considerable levels in the economy, growth becomes irrelevant in reducing undernourishment.

**Annex Table 1.SF.1.3. Prevalence of Undernourished. Transmission Channels**

| | (1) |
|---|---|
| ΔIn GDP pc | -0.468 |
| | (1.389) |
| Δ Food inflation | 0.153 |
| | (0.104) |
| ΔIn Social transfers | -0.021 |
| | (0.063) |
| ΔIn GDP pc # GDP pc | 0.020 |
| | (0.040) |
| ΔIn GDP pc # Income bottom 20% | -16.14 |
| | (14.32) |
| ΔIn GDP pc # Soc. prot. exp. | 1.920 |
| | (6.608) |
| ΔIn GDP pc # Food import dep. | 0.960 |
| | (5.588) |
| N | 1644 |

Sources: UN FAO, IMF data and IMF staff calculation

Note: Column 1 shows estimates of the equation with interactions of W with growth. Only relevant coefficients are reported.

## Domestic Food Price Inflation: Econometric Analysis.

To explain variation in domestic food price inflation, a panel dataset that covers 121 countries between 2001-2018 is employed. The main goals of the regression analysis are to estimate (i) the pass-through from world food price inflation to domestic food price inflation and (ii) the effect of food production shocks on domestic food price inflation.

Letting the indices *i* and *t* refer to countries and years respectively, the following specification is estimated, which relates domestic food price inflation, $\Delta y_{it}$, to contemporaneous and lagged world food price inflation, $\Delta y_{i,t}^{w}$ and $\Delta y_{i,t-1}^{w}$, and a vector of lagged per capita food supply shocks (in logs) $\boldsymbol{S_{i,t-1}}$:

$$\Delta y_{it} = \beta_0 + \beta_1 \Delta y_{i,t}^{w} + \beta_2 \Delta y_{i,t-1}^{w} + \boldsymbol{\beta_3 S_{i,t-1}} + \boldsymbol{\beta_4 X_{it}} + u_i + year + \varepsilon_{it} \qquad (2)$$

[1] For the cereal energy share we prefer the FE to the FE-IV estimates, since the overidentification test did not provide sufficient evidence in support of the null hypothesis of valid instruments, while for total protein we rely on the FE-IV estimates based on the IV diagnostic test.

where $\boldsymbol{X_{it}}$ is a vector of control variables, including trend headline inflation (to control for monetary factors) and exchange rate appreciation (as most international food commodities are traded in USD), $u_i$ represents country fixed effects to control for average differences across countries of (unobservable) time-invariant predictors of food inflation, and $year$ represents a year trend.[2] Food supply per capita shocks are calculated at domestic, regional, and rest-of-world level.[3]

Using the benchmark specification (Annex Table 1.SF.1.4, column 4) results indicate that the pass-through from world food inflation to domestic food inflation is about 26.4 percent. A negative 10 percent domestic food supply shock raises domestic food inflation by 0.24 p.p. At the 10th percentile in terms of food import dependency, however, the effect is much larger, that is, 0.82 p.p., whereas at the 90th percentile the effect is very close to 0. The exchange rate pass-through equals 19 percent.

In Annex Table 1.SF.1.5 we extend our empirical specification by also including food supply shocks at the regional and rest-of-world level. Once we control for world food price inflation, the rest-of-world food supply shock is no longer significant[4], while the domestic and regional shocks remain statistically significant (column 6). Based on this specification, domestic and regional supply shocks of 10 percent raise domestic food prices by 0.1 p.p. and 0.7 p.p. respectively, showing the importance of stable food supply also at the local and regional level. Since the bulk of international trade including food is intra-regional rather than inter-regional, this can explain why regional supply shocks remain a strong determinant of domestic food prices.

Regional shocks tend to be smaller than domestic shocks, however, as the effects of a negative shock in one country of the region tend to be washed out by a positive shock in another. It is found that a negative supply shock of one standard deviation increases food price inflation by 0.3 p.p. in the case of a domestic shock, and by 0.7 p.p. in the case of a regional shock. Thus, regional shocks can explain more of the variation in food price inflation than domestic shocks, but the difference between those is smaller than the difference in magnitude between the regression coefficients.

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[2] Food CPI and headline CPI represent a combination of data from Haver Analytics and the International Monetary Fund (where we use log-differences and multiply by 100 to obtain the inflation variables (in % change)); exchange rates (in US$/LCU) are from the International Monetary Fund (and transformed into our appreciation variable using log-differences); food supply per capita is the sum of production of 4 major staple foods (maize, rice, soybeans, wheat) (in kcal/capita/day) and is from the Food and Agriculture Organization (and for which we obtain the % deviation from trend production using the cyclical component from a Hodrick-Prescott decomposition); and import dependency is the ratio of food imports (in current USD) divided by the sum of food production, food imports minus food exports (all in current USD) and comes from the Food and Agriculture Organization.

[3] The regional supply shock for country *i* represents the average percentage deviation from trend production in all countries within the region, except country *i*. The rest-of-world shock for country i represents the average percentage deviation from trend production in all countries outside the country's region. Regions are defined following the World Bank classification which distinguishes between 7 regions in the world.

[4] Indeed, a simple regression of annual world food price inflation on global GDP growth and world food supply shocks shows that negative world food supply shocks increase world food price inflation.

**Annex Table 1.SF.1.4. Static Specification With Supply Shocks Obtained From HP Filter**

**(Domestic food supply shocks only)**

| | (1) Food Inflation | (2) Food Inflation | (3) Food Inflation | (4) Food Inflation |
|---|---|---|---|---|
| Headline Inflation - trend | 1.281*** | 1.078*** | 1.076*** | 1.076*** |
| | (0.121) | (0.0815) | (0.0817) | (0.0814) |
| Exchange Rate (in USD/LCU) (log difference) | -0.0598* | -0.168*** | -0.169*** | -0.170*** |
| | (0.0252) | (0.0264) | (0.0265) | (0.0267) |
| L.Domestic Food Supply p.c. - detrended (log) | -0.0236*** | -0.0126* | -0.0124* | -0.0831** |
| | -0.0069 | -0.005 | -0.0049 | (0.0268) |
| FAO Food Price Index (log difference) | | 0.134*** | 0.135*** | 0.165*** |
| | | (0.0132) | (0.0133) | (0.0425) |
| L.FAO Food Price Index (log difference) | | 0.0758*** | 0.0763*** | 0.0992** |
| | | -0.0076 | -0.0077 | (0.0300) |
| Food Import Dependency (log) # FAO food price index (log difference) | | | | -0.00782 |
| | | | | -0.0095 |
| Food Import Dependency (log) # L.FAO food price index (log difference) | | | | -0.00615 |
| | | | | -0.0067 |
| Food Import Dependency (log) | | | -0.248 | -0.178 |
| | | | (0.300) | (0.301) |
| Food Import Dependency (log) # L.Domestic Food Supply p.c. - detrended (log) | | | | 0.0171** |
| | | | | (0.00614) |
| Year Trend | -0.00646 | 0.0717*** | 0.0800** | 0.0774** |
| | (0.0247) | (0.0208) | (0.0240) | (0.0239) |
| Model | fe | fe | fe | fe |
| $R^2$ | 0.348 | 0.484 | 0.485 | 0.487 |
| Observations | 1596 | 1596 | 1596 | 1596 |
| # of countries | 114 | 114 | 114 | 114 |

Sources: Food and Agriculture Organization; United States Department of Agriculture; World Bank, Climate Change Knowledge Portal; World Bank, World Development Indicators database; and IMF staff calculations.

Note: Standard errors are in parentheses. Robust standard errors clustered at the country level in parentheses. Constant and country fixed effects included in all regressions but not reported. fe = country fixed effects; LCU = Local currency unit; USD = dollar.
+ p<0.10; * p < 0.05; ** p < 0.01; *** p < 0.001.

**Annex Table 1.SF.1.5. Static Specification With Supply Shocks Obtained From HP Filter.**
**(Also includes regional and rest-of-world shocks next to domestic food supply shocks)**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| | **Food Inflation** | **Food Inflation** | **Food Inflation** | **Food Inflation** | **Food Inflation** | **Food Inflation** | **Food Inflation** |
| Headline Inflation - trend | 0.990*** | 0.985*** | 1.104*** | 0.989*** | 1.119*** | 0.984*** | 1.097*** |
| | (0.193) | (0.192) | (0.221) | (0.193) | (0.226) | (0.193) | (0.222) |
| Exchange Rate (in USD/LCU) (log difference) | -0.186*** | -0.191*** | -0.102*** | -0.187*** | -0.0875*** | -0.192*** | -0.107*** |
| | (0.0252) | (0.0250) | (0.0248) | (0.0249) | (0.0258) | (0.0247) | (0.0252) |
| L.Domestic Food Supply p.c. - detrended (log) | -0.0143** | -0.0108* | -0.0175** | -0.0143** | -0.0244** | -0.0107* | -0.0173** |
| | -0.0054 | -0.0049 | -0.0061 | -0.0054 | -0.0074 | -0.0049 | -0.0061 |
| L.Regional Food Supply p.c. - detrended (log) | | -0.0706*** | -0.128*** | | | -0.0729*** | -0.125*** |
| | | (0.0162) | (0.0201) | | | (0.0155) | (0.0199) |
| L.RoW Food Supply p.c. - detrended (log) | | | | -0.107+ | -0.170* | -0.120+ | -0.152* |
| | | | | (0.0640) | (0.0674) | (0.0634) | (0.0683) |
| FAO Food Price Index (log difference) | 0.137*** | 0.128*** | | 0.132*** | | 0.122*** | |
| | -0.0127 | (0.0125) | | (0.0124) | | (0.0119) | |
| L.FAO Food Price Index (log difference) | 0.0780*** | 0.0791*** | | 0.0828*** | | 0.0845*** | |
| | -0.0074 | -0.0074 | | -0.008 | | -0.008 | |
| Year Trend | 0.0653+ | 0.0601 | -0.0354 | 0.0737+ | -0.0190 | 0.0694+ | -0.0242 |
| | (0.0383) | (0.0385) | (0.0458) | (0.0396) | (0.0466) | (0.0398) | (0.0461) |
| Model | fe | fe | fe | fe | fe | fe | fe |
| $R^2$ | 0.542 | 0.548 | 0.447 | 0.544 | 0.432 | 0.55 | 0.45 |
| Observations | 1728 | 1728 | 1728 | 1728 | 1728 | 1728 | 1728 |
| # of countries | 121 | 121 | 121 | 121 | 121 | 121 | 121 |

Sources: Food and Agriculture Organization; United States Department of Agriculture; World Bank, Climate Change Knowledge Portal; World Bank, World Development Indicators database; and IMF

Note: Standard errors are in parentheses. Robust standard errors clustered at the country level in parentheses. Constant and country fixed effects included in all regressions but not reported. fe = country fixed effects; LCU = Local currency unit; RoW = Rest-of-World; USD = dollar.

+ p<0.10; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.