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"December 2, 2001";
"E STABILITY OF INERTIAL FORWARD RULES";
"General Case with all of phix, phipi, phir positive";

Clear[phix, phipi, phir, sigma, kappa, rho, beta, bbar, omega, delta, bbar,
  bbar11, bbar12, bbar13, bbar21, bbar22, bbar23, bbar31, bbar32, bbar33]

<< LinearAlgebra`MatrixManipulation`;

"Matrices for MSV solution and E-stability";

omega = {{sigma * ((1 / sigma) - phix), sigma * (1 - phipi), 0},
  {kappa * sigma * ((1 / sigma) - phix),
  sigma * (kappa + beta * (1 / sigma) - kappa * phipi), 0},
  {phix, phipi, 0}};

delta = {{0, 0, -sigma * phir},
  {0, 0, -kappa * sigma * phir},
  {0, 0, phir}};

"bbar matrix below";
bbar = {{bbar11, bbar12, bbar13},
  {bbar21, bbar22, bbar23},
  {bbar31, bbar32, bbar33}};

bbar11 = 0;
bbar12 = 0;
bbar21 = 0;
bbar22 = 0;
bbar31 = 0;
bbar32 = 0;
bbar33 = phir / (1 - bbar13 * phix - bbar23 * phipi);

"function '
  kronecker' defines how to compute the kronecker product of 2 matrices";

kronecker[f_, p_List, q_List] :=
  Flatten[Map[Flatten, Transpose[Outer[f, p, q], {1, 3, 2}], {2}], 1];

"E STABILITY CONDITIONS GIVEN BELOW";

DT1[a_] := kronecker[Times, Transpose[a], omega] +
  kronecker[Times, IdentityMatrix[3], omega.a];
DT2[a_] := rho * omega + omega.a;
DT3[a_] := omega + omega.a;

mat3 = Simplify[omega + omega.bbar];
mat3i = mat3 - IdentityMatrix[3];

"CHARACTERISTIC POLYNOMIAL OF (omega+omega.bbar- I) COMPUTED BELOW";

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chpmat3i = Simplify[-Det[mat3i - mu * IdentityMatrix[3]]]

"characteristic polynomial of (omega+omega.bbar- I) below";
chpmat3i = (1 + mu)
  (mu2 + (-kappa + kappa phipi + phix - bbar23 phix - beta phix) sigma - mu (-1 + beta +
    bbar23 phipi + bbar13 phix + kappa sigma - kappa phipi sigma - phix sigma) +
    bbar13 (-kappa phipi - phix + beta phix + kappa phix sigma));

mat1 = Simplify[DT1[bbar] - IdentityMatrix[9]];

"CHARACTERISTIC POLYNOMIAL OF (DT1[bbar]-I) COMPUTED BELOW";
chpmat1 = Simplify[-Det[mat1 - mu * IdentityMatrix[9]]]

"characteristic polynomial of (DT1[bbar]- I) evaluated below";
chpmat1 = ((1 + mu)5 (1 + mu - bbar23 phipi - bbar13 phix)2
  (1 - bbar233 phipi3 - phir - beta phir - bbar13 kappa phipi phir +
    beta phir2 - 3 bbar13 phix + bbar13 phir phix + 2 bbar13 beta phir phix +
    bbar132 kappa phipi phir phix + 3 bbar132 phix2 - bbar132 beta phir phix2 -
    bbar133 phix3 + mu2 (-1 + bbar23 phipi + bbar13 phix)2 - kappa phir sigma +
    kappa phipi phir sigma + phir phix sigma + 2 bbar13 kappa phir phix sigma -
    bbar13 kappa phipi phir phix sigma - beta phir2 phix sigma -
    bbar13 phir phix2 sigma - bbar132 kappa phir phix2 sigma +
    bbar232 phipi (3 phipi - phipi phir - 3 bbar13 phipi phix + phir phix sigma) -
    mu (-1 + bbar23 phipi + bbar13 phix) (2 + bbar232 phipi2 - phir - beta phir -
    3 bbar13 phix + bbar132 phix2 + bbar23 phipi (-3 + 2 bbar13 phix) -
    kappa phir sigma + kappa phipi phir sigma + phir phix sigma) +
    bbar23 (-3 phipi + 2 phipi phir + beta phipi phir +
    bbar13 kappa phipi2 phir + 6 bbar13 phipi phix - bbar13 phipi phir phix -
    bbar13 beta phipi phir phix - 3 bbar132 phipi phix2 + kappa phipi phir sigma -
    kappa phipi2 phir sigma - phir phix sigma - phipi phir phix sigma -
    bbar13 kappa phipi phir phix sigma + bbar13 phir phix2 sigma))) /
  (-1 + bbar23 phipi + bbar13 phix)2;

mat2 = Simplify[rho * omega + omega . bbar];
mat2i = mat2 - IdentityMatrix[3];

"CHARACTERISTIC POLYNOMIAL OF (rho*omega+omega.bbar- I) COMPUTED BELOW";
chpmat2i = Simplify[-Det[mat2i - mu * IdentityMatrix[3]]]

"characteristic polynomial of (rho*omega+omega.bbar- I) evaluated below";
chpmat2i = (1 + mu) (1 + mu2 - bbar13 phix - rho - beta rho -
  bbar13 kappa phipi rho + bbar13 beta phix rho + beta rho2 - kappa rho sigma +
  kappa phipi rho sigma + phix rho sigma + bbar13 kappa phix rho sigma -
  beta phix rho2 sigma + bbar23 (-phipi + phipi rho - phix rho sigma) -
  mu (-2 + bbar23 phipi + bbar13 phix + rho + beta rho + kappa rho sigma -
  kappa phipi rho sigma - phix rho sigma));

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