Impact of macroeconomic policies on national food security in Pakistan: simulation analyses under a simultaneous equation framework

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Appendix A: Variables Identification

Variable	Description
DC_t^A	Domestic credit to Agriculture sector
D^{9296}	Dummy variable representing effects of flood
D^{9407}	Dummy variable representing privatization policy
D^{9901}	Dummy variable representing effects of atomic explosion in Pakistan
D^{0207}	Dummy variable representing effects of 9/11 and subsequent events
D^{0407}	Dummy variable representing oil price hike and food price hike
ER_t	Nominal exchange rate (Rupees per US dollar)
E_t^A	Energy consumption in agricultural sector
F_t^A	Fertilizer off-take
FP_t	Food Production Index
g^A	Annual compound growth rate of output in agricultural sector used to construct initial period capital stock
I_t^{GA}	Expenditure on public fixed investment in agricultural sector
I_t^{GG}	General government investment expenditure
I_t^{PA}	Expenditure on private fixed investment in agricultural sector
K_t^A	Capital stock in agricultural sector at the beginig of period t
L_t^A	Labor employed in agricultural sector
$M2$	Broad money
N_t	Population size
P_t	GDP deflator (based on GDP at factor cost)
P_t^{EN}	Price index of energy
P_t^{FD}	Food Price Index
P_t^{FR}	Price index of fertilizers

Variable	Description
P_t^{KA}	User cost of capital in agricultural sector
P_t^{MA}	Price index of capital goods for agricultural sector
P_t^{WO}	World average Oil spot Price (US $ per barrel)
R_t	Total government revenues
r_t^{ib}	Inter bank call money rate (Nominal interest rate)
U_t	Urbanization rate
UR_t	Unemployment Rate
W_t^A	Wage rate in agricultural sector
Y_t	GDP at market prices
Y_t^A	Value added in agricultural sector
Y_t^{FC}	GDP at factor costs
Y_t^F	Food Production
Y_t^{NF}	Non-Food output in Agricultural sector
Y_t^O	Value added in non-agricultural sectors
Y_t^{PC}	Per capita income
δ	Annual depreciation rate of fixed capital in agricultural sector
π_t	Inflation rate based on GDP deflator

Appendix B

Estimated equations (Highlighted estimates are insignificant)

$$\text{LOG}(FP_t) = 4.212 + 0.0202 \times \text{LOG}(F_t^A) + 0.05005 \times \text{LOG}(K_t^A) - 0.09009 \times \text{LOG}(L_t^A) + 0.0346 \times \text{LOG}(E_t^A) - 0.9952 \times \text{LOG}(N_t) + 0.0270 \times @\text{TREND} + 0.7170 \times \text{LOG}(FP_{t-1}) + \underline{\mathbf{0.0038}} \times \text{LOG}(DC_t^A) - 0.0428 \times D^{0214} + [\text{AR}(2) = -0.3892]$$

Instruments: c $\log(FP_{t-1})$ $\log(FP_{t-\backslash 2})$ $\log(F_{t-1}^A)$ $\log(L_{t-1}^A)$ $\log(E_{t-1}^A)$ $\log(N_t)$ @trend D^{0214} $\log(P_{t-1})$ $\log(DC_t)$ $\log(P_{t-1}^{EN})$ $\log(DC_{t-1})$

$$\text{LOG}(P_t^{FD}) = 1.4297 - 0.6231 \times \text{LOG}(FP_t) - \underline{\mathbf{0.1398}} \times \text{LOG}(Y_t^{PC}) + 0.2675 \times \text{LOG}(M2) + 1.4136 \times \pi_t \pi_t + 0.9319 \times \text{LOG}(P_{t-1}^{FD}) - 0.0238 \times \text{Trend} + 0.0292 \times D^{0714}$$

Instruments: c $\log(P_{t-1}^{FD})$ $\log(P_{t-2}^{FD})$ $\log(FP_{t-1})$ $\log(FP_{t-2})$ $\log(Y_{t-1}^{PC})$ π_{t-1} $\log(M2_{t-1})$ D^{0714}

$\text{LOG}(E_t^A) = -22.6034 - \underline{\mathbf{0.04457}} \times \text{LOG}(P_t^{FR}) + 0.8912 \times \text{LOG}(K_t^A) + \underline{\mathbf{0.461463631787}} \times \text{LOG}(W_t^A) - 0.3552 \times \text{LOG}(P_t^{EN}) + 2.9175 \times \text{LOG}(FP_t) - \underline{\mathbf{0.0097}} \times \text{LOG}(E_{t-1}^A) + [\text{AR}(1) = 0.4140] - \underline{\mathbf{0.1397}} \times D^{9901} + 0.0058 \times D^{0214}$

Instruments: c $\log(E_{t-1}^A)$ $\log(P_{t-1}^{FR})$ $\log(K_t^A)$ $\log(K_{t-1}^A)$ $\log(W_t^A)$ $\log(P_{t-1}^{EN})$ $\log(P_t^{wo})$ $\log(FP_{t-1})$ UB_t UR_t $\log(N_t)$ D^{9901} D^{0214}

$\text{LOG}(L_t^A) = -0.9101 - 0.2103 \times \text{LOG}(P_t^{FR}) - 0.2369 \times \text{LOG}(K_t^A) - \underline{\mathbf{0.1183}} \times \text{LOG}(W_t^A) + 0.2232 \times \text{LOG}(P_t^{EN}) + 1.3536 \times \text{LOG}(FP_t) + 0.6358 \times \text{LOG}(\text{L\_A}(-1))$

Instruments: c $\log(L_{t-1}^A)$ $\log(FP_{t-1})$ $\log(K_t^A)$ $\log(W_{t-1}^A)$ UR_t UR_{t-1} $\log(N_t)$ $\log(\text{p}(-1))$ $\log(P_{t-1}^{EN})$ $\log(L_{t-2}^A)$

$\text{LOG}(F_t^A) = -6.7547 - 0.5228 \times \text{LOG}(P_t^{FR}) - \underline{\mathbf{0.2272}} \times \text{LOG}(K_t^A) + 1.7282 \times \text{LOG}(W_t^A) + 0.51390 \times \text{LOG}(P_t^{EN}) + \underline{\mathbf{2.1447}} \times \text{LOG}(FP_t) + [\text{AR}(1) = 0.8271]$

Instruments: c $\log(F_{t-1}^A)$ $\log(P_{t-1}^{FR})$ $\log(K_t^A)$ $\log(W_{t-1}^A)$ $\log(P_t^{EN})$ $\log(FP_{t-1})$ $\log(P_{t-1})$ $\log(P_{t-2})$

$\text{LOG}(W_t^A) = -0.3361 + \underline{\mathbf{0.0211}} \times \text{LOG}(P_t) + 0.1773 \times \text{LOG}(Y_t^A) + 0.0188 \times UR_t + 0.5493 \times \text{LOG}(W_{t-1}^A) - 0.0668 \times D^{9415} - 0.0669 \times D^{0214}$

Instruments: c $\log(W_{t-1}^A)$ $\log(W_{t-2}^A)$ $\log(P_t)$ $\log(Y_{t-1}^A)$ $\log(K_t^A)$ D^{9415} D^{0214} UR_{t-1}

$\text{LOG}(I_t^{GA}) = -11.1405 - \underline{\mathbf{0.5096}} \times \text{LOG}(\text{R}) + \underline{\mathbf{0.5373}} \times \text{LOG}(Y_t^A) + 0.9253 \times \text{LOG}(I_t^{GG}) + 0.8307 \times \text{LOG}(I_{t-1}^{GA}) + [\text{AR}(1) = -\underline{\mathbf{0.1654}}, \text{AR}(2) = -0.5482] + 0.2699 \times D^{9296}$

Instruments: c $\log(I_{t-1}^{GA})$ $\log(I_{t-2}^{GA})$ $\log(I_{t-3}^{GA})$ $\log(R_{t-1})$ $\log(Y_{t-1}^A)$ $\log(I_{t-1}^{GG})$ D^{9296} UB_t $\log(N_t)$

$\text{LOG}(I_t^{PA}) = 4.597 + 0.0690 \times \text{LOG}(I_t^{GA}) + 0.4534 \times \text{LOG}(I_t^{GG}) - 2.1732 \times (r_t^{ib}) - \underline{\mathbf{0.01430}} \times \text{LOG}(Y_{t-1}^A) + 0.2363 \times \text{LOG}(DC_t^A) + 0.0469 \times D^{0414} - 0.3298 \times D^{0214} + [\text{AR}(1) = 0.5885, \text{AR}(2) = -0.2597]$

Instruments: c $\log(I_{t-1}^{PA})$ $\log(I_{t-1}^{GA})$ $\log(I_{t-1}^{GG})$ $\log(R_{t-1})$ r_t^{ib} P_{t-1}^{KA} $\log(Y_{t-1}^A)$ $\log(DC_t^A)$ D^{0414} D^{0214} UB_t $\log(N_t)$

$$\text{LOG}(I_t^{GG}) = 2.8609 + 0.2181 \times \text{LOG}(R_t) + 0.5351 \times \text{LOG}(I_{t-1}^{GG}) - 0.2640 \times D^{9415}$$

Instruments:

C LOG(I_{t-1}^{GG}) LOG(I_{t-2}^{GG}) LOG(R_t) D^{9415}

$$\text{LOG}(M2) = 0.6464 + 0.2502 \times \text{LOG}(P_t) + 0.1537 \times \text{LOG(Y)} - 0.7742 \times (r_t^{ib}) + 1.1795 \times \text{LOG}(M2_{t-1}) - 0.3786 \times \text{LOG}(M2_{t-2}) + [\text{AR}(1) = -0.2167]$$

Instruments:

C LOG($M2_{t-1}$) log($M2_{t-2}$) LOG(P_{t-1}) log(Y_{t-1}) LOG(P_{t-2}) log(Y_{t-2}) (r_{t-1}^{ib})

$$\text{LOG}(P_t) = 2.402 - 0.6137 \times \text{LOG}(Y_t^{FC}) + 0.4374 \times \text{LOG}(M2) + 0.2071 \times \text{LOG}(ER_t) + 0.3250 \times \text{LOG}(P_t^{EN}) + [\text{AR}(1) = 0.8666]$$

Instruments:

c LOG(P_{t-1}) LOG(P_{t-2}) log(Y_{t-1}^{FC}) log(Y_{t-2}^{FC}) log(Y_{t-3}^{FC}) log($M2_{t-1}$) log(ER_{t-1}) log(P_{t-1}) t