Chapter 1
The Traditional Approach to Fluctuations

- Main references :
  - Romer [2001], Chapter 5
  - Blanchard & Quah AER, 1989
- Other references that could be read :

– Blanchard and Fisher [1989], Chapter 10, Paragraph 3

– Sargent [1987], Chapter 1

1 Introduction

- Here I present the model of the Neoclassical synthesis, that was the standard workhorse of macroecomics until the mid 70's, and that is still the common wisdom among many politicians and journalists.
- Based on IS-LM and AD-AS models
- Can be seen as General Equilibrium without explicit micro-foundations of individual decisions and description of markets organization

2 The AD-AS Model

2.1 The Model

- AD: Level of aggregate demand as a function of the general price level (M = money supply, G=govt expenditures)

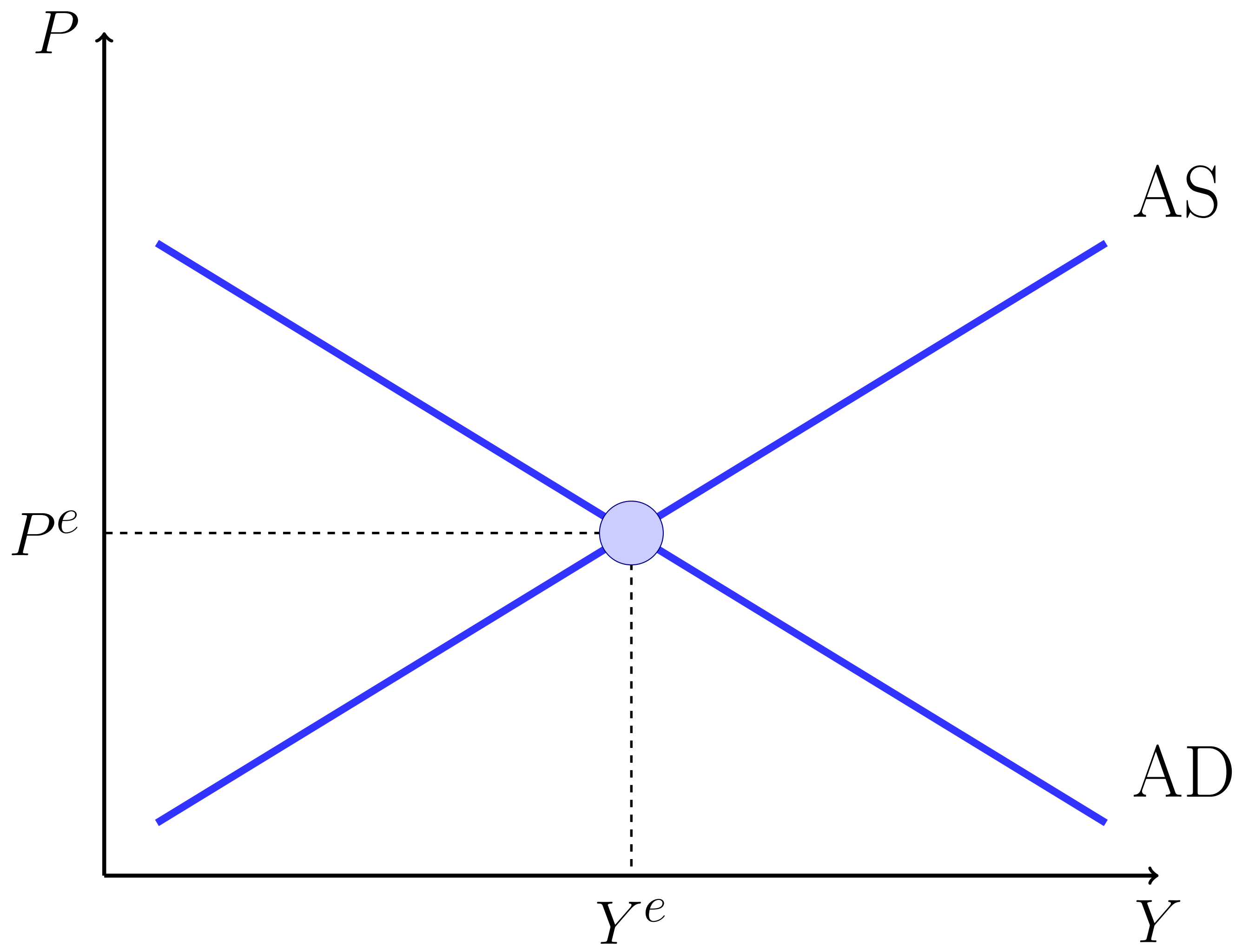
$$P = a_0 - a_1 Y + a_2 M + a_3 G \tag{1}$$

- AS: Level of aggregate supply as a function of the general price level (Q = productivity)

$$Y = b_0 + b_1 P + b_2 Q \tag{2}$$

- Note: Y = value added = income = expenditures (regarding only final goods)

Figure 1: Equilibrium of the AD-AS Model



• One can compute the solution and multipliers

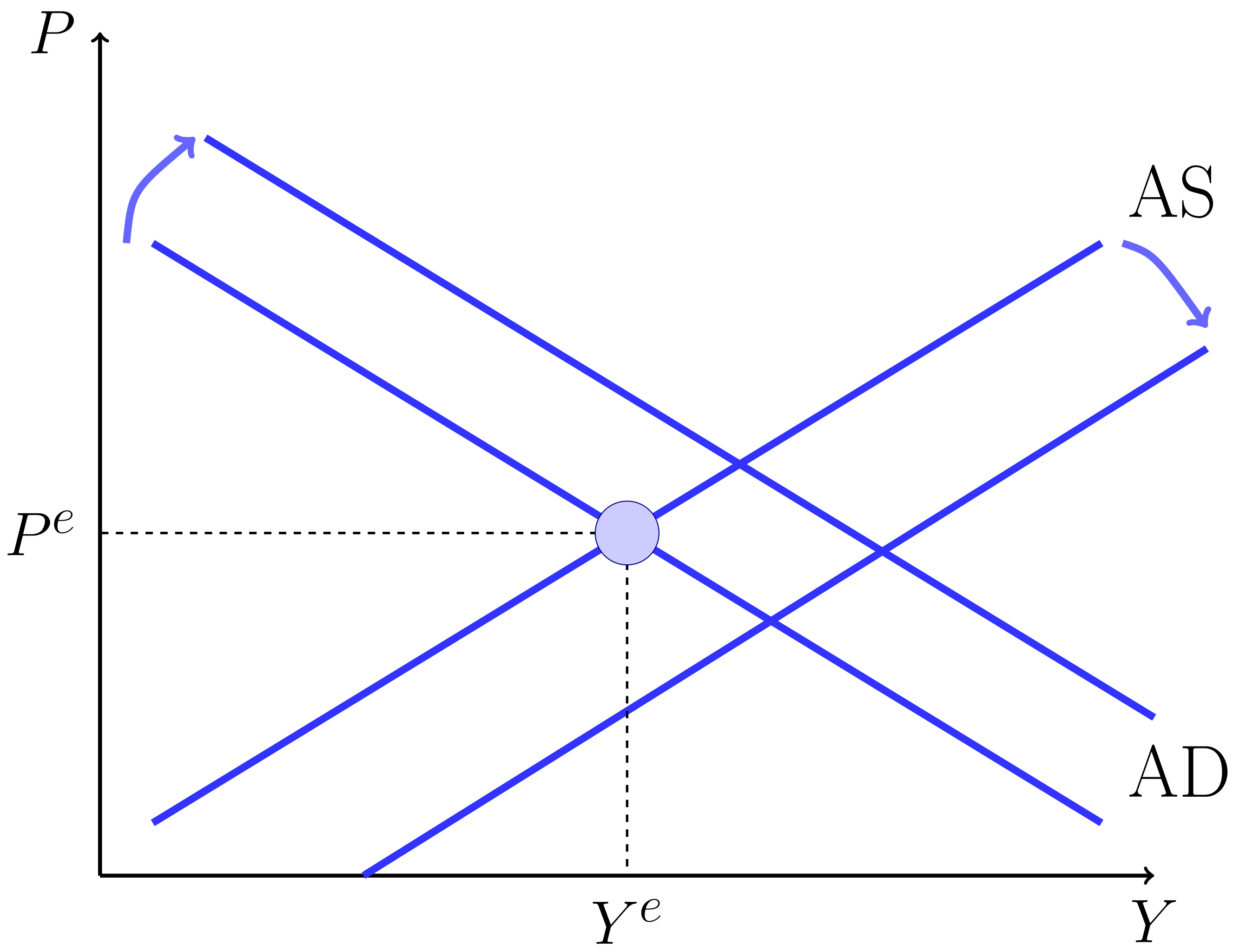
$$
\begin{aligned}
P &= \left(\frac{a_0 - a_1 b_0}{1 + a_1 b_1}\right) + \left(\frac{a_2}{1 + a_1 b_1}\right) M + \left(\frac{a_3}{1 + a_1 b_1}\right) G - \left(\frac{a_1 b_2}{1 + a_1 b_1}\right) Q \\
Y &= \left(\frac{b_0 + b_1 a_0}{1 + a_1 b_1}\right) + \left(\frac{b_1 a_2}{1 + a_1 b_1}\right) M + \left(\frac{b_1 a_3}{1 + a_1 b_1}\right) G + \left(\frac{b_2}{1 + a_1 b_1}\right) Q
\end{aligned}
$$

• The model is mainly used for policy evaluation : $\frac{\partial Y}{\partial G}$, $\frac{\partial Y}{\partial M}$, $\frac{\partial Y}{\partial Q}$, $\frac{\partial P}{\partial M}$, *etc...* (oil price shock, monetary expansion, ...)

• Most of the debate was then the size and signs of the multipliers.

• This model have foundations, although not micro-foundations: IS-LM for AD and the functioning of the labor market for AS.

Figure 2: Shocks and Policies in the AD-AS Model



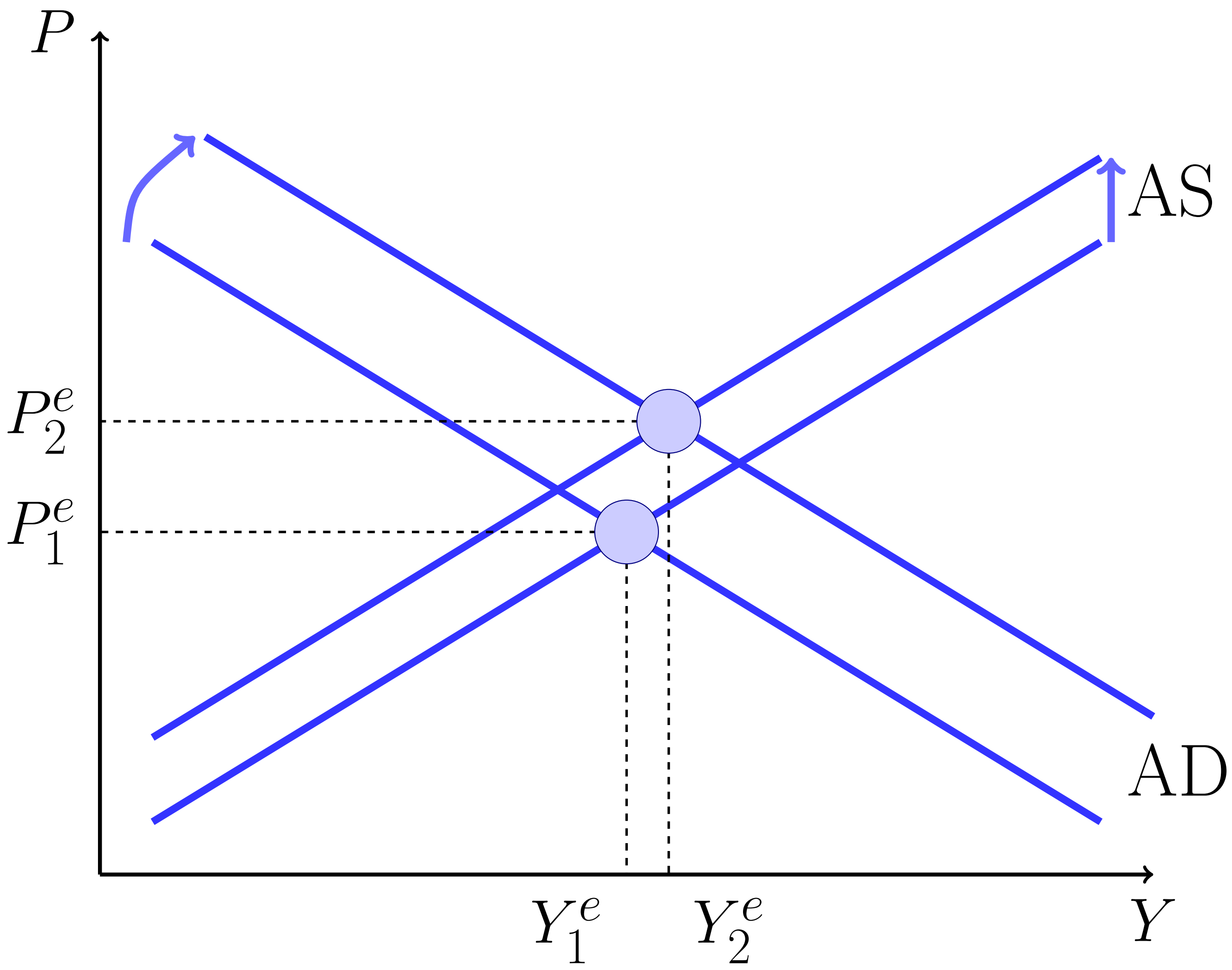
2.2 A Case study: From Keynesianism to Monetarism : Mitterrand 1981-1990

- 1981: the newly elected socialist French President implements a classic socialist program:

  1. sharp increase of the minimum wage
  2. new tax on wealth
  3. extensive nationalizations (banks, electronic, chemicals,...)
  4. workweek reduction at constant wages
  5. fiscal expansion financed by public debt and money creation

$\rightsquigarrow$ shifts of AD and AS

Figure 3: The Mitterrand early 80's Policy



- As a consequence, the country experienced higher inflation than the rest of Europe, but also higher growth

Table 1: French and German Macroeconomic performances 1980-1990

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Money Growth											
France	9.7	11	11.4	11.5	9.5	6.8	6.3	7.3	7.4	7.8	7.5
Germany	6.2	5	7.1	5.3	4.7	5	6.6	5.9	6.9	5.5	5.9
Inflation											
France	11.6	11.4	12	9.6	7.3	5.8	5.3	2.9	3.3	3.6	2.7
Germany	4.8	4	4.4	3.3	2.0	2.2	3.1	2	1.6	2.6	3.4
GDP Growth											
France	1.4	1.2	2.3	0.8	1.5	1.8	2.4	2.0	3.6	3.6	2.8
Germany	1.4	0.2	-0.6	1.5	2.8	2.0	2.3	1.7	3.7	3.3	4.7
Unemp											
France	6.2	7.3	8.0	8.2	9.8	10.2	10.3	10.4	9.9	9.4	9.0
Germany	2.7	3.9	5.6	6.9	7.1	7.1	6.3	6.2	6.1	5.5	5.1
Current Account											
France	-0.6	-0.8	-2.1	-0.8	0.0	0.1	0.5	-0.1	-0.3	-0.1	-1.0

- The problem was then with the fixed exchange rate within the EMS. Even with capital controls, faster money growth leads to larger inflation, and therefore less competitivity given the fixed exchange rate $\leadsto$ surge in unemployment
- deterioration of the current account $\leadsto$ 3 devaluations between 1981 and 1883
- Reversal of policy in 1983: "*la politique de rigueur*" $\leadsto$ freeze govt expenditures, increase taxes, wage guidelines to reduce wages pressures, slowdown in money supply growth, reduction of the budget deficit.

3 AD-AS and the Decomposition of Macroeconomic Fluctuations

- Is the AS-AS model an usefull model to descrive actual economies?
- I use a Blanchard & Quah (AER 1989) (BQ) type of analysis to evaluate the relative importance of "supply" and "demand" shock
- The idea is to decompose any movement of the economy as the consequence of 2 orthogonal shocks: a demand shock and a supply one.

3.1 Identification and Economic Interpretation

- Assume that the model economy is the following AD-AS:

$$\begin{cases} P = -\alpha Y + \varepsilon^D & (AD) \\ P = \beta Y - \varepsilon^S & (AS) \end{cases}$$

- α and β are positive constants
- Shocks are zero-mean stochastic variables

- Remark: How do we obtain such a linear model in which the non-stochastic solution is $Y = P = 0$?

$$\begin{cases} \mathcal{P} = A \ \ \mathcal{Y}^{-\alpha} \ \ e^{\varepsilon^D} & (AD) \\ \mathcal{P} = B \ \ \mathcal{Y}^{\beta} \ \ e^{-\varepsilon^S} & (AS) \end{cases}$$

- Compute non-stochastic solution:

$$\begin{cases} \overline{\mathcal{Y}} = \left(\frac{A}{B}\right)^{\frac{1}{\alpha+\beta}} \\ \overline{\mathcal{P}} = A^{\frac{\beta}{\alpha+\beta}} B^{\frac{\alpha}{\alpha+\beta}} \end{cases}$$

- Denote $X = \log \mathcal{X} - \log \overline{\mathcal{X}}$
- We then obtain

$$\begin{cases} P = -\alpha Y + \varepsilon^D & (AD) \\ P = \beta Y - \varepsilon^S & (AS) \end{cases}$$

- Assume that we know α and β.
- Then, one can identify demand and supply shocks (namely ε^D and ε^S)

Figure 4: Observation: The economy went from A to B and C

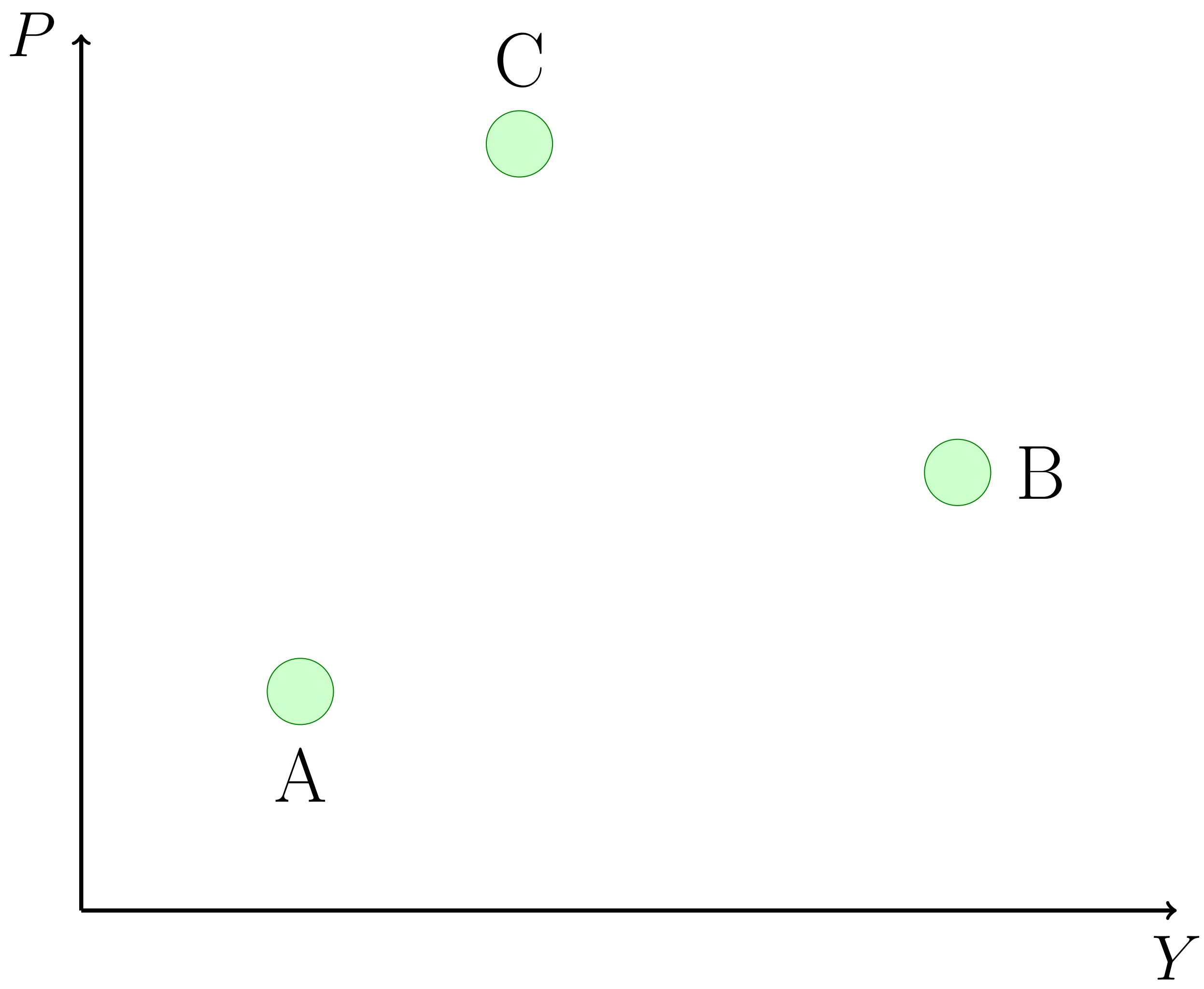


Figure 5: We aim at putting names (stories) on those green arrows

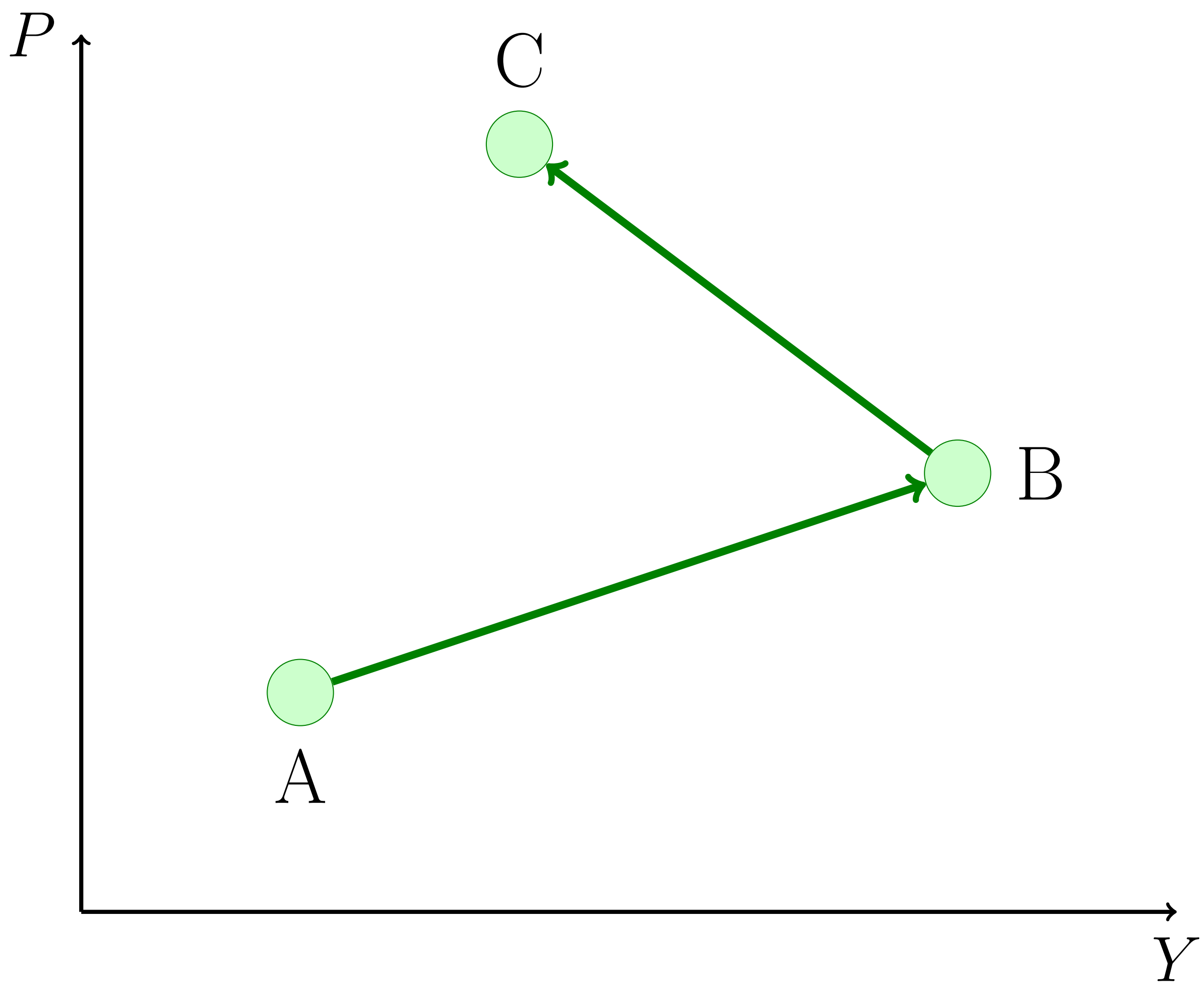


Figure 6: The AD-AS model provides us with a theory of economic fluctuations (the green arrows) with the help of the blue shifts

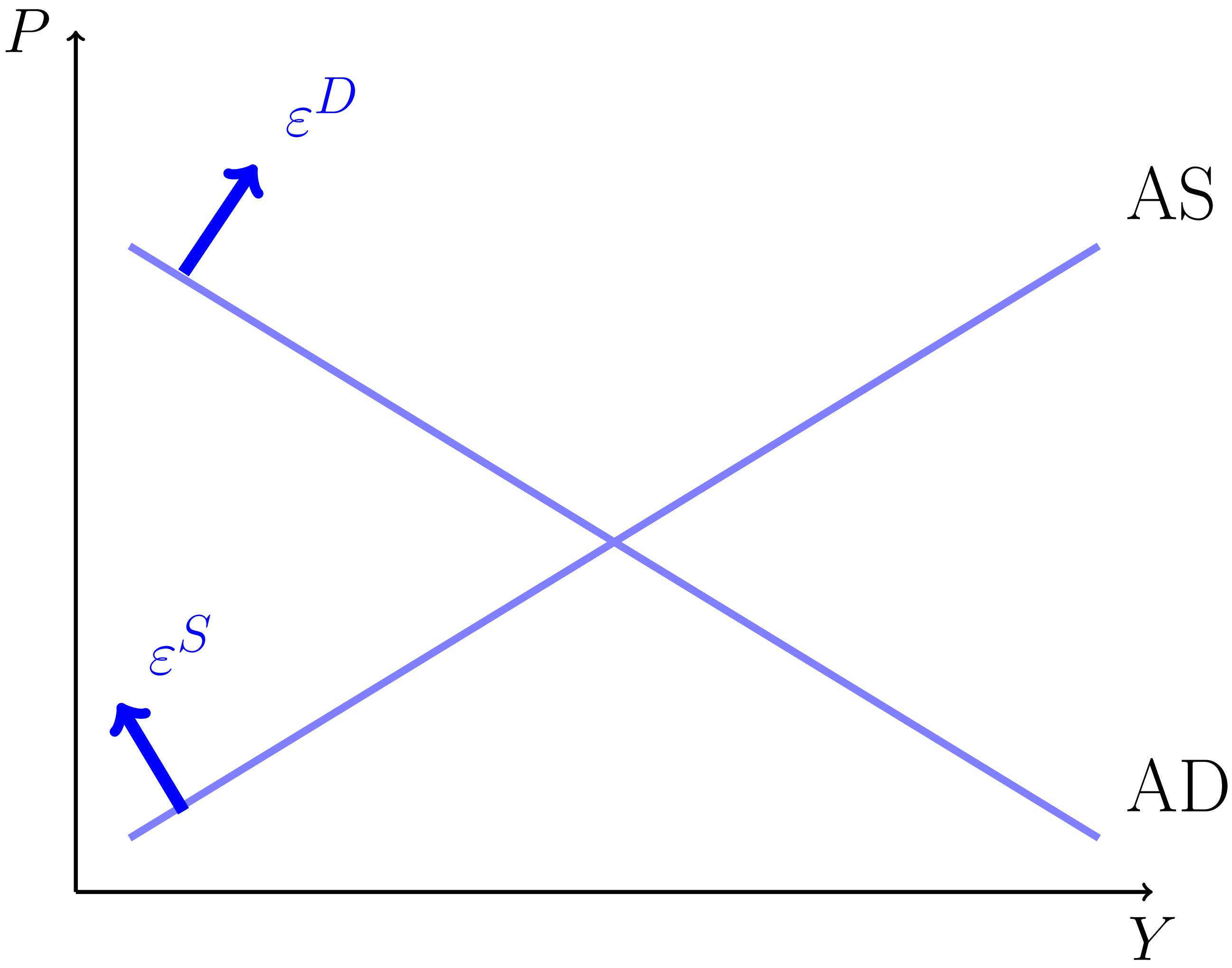


Figure 7: Each Observation is at the crossing of one AD and one AS curve

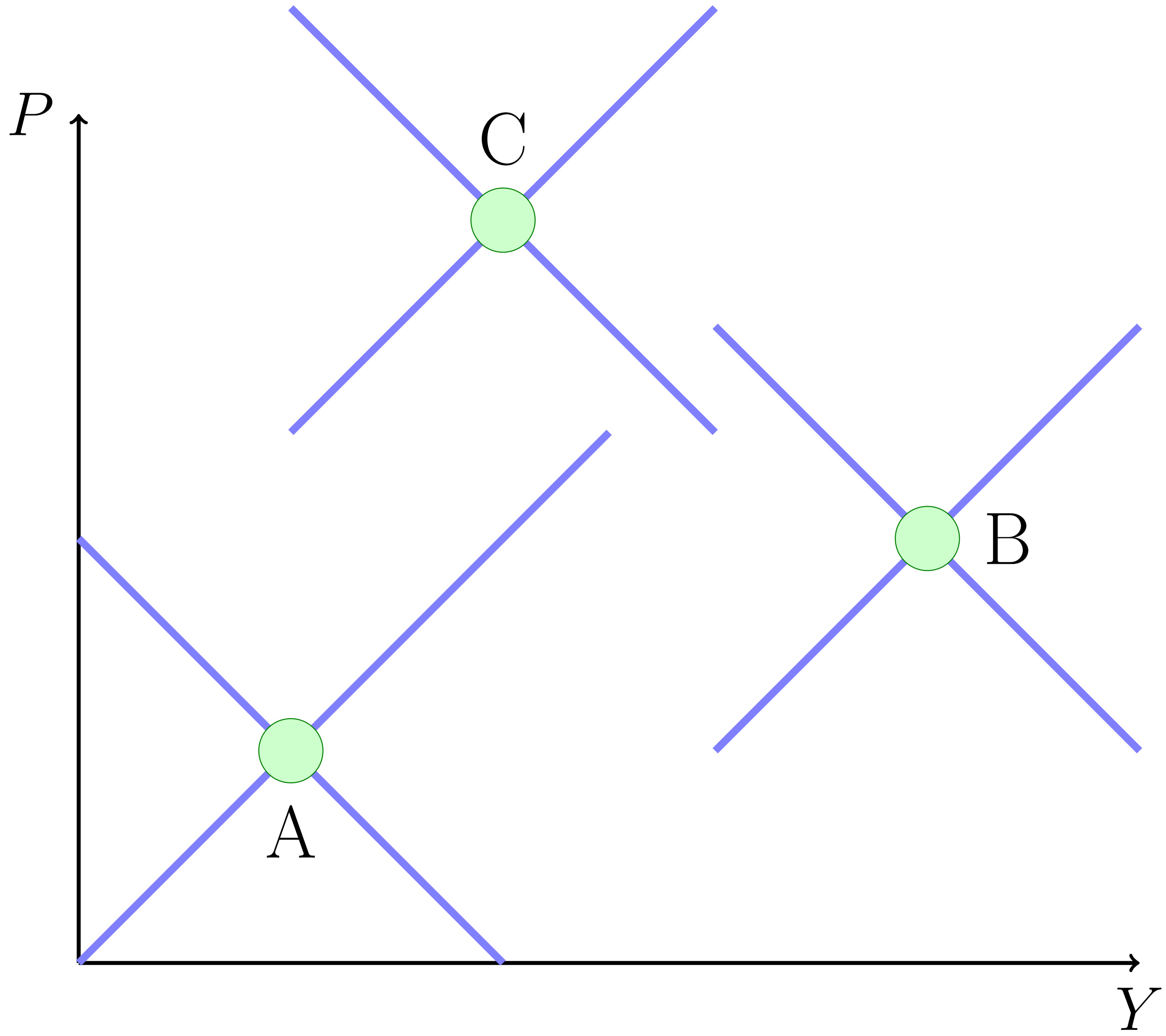


Figure 8: This is the structural interpretation of the move from A to B

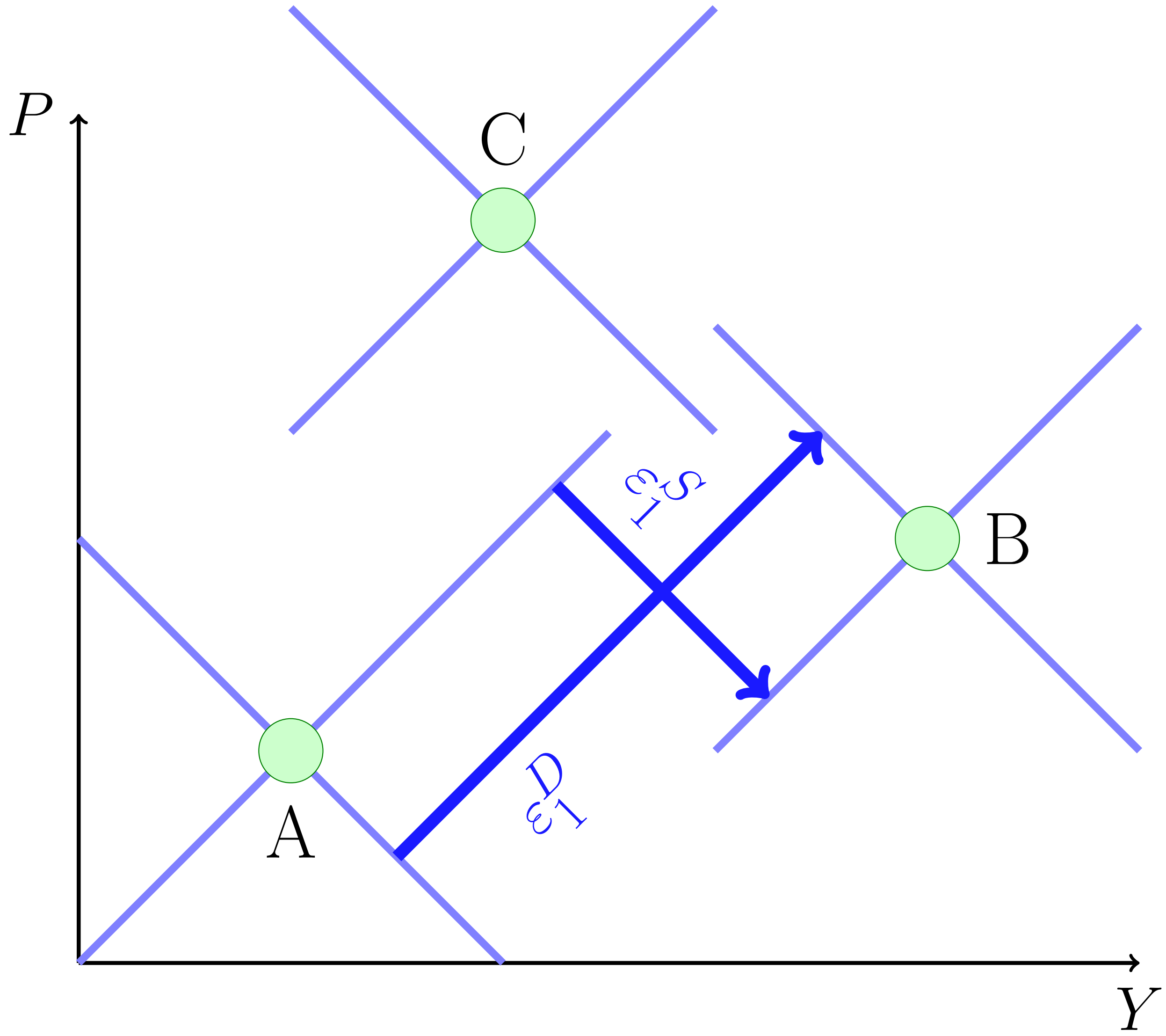


Figure 9: This is the structural interpretation of the move from B to C

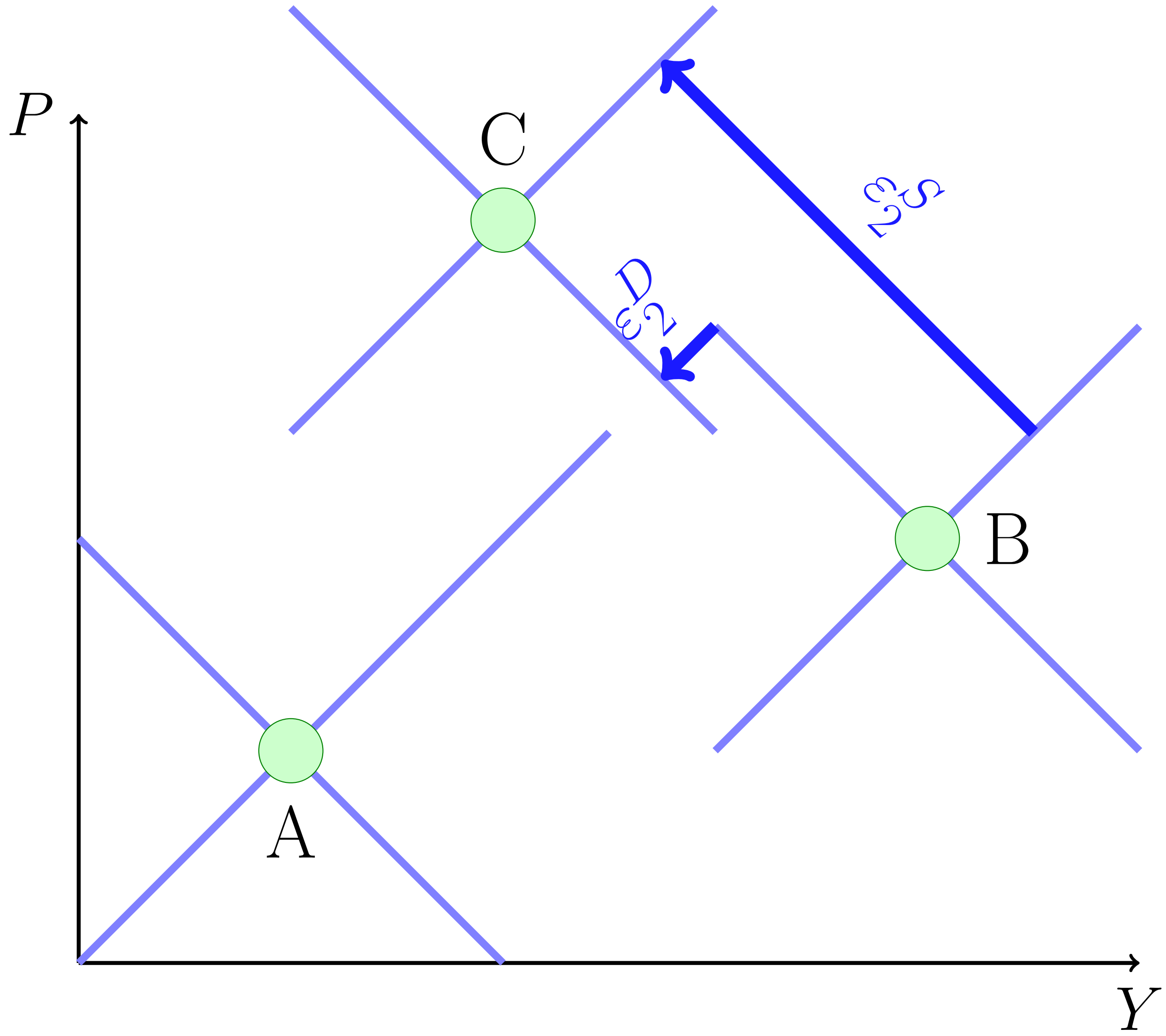
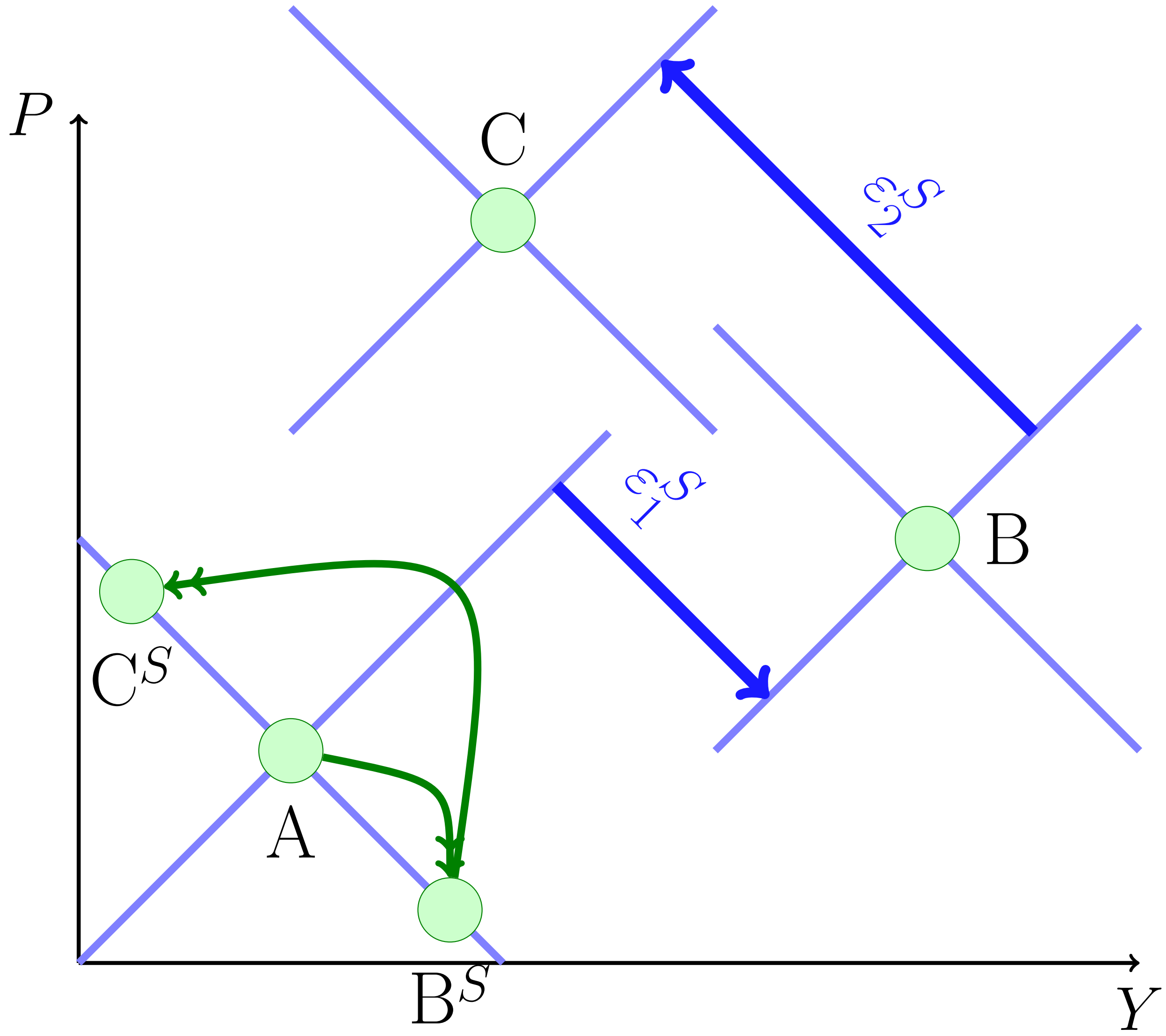


Figure 10: Counterfactual: What would have happen absent of demand shocks



• The algebra is even more simple. If one solves the model

$$\begin{cases} P = -\alpha Y + \varepsilon^D & (AD) \\ P = \beta Y - \varepsilon^S & (AS) \end{cases}$$

one gets

$$\begin{cases} P = \frac{\beta}{\alpha+\beta}\varepsilon^D - \frac{\alpha}{\alpha+\beta}\varepsilon^S \\ Y = \frac{1}{\alpha+\beta}\varepsilon^D + \frac{1}{\alpha+\beta}\varepsilon^S \end{cases}$$

• When one observes Y and P, this is a set of 2 equations with 2 unknowns, ε^D and ε^S $\rightsquigarrow$ one can recover the structural shocks.

• The problem is that in the real world, we do not know α and β

• One way could be to estimate each of the two equations using instrumental variables (oil price when estimating AD, money supply or Gvt expenditures when estimating AS)

- But it is very unlikely that this very simple and static model captures a significant part of the economy variance

3.2 A Dynamic Model

- Assume that the economy is best described by the following dynamic model:

$$
\begin{cases}
P_t = \alpha_0^D Y_t + \alpha_1^D Y_{t-1} + \alpha_2^D Y_{t-2} + \cdots + \alpha_N^D Y_{t-N} \\
\quad + \beta_1^D P_{t-1} + \beta_2^D P_{t-2} + \cdots + \beta_N^D P_{t-N} + \varepsilon_t^D & (AD) \\
P_t = \alpha_0^S Y_t + \alpha_1^S Y_{t-1} + \alpha_2^S Y_{t-2} + \cdots + \alpha_N^S Y_{t-N} \\
\quad + \beta_1^S P_{t-1} + \beta_2^S P_{t-2} + \cdots + \beta_N^S P_{t-N} + \varepsilon_t^S & (AS)
\end{cases}
$$

- Demand and Supply shocks are independent.

3.3 A Simple Dynamic Model

- Consider the simple dynamic model

$$X_t = \rho X_{t-1} + \varepsilon_t \tag{1}$$

with $0 < \rho < 1$ and ε *iid*, with $E(\varepsilon_t) = 0$, $V(\varepsilon_t) = \sigma^2$

- (1) is the autoregressive (AR) representation of the model.
- One can write a moving average (MA) representation, which expresses X_t as a function of the current and past values of ε.

$$\begin{aligned}
X_t &= \rho X_{t-1} + \varepsilon_t \\
&= \rho\big(\rho X_{t-2} + \varepsilon_{t-1}\big) + \varepsilon_t \\
&= \rho^2 X_{t-2} + \rho\varepsilon_{t-1} + \varepsilon_t \\
&= \rho^3 X_{t-3} + \rho^2\varepsilon_{t-2} + \rho\varepsilon_{t-1} + \varepsilon_t \\
&= \rho^n X_{t-n} + \rho^{n-1}\varepsilon_{t-n+1} + \cdots + \rho\varepsilon_{t-1} + \varepsilon_t
\end{aligned}$$

- When $n \to \infty$, as $0 < \rho < 1$

$$X_t = \sum_{i=0}^{\infty} \rho^i \varepsilon_{t-i}$$

- Making use of the lag operator notation: $LX_t = X_{t-1}$, $L^i X_t = X_{t-i}$, $i \in \mathcal{Z}$

$$
\begin{aligned}
X_t &= \rho X_{t-1} + \varepsilon_t \\
X_t &= \rho L X_t + \varepsilon_t \\
(1-\rho L) X_t &= \varepsilon_t \\
X_t &= \tfrac{1}{1-\rho L} \varepsilon_t \\
X_t &= (1 + \rho L + \rho^2 L^2 + \cdots + \rho^n L^n + \cdots) \varepsilon_t \\
X_t &= \varepsilon_t + \rho \varepsilon_{t-1} + \cdots + \rho^{n-1} \varepsilon_{t-n+1} + \rho^n \varepsilon_{t-n} + \cdots
\end{aligned}
$$

- More generally, a univariate MA(∞) is denoted:

$$X_t = a_0 \varepsilon_t + a_1 \varepsilon_{t-1} + \cdots + a_{n-1} \varepsilon_{t-n+1} + a_n \varepsilon_{t-n} + \cdots$$

• One can use the MA representation of the model to compute various indicators.

Impulse response function: what is the dynamic effect of a shock? Assume that for $t = -\infty$ to 0, $\varepsilon_t = 0$, such that $X_0 = 0$.

• The shock is $\varepsilon_1 = 1$, with $\varepsilon_t = 0$ for $t > 1$.

• Then $X_1 = 1$, $X_2 = \rho$, $X_3 = \rho^2$, etc...

• Note that the IRF is given by the coefficients of the MA representation.

Forecast Error Variance: The mathematical expectation of X_{t+1} based on the information of period t is denoted $E_t(X_{t+1})$.

$$\begin{aligned} E_t(X_{t+1}) &= E_t(\rho X_t + \varepsilon_{t+1}) \\ &= \rho \underbrace{E_t X_t}_{X_t} + \underbrace{E_t \varepsilon_{t+1}}_{0} \end{aligned}$$

- The one-step forecast error if X_t is $FE_1 = X_{t+1} - E_t(X_{t+1}) = \varepsilon_{t+1}$.
- $E_t(FE_1) = 0$ and $V(FE_1) = \sigma^2$
- Similarly, $FE_k = X_{t+k} - E_t(X_{t+k}) = \rho^{k-1}\varepsilon_{t+1} + \rho^{k-2}\varepsilon_{t+2} + \cdots + \varepsilon_{t+k}$,

$E_t(FE_k) = 0$ and $V(FE_k) = (\rho^{2(k-1)} + \rho^{2(k-2)} + \cdots + \rho^2 + 1)\sigma^2$

- Note again that these statistics are functions of the MA coefficients.

- For example, $V(FE_k) = (a_k^2 + a_{k-1}^2 + \cdots + a_1^2 + a_0^2)\sigma^2$

3.4 VAR and VMA Representations of the Model

- Assume that the economy is best described by the following dynamic model:

$$
\begin{cases}
P_t = \alpha_0^D Y_t + \alpha_1^D Y_{t-1} + \alpha_2^D Y_{t-2} + \cdots + \alpha_N^D Y_{t-N} \\
\quad + \beta_1^D P_{t-1} + \beta_2^D P_{t-2} + \cdots + \beta_N^D P_{t-N} + \varepsilon_t^D & (AD) \\
P_t = \alpha_0^S Y_t + \alpha_1^S Y_{t-1} + \alpha_2^S Y_{t-2} + \cdots + \alpha_N^S Y_{t-N} \\
\quad + \beta_1^S P_{t-1} + \beta_2^S P_{t-2} + \cdots + \beta_S^P P_{t-N} + \varepsilon_t^S & (AS)
\end{cases}
$$

- making use of the lag operator notation:

$$LX_t = X_{t-1},\ L^i X_t = X_{t-i},\ i \in \mathcal{Z}$$

• and rearranging terms

$$\begin{cases} Y_t = (\alpha_1^Y + \alpha_2^Y L + \cdots + \alpha_N^Y L^{N-1})Y_{t-1} \\ \quad + (\beta_1^Y + \beta_2^Y L + \cdots + \beta_N^Y L^{N-1})P_{t-1} + \gamma_D^Y \varepsilon_t^D + \gamma_S^Y \varepsilon_t^S & (1) \\ P_t = (\alpha_1^P + \alpha_2^P L + \cdots + \alpha_N^P L^{N-1})Y_{t-1} \\ \quad + (\beta_1^P + \beta_2^P L + \cdots + \beta_N^P L^{N-1})P_{t-1} + \gamma_D^P \varepsilon_t^D + \gamma_S^P \varepsilon_t^S & (2) \end{cases}$$

• or equivalently

$$X_t = \widehat{A}(L) X_{t-1} + B\varepsilon_t$$

with $X_t = (Y_t, P_t)'$ and $\varepsilon_t = (\varepsilon_t^D, \varepsilon_t^S)$

• This is the VAR (Vectorial Auto Regressive) representation of the equilibrium.

• It is convenient to work with the VMA (Vectorial Moving Average) representation

$$X_t = \frac{B}{I - \widehat{A}(L)L}\varepsilon_t$$

or

$$X(t) = \sum_{j=0}^{\infty} A(j)\varepsilon_{t-j}$$

with $\text{Var}(\varepsilon_t) = I$ and

$$A(j) = \begin{pmatrix} a_{11}(j) & a_{12}(j) \\ a_{21}(j) & a_{22}(j) \end{pmatrix}$$

• This dynamic model, if derived from a structural one, puts a lot of restrictions on the sequence of $A(\cdot)$

3.5 Impulse Response Function (IRF), Variance decomposition and Historical decomposition

• Here I derive some summary statistics from the VMA representation

• Let us consider output. We have

$$Y_t = \sum_{j=0}^{\infty} a_{11}(j)\varepsilon_{t-j}^{D} + \sum_{j=0}^{\infty} a_{12}(j)\varepsilon_{t-j}^{S}$$

• The IRF to a demand shock is $\{a_{11}(0), a_{11}(1), a_{11}(2), ...\}$ and the

IRF to a supply shock is $\{a_{12}(0), a_{12}(1), a_{12}(2), ...\}$

- The Forecast Error in predicting Y at horizon 1 is

$$Y_{t+1} - E_t Y_{t+1} = a_{11}(0)\varepsilon^D_{t+1} + a_{12}(0)\varepsilon^S_{t+1}$$

and the share of the variance of FE at horizon 1 attributable to the demand shock is

$$\frac{a_{11}^2(0)}{a_{11}^2(0) + a_{12}^2(0)}$$

(the variances of the structural shocks is normalized to 1).

- At horizon k, this share is

$$\frac{\sum_{j=0}^{k} a_{11}^2(j)}{\sum_{j=0}^{k} a_{11}^2(\mathbf{j}) + \sum_{j=0}^{k} a_{12}^2(j)}$$

• Historical decomposition : what would have happen if only demand or supply shocks have been there?

$$Y_t^D = \sum_{j=0}^{\infty} a_{11}(j)\varepsilon_{t-j}^D$$

$$Y_t^S = \sum_{j=0}^{\infty} a_{12}(j)\varepsilon_{t-j}^S$$

3.6 The Need For Identification Assumptions

• Let us estimate a VAR model with Y and P.

$$X_t = \widetilde{A}(L) X_{t-1} + \nu_t$$

with $\text{Var}(\nu) = \Omega$ and $C(0) = I$ by normalization.

• Note that the νs are different from the ϵs (they are an unknown linear combination of the ϵs)

• From this estimated VAR form, one can recover the following *non structural* (or *reduced form)* VMA representation

$$X(t) = \sum_{j=0}^{\infty} C(j) \nu_{t-j}$$

• How can ν be cut into two orthogonal pieces that we will label demand and supply shocks?

- Compare this VMA representation with the *structural* one

$$X(t) = \sum_{j=0}^{\infty} A(j)\varepsilon_{t-j}$$

- As the two equations are representations of the same model,

$$\nu = A(0)\varepsilon \text{ and } A(j) = C(j)A(0) \text{ for } j > 0.$$

- Estimation gives us C.
- Once we know $A(0)$, we have everything. We have therefore 4 unknowns: $a_{11}(0), a_{12}(0)$, $a_{21}(0)$ and $a_{22}(0)$.
- How do we get $A(0)$? First, if $\nu = A(0)\varepsilon$, then ν and $A(0)\varepsilon$ have

the same variance-covariance matrix.

- The one of ν is the Ω (estimated). The one of ε is I by assumption.
- Therefore, one has

$$V(A(0)\varepsilon) = V(\nu) \Longleftrightarrow A(0)A(0)' = \Omega$$

or

$$\begin{pmatrix} a_{11}(0) & a_{12}(0) \\ a_{21}(0) & a_{22}(0) \end{pmatrix} \times \begin{pmatrix} a_{11}(0) & a_{12}(0) \\ a_{21}(0) & a_{22}(0) \end{pmatrix}' = \begin{pmatrix} \omega_{11}(0) & \omega_{12}(0) \\ \omega_{12}(0) & \omega_{22}(0) \end{pmatrix}$$

- This gives us 3 equations (because Ω and $A(0)A(0)'$ are symmetrical) for 4 unknowns (the 4 coefficients of $A(0)$)

- We need one identifying assumption, that will allow us to separate aggregate demand shocks from aggregate supply ones.
- This last condition cannot come from the math. It has to be a restriction imposed by the economist, based on some "reasonable" property of the economy.

3.7 The Identifying Restriction

- Here only one extra restriction is needed because we have a 2-variables VAR. It could be more in larger models.
- This restriction should come from a model.

- Blanchard-Quah proposed the following restriction: *Only supply shocks affect output in the long run* or in other words *Demand shocks do not affect output in the long run.*
- The long run effect of a demand shock is $a_{11}(\infty)$
- But $A(\infty) = C(\infty)A(0)$ or

$$\begin{pmatrix} a_{11}(\infty) & a_{12}(\infty) \\ a_{21}(\infty) & a_{22}(\infty) \end{pmatrix} = \begin{pmatrix} c_{11}(\infty) & c_{12}(\infty) \\ c_{21}(\infty) & c_{22}(\infty) \end{pmatrix} \times \begin{pmatrix} a_{11}(0) & a_{12}(0) \\ a_{21}(0) & a_{22}(0) \end{pmatrix}$$

- The fourth restriction is therefore

$$c_{11}(\infty)a_{11}(0) + c_{\mathbf{12}}(\infty)a_{21}(0) = 0$$

- Recall that the $c_{ij}(\infty)$ are known (from estimation).

• We can therefore compute $A(0)$.

• Once we have $A(0)$, and the estimated VAR, we can compute IRF to shocks and Forecast Error Variance decomposition

3.8 Some Extra Difficulties

• Here, I have assumed that both the model and the estimated VAR could be written and estimated as

$$X_t = \widehat{A}(L)X_{t-1} + B\varepsilon_t$$

• Both theory and estimation could imply that there are some constants or trends in this expression

$$X_t = \widehat{A}(L)X_{t-1} + B\varepsilon_t + K_1 + K_2 t$$

• There is also an issue about the best way to specify the VAR if the series are non stationary (ie if shocks have permanent effect, which is the case here). It might be more efficient to specify the VAR in difference

$$(1-L)X_t = (1-L)\widehat{A}(L)X_{t-1} + B\varepsilon_t + K_1$$

• In each of these case, although the algebra is more tedious, the same results than the one I have presented here apply.

3.9 Data

- Data: US 1947Q1-2008Q3 quarterly data
- Output is Real GDP, Prices series is the GNP deflator.
- With some abuse of the interpretation of the AD-AS model, I consider not P and Y but ΔP and ΔY.

Figure 11: US Output and Prices, 1947Q1-2008Q3

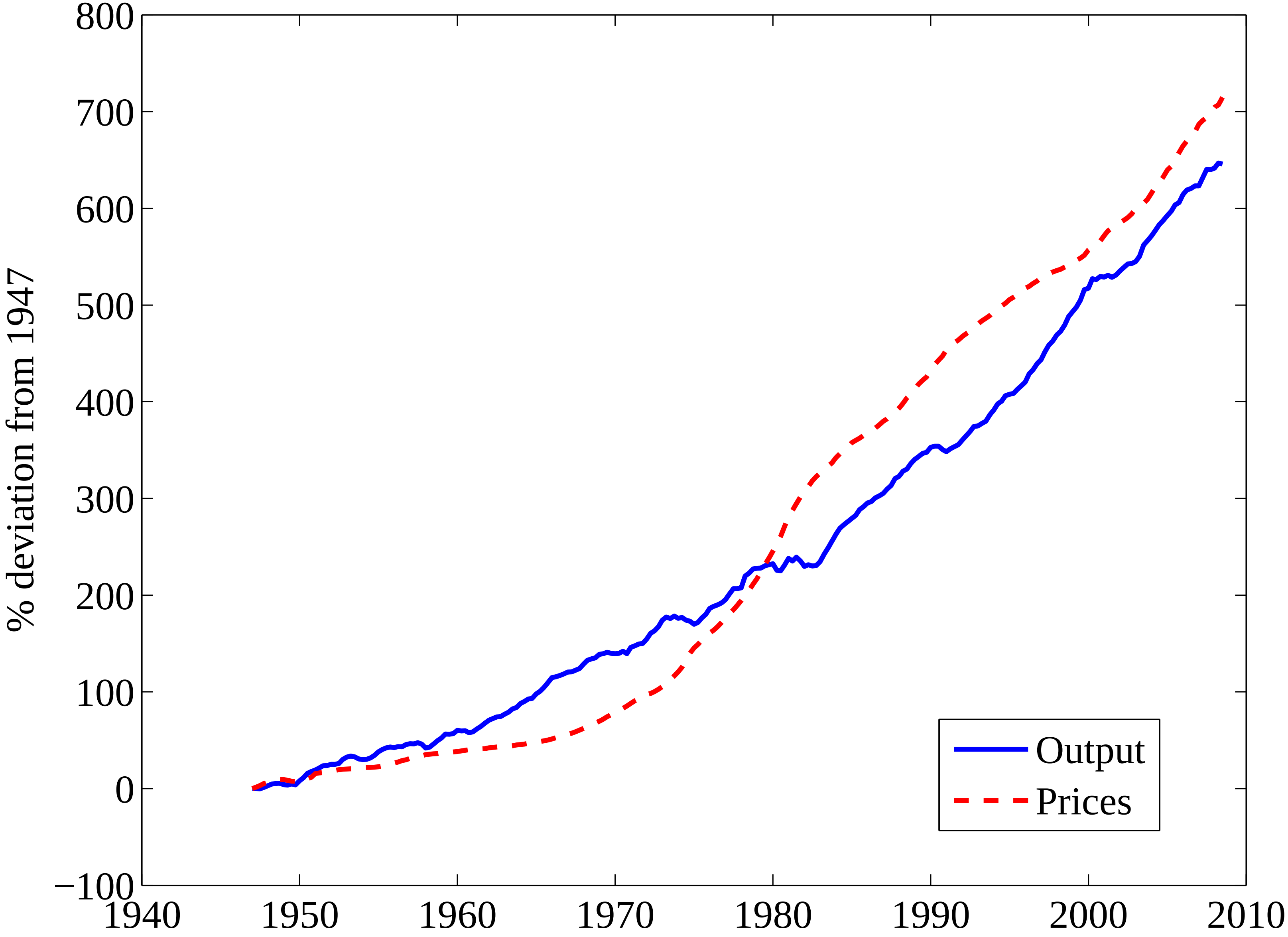
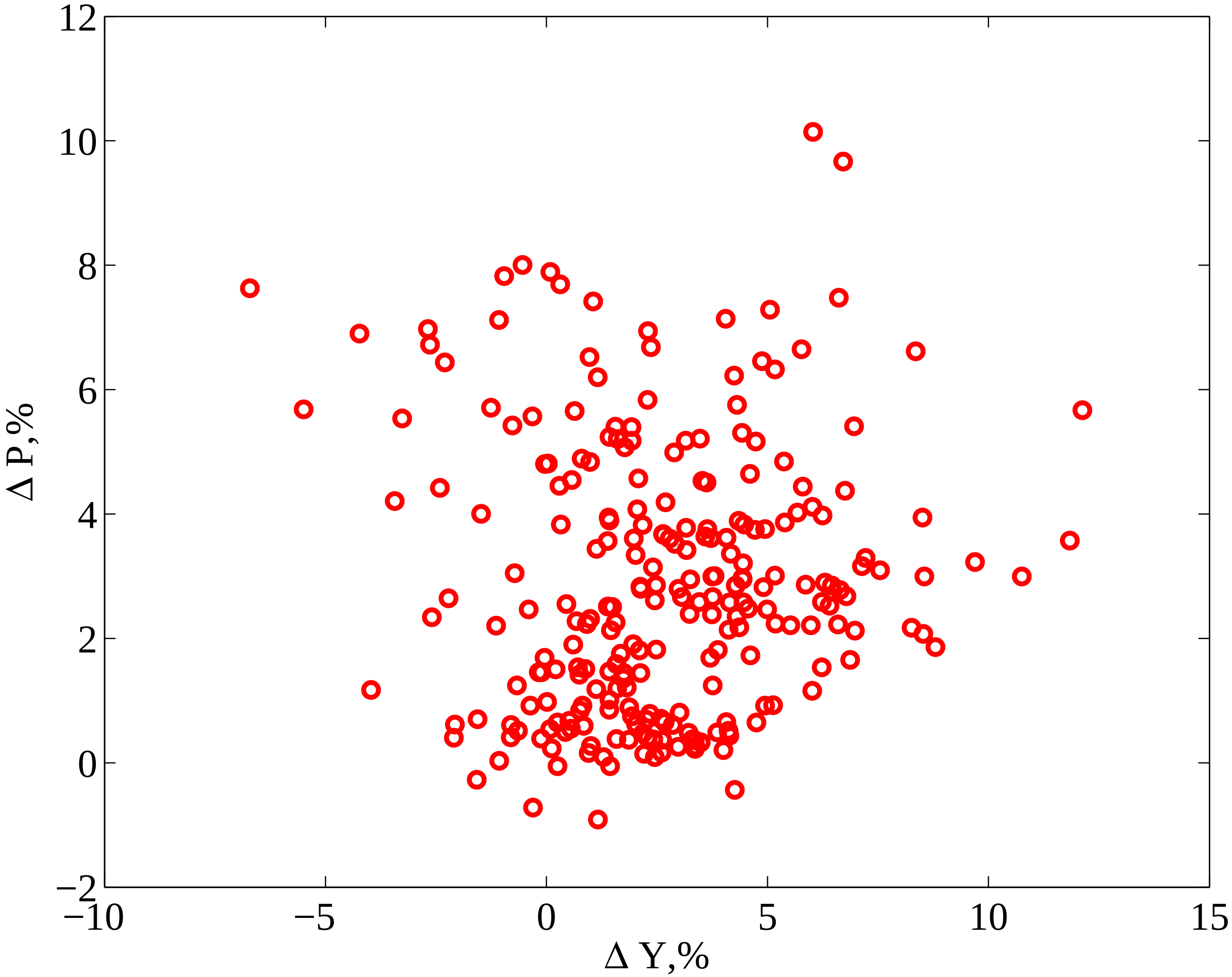


Figure 12: US Growth Rates of Output and Prices, 1947Q1-2008Q3



3.10 Results: IRF and Variance Decomposition

Figure 13: Estimated Shocks

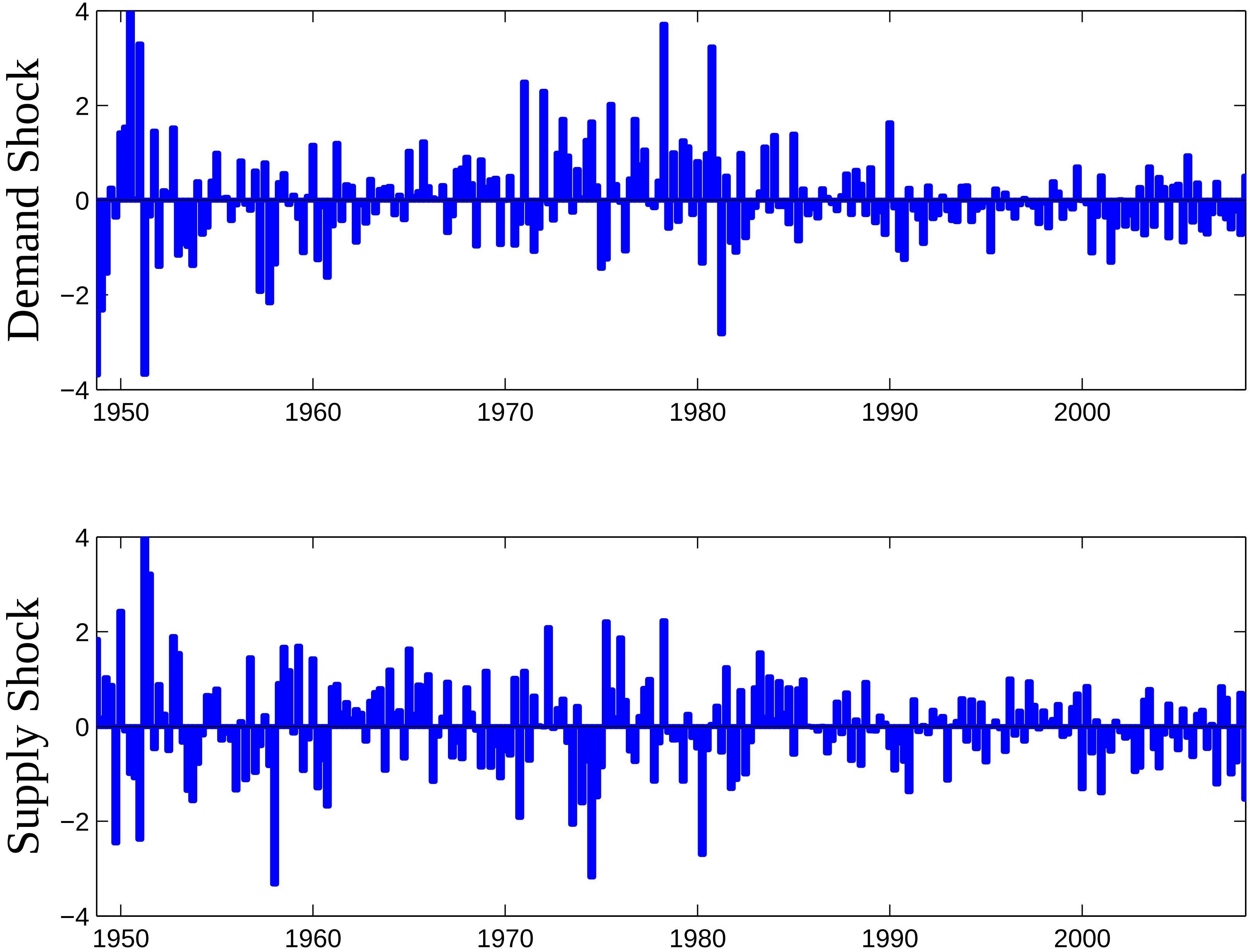


Figure 14: IRF

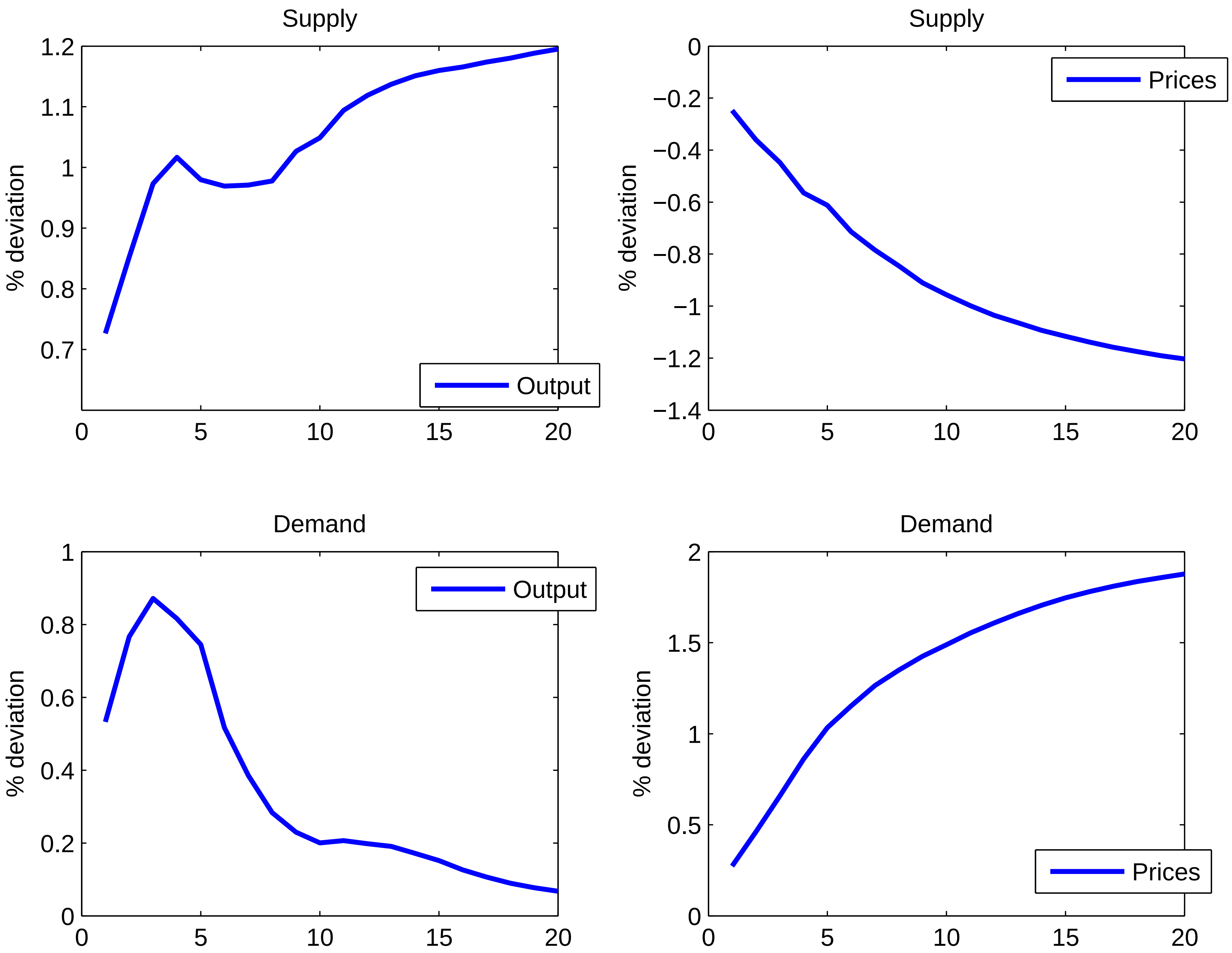


Figure 15: Output FE Variance Decomposition

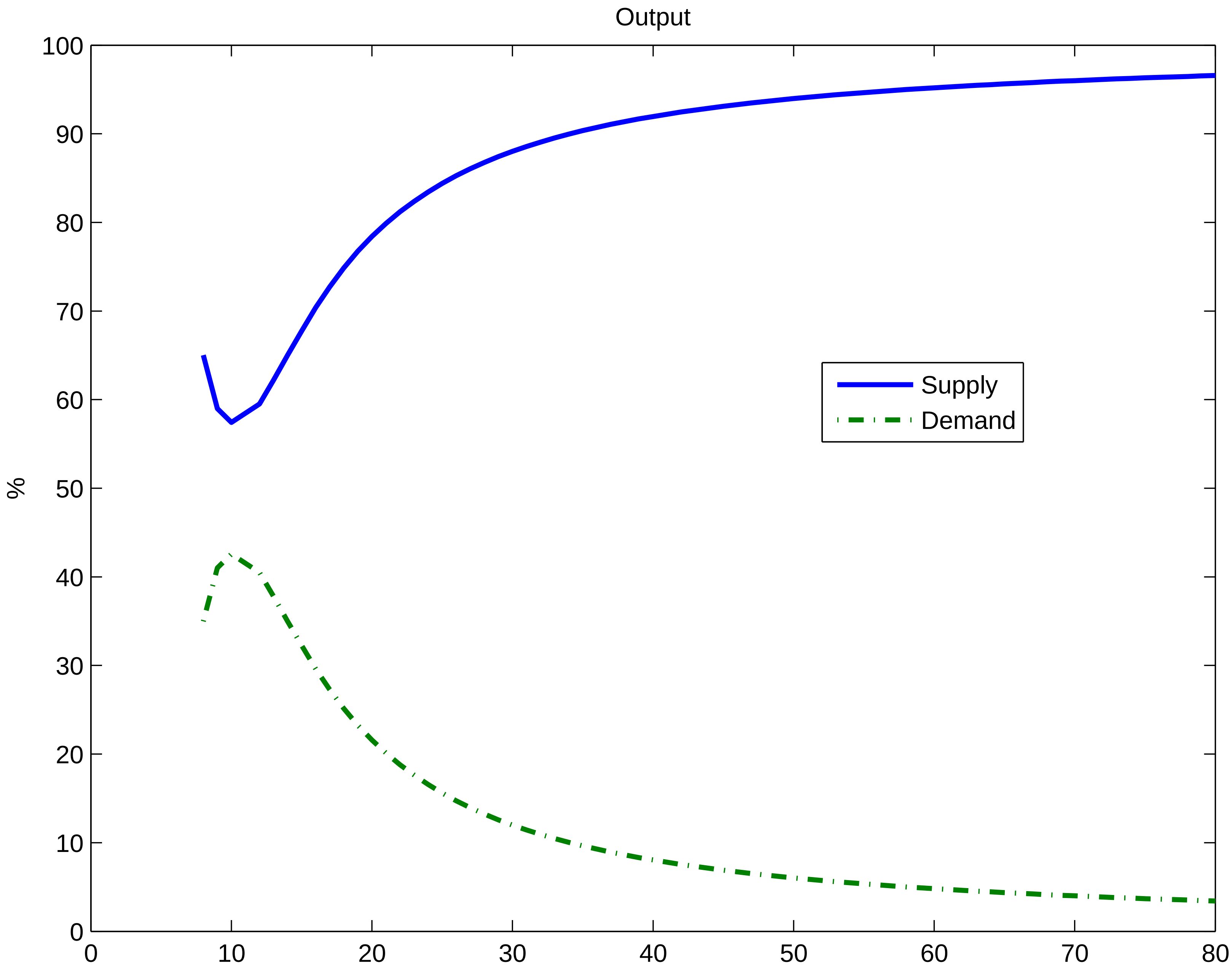
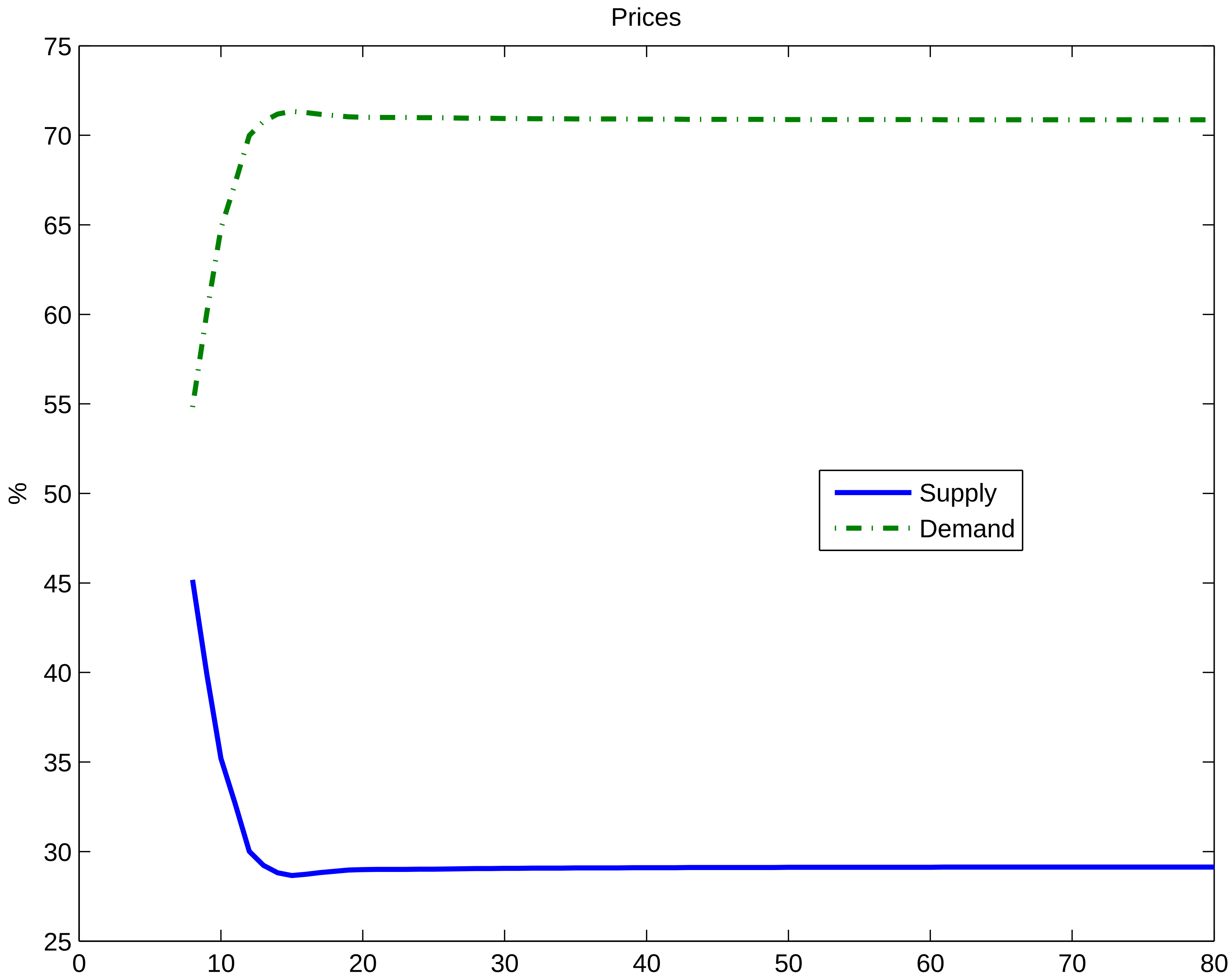


Figure 16: Prices FE Variance Decomposition



3.11 Results: Historical Decomposition

- I use the following color code:
- **Blue: actual series**
- **Green: the series with no shocks**
- **Pink: the series with only the supply shocks**
- **Red: the series with only the demand shocks**

Figure 17: Historical Decomposition: Whole Sample

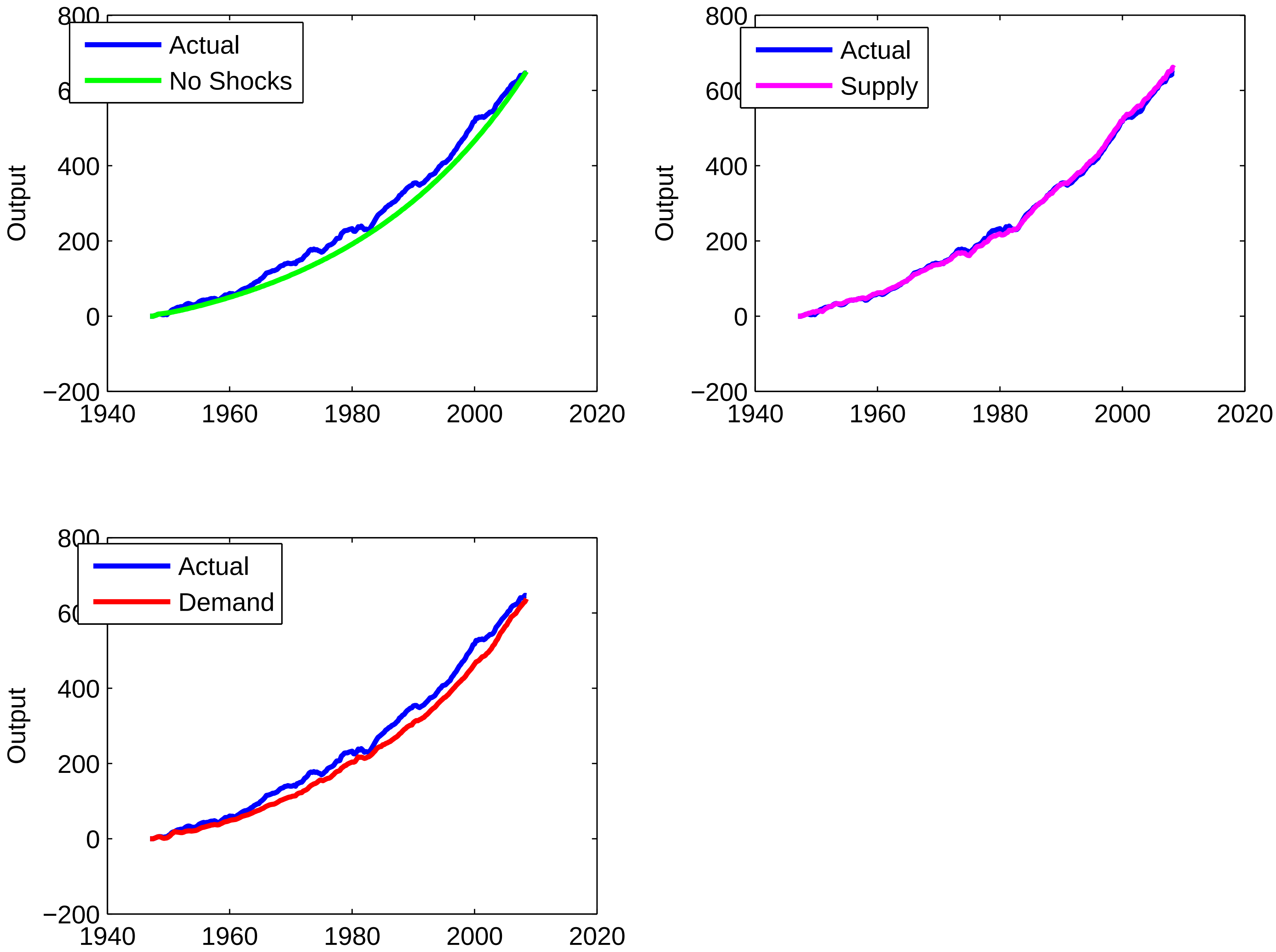


Figure 18: Historical Decomposition: Whole Sample

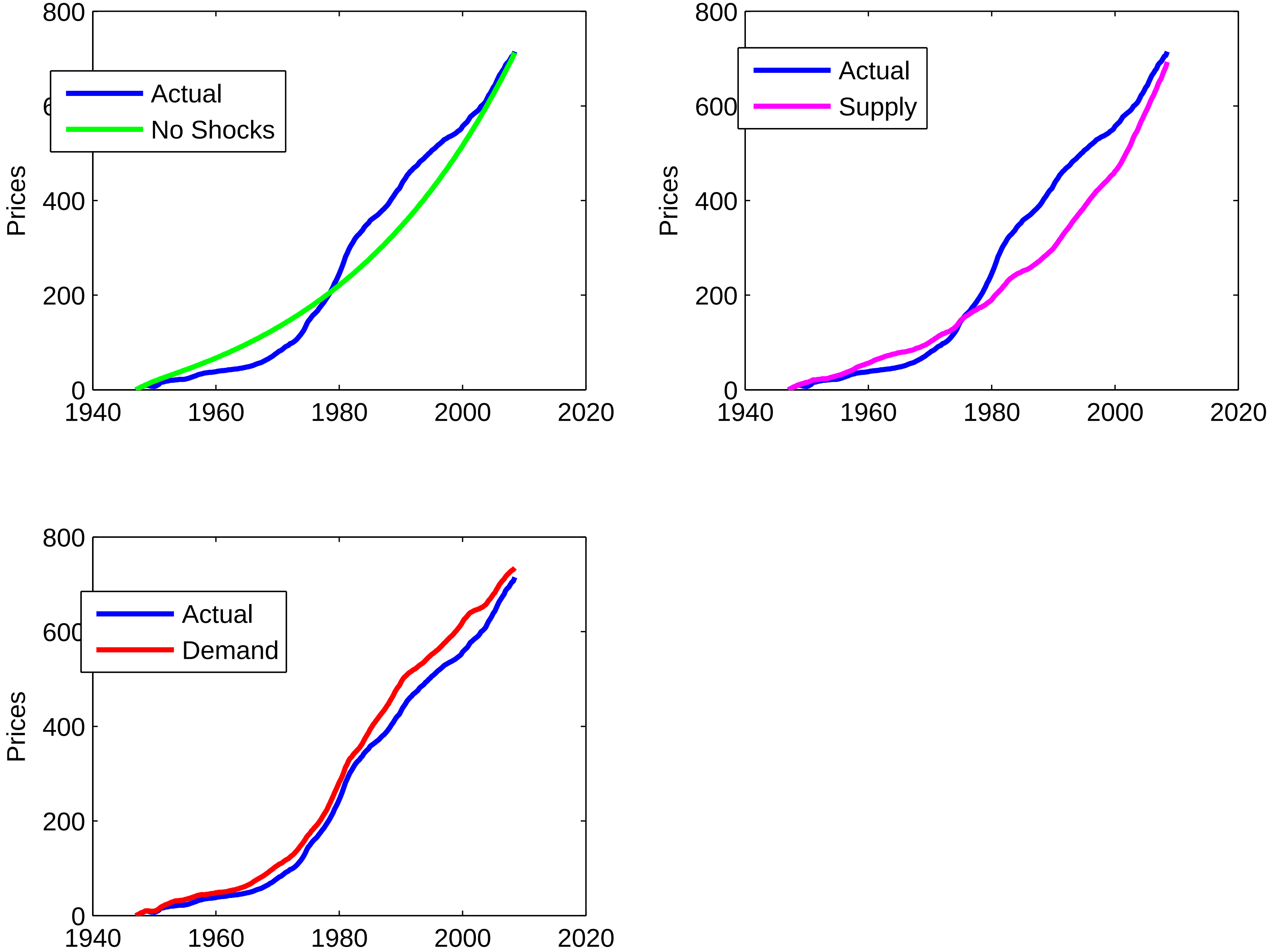


Figure 19: Historical Decomposition: Whole Sample

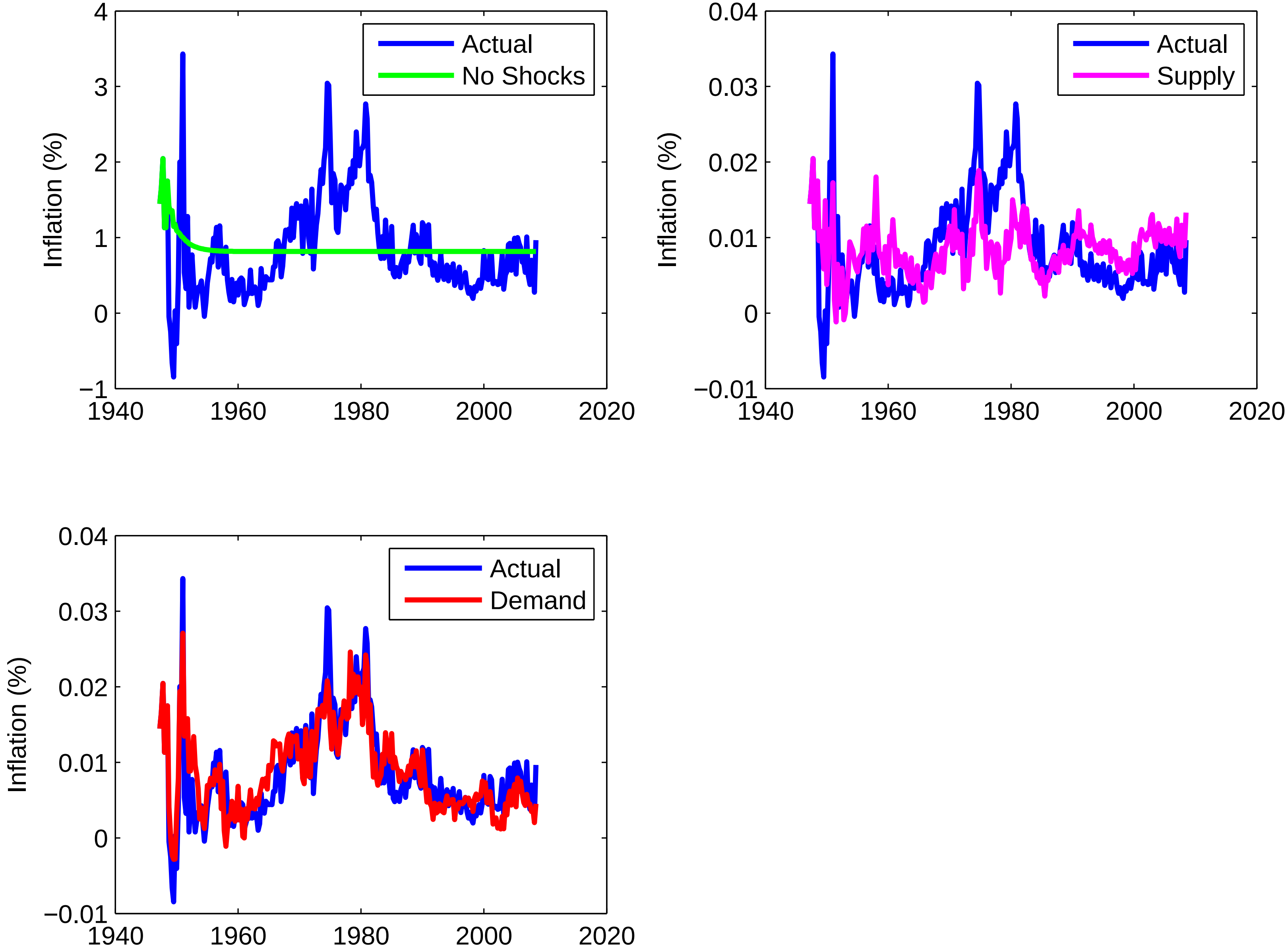


Figure 20: Historical Decomposition: Whole Sample

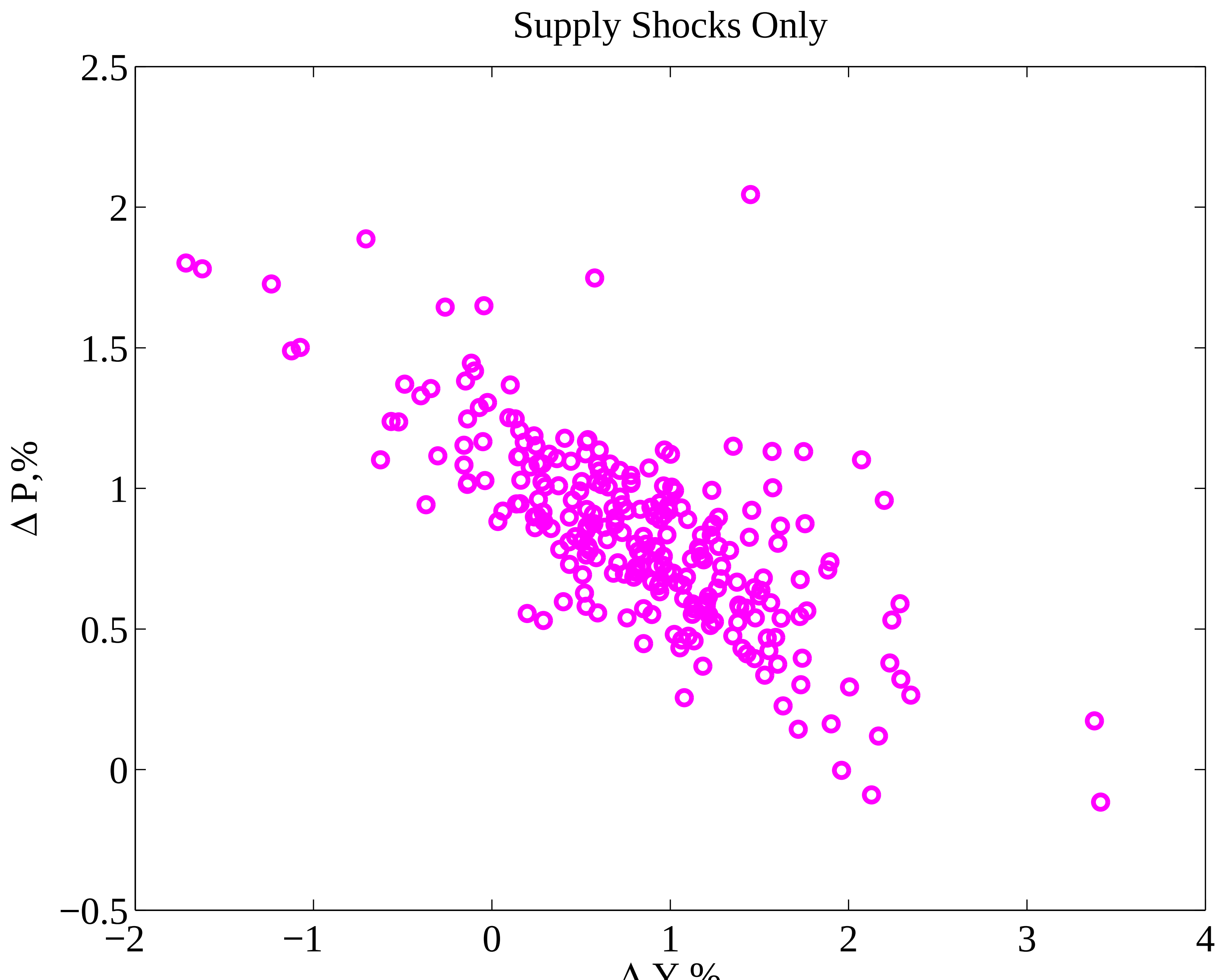


Figure 21: Historical Decomposition: Whole Sample

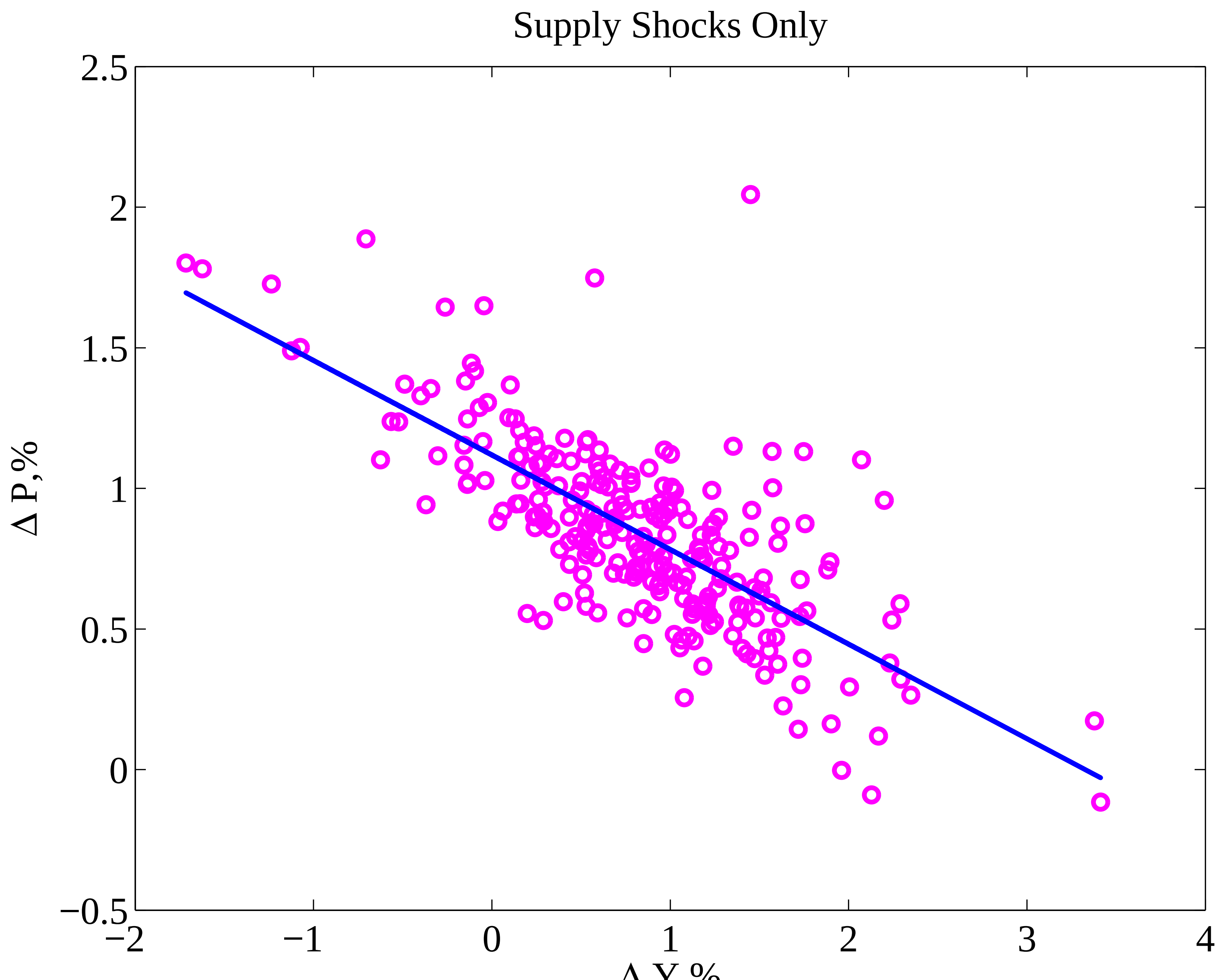


Figure 22: Historical Decomposition: Whole Sample

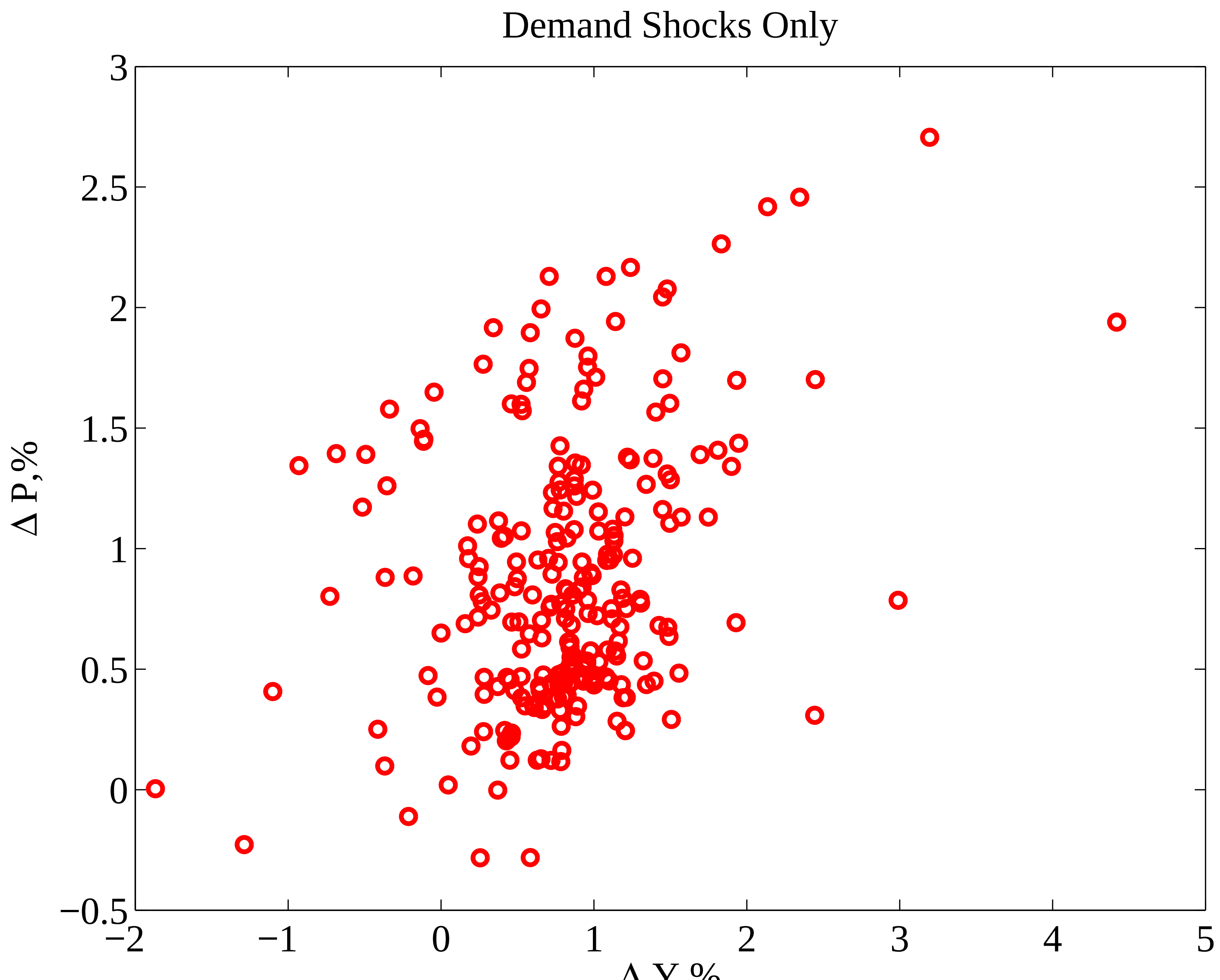


Figure 23: Historical Decomposition: Whole Sample

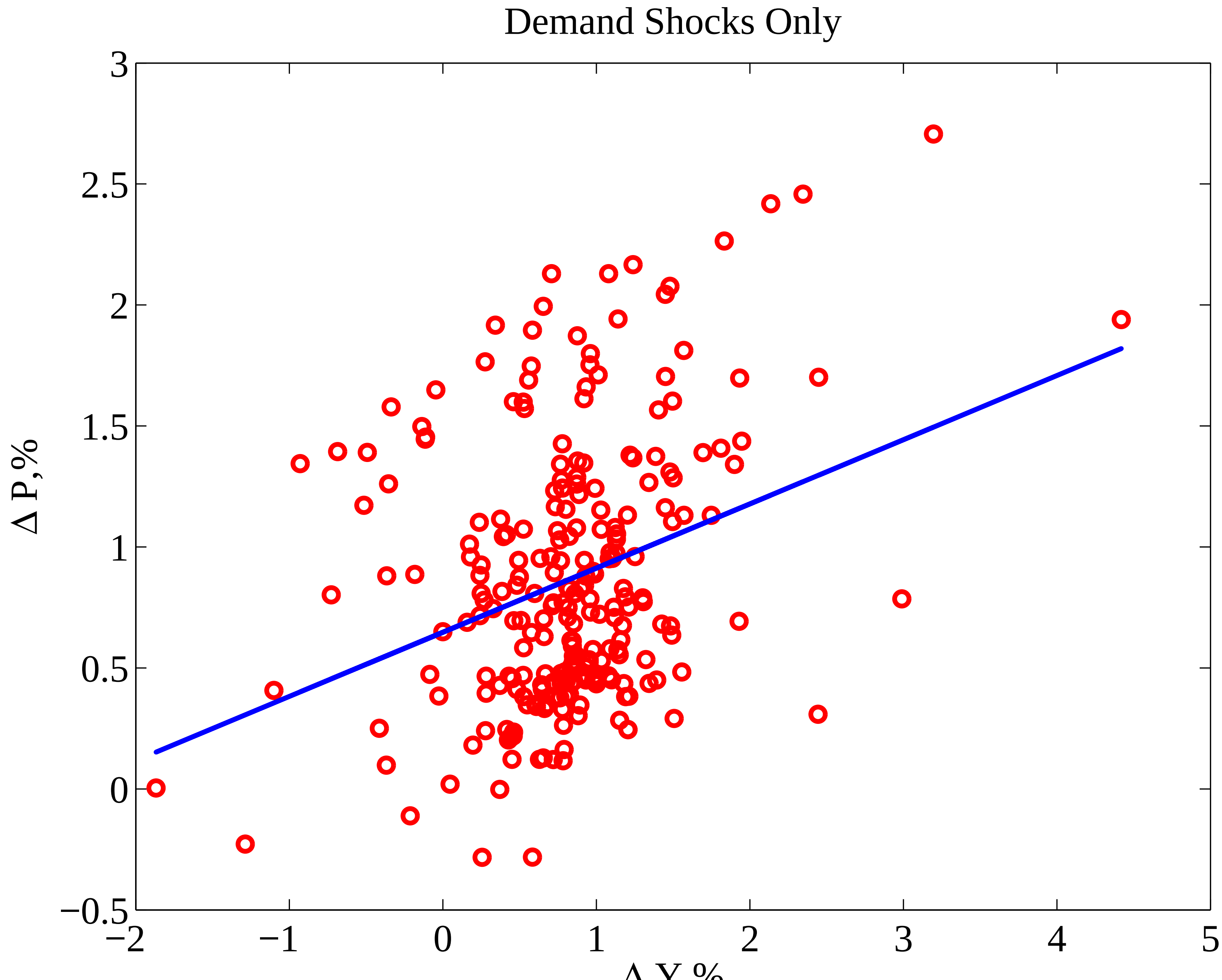


Figure 24: Historical Decomposition: First Oil Shock

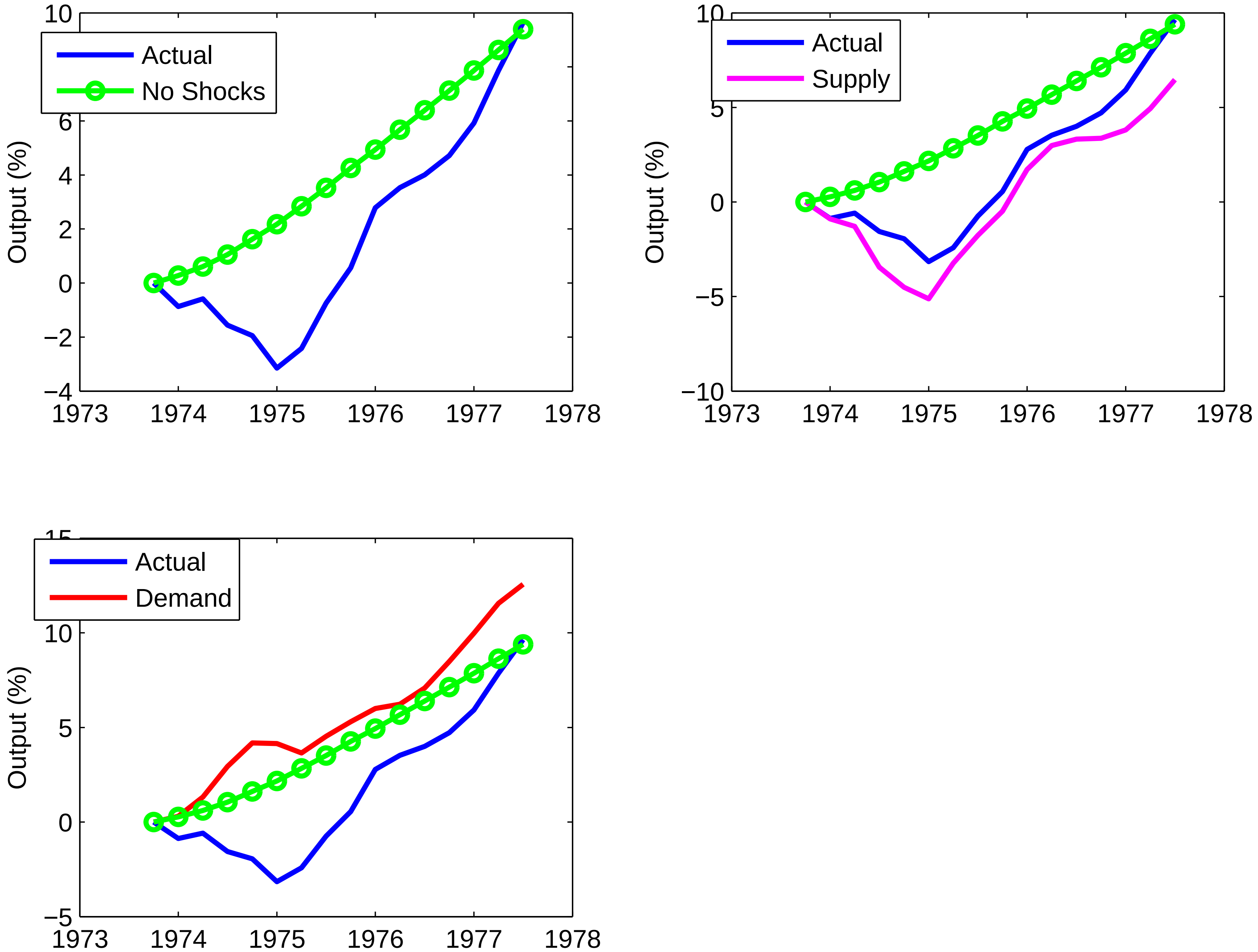


Figure 25: Historical Decomposition: First Oil Shock

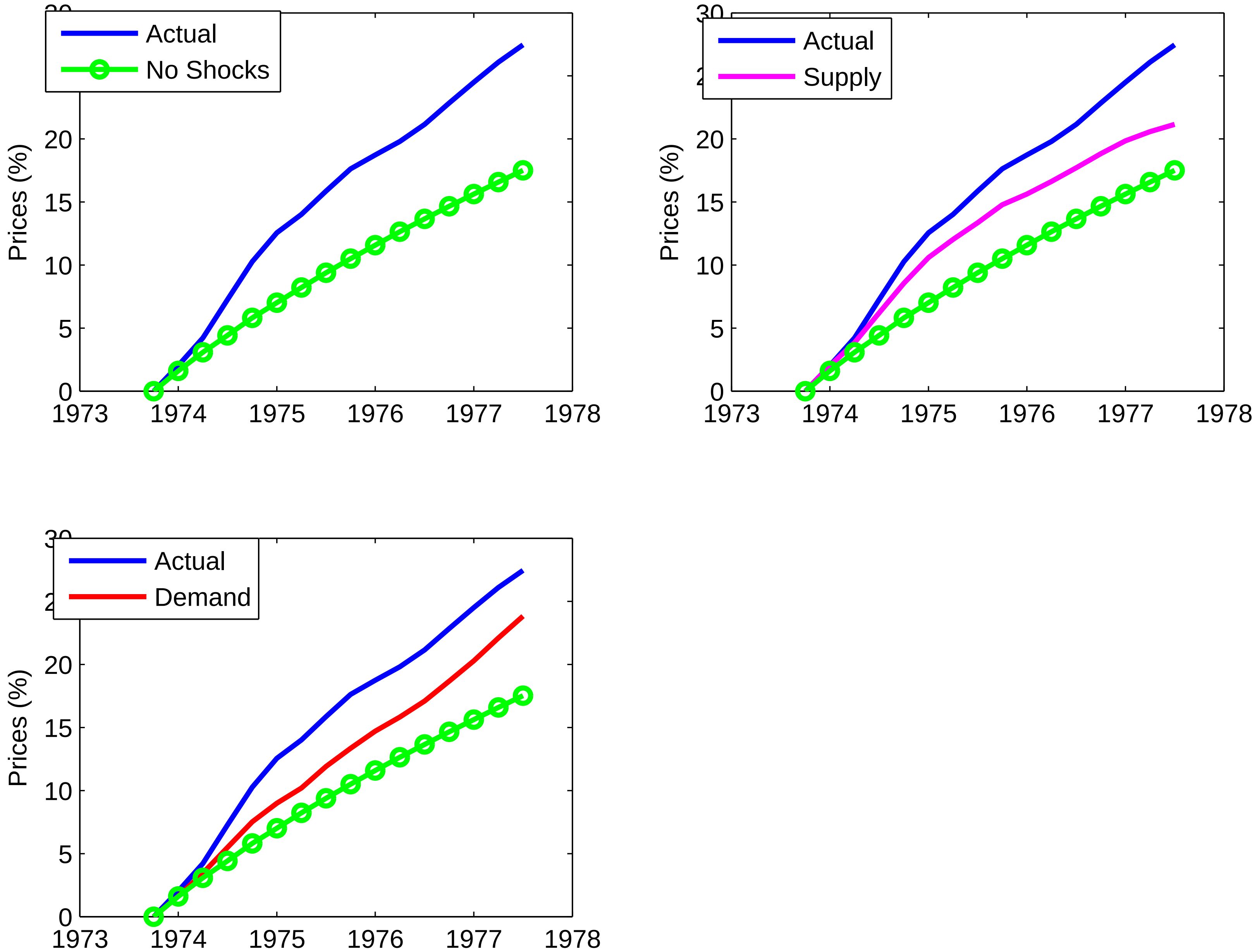


Figure 26: Historical Decomposition: First Oil Shock

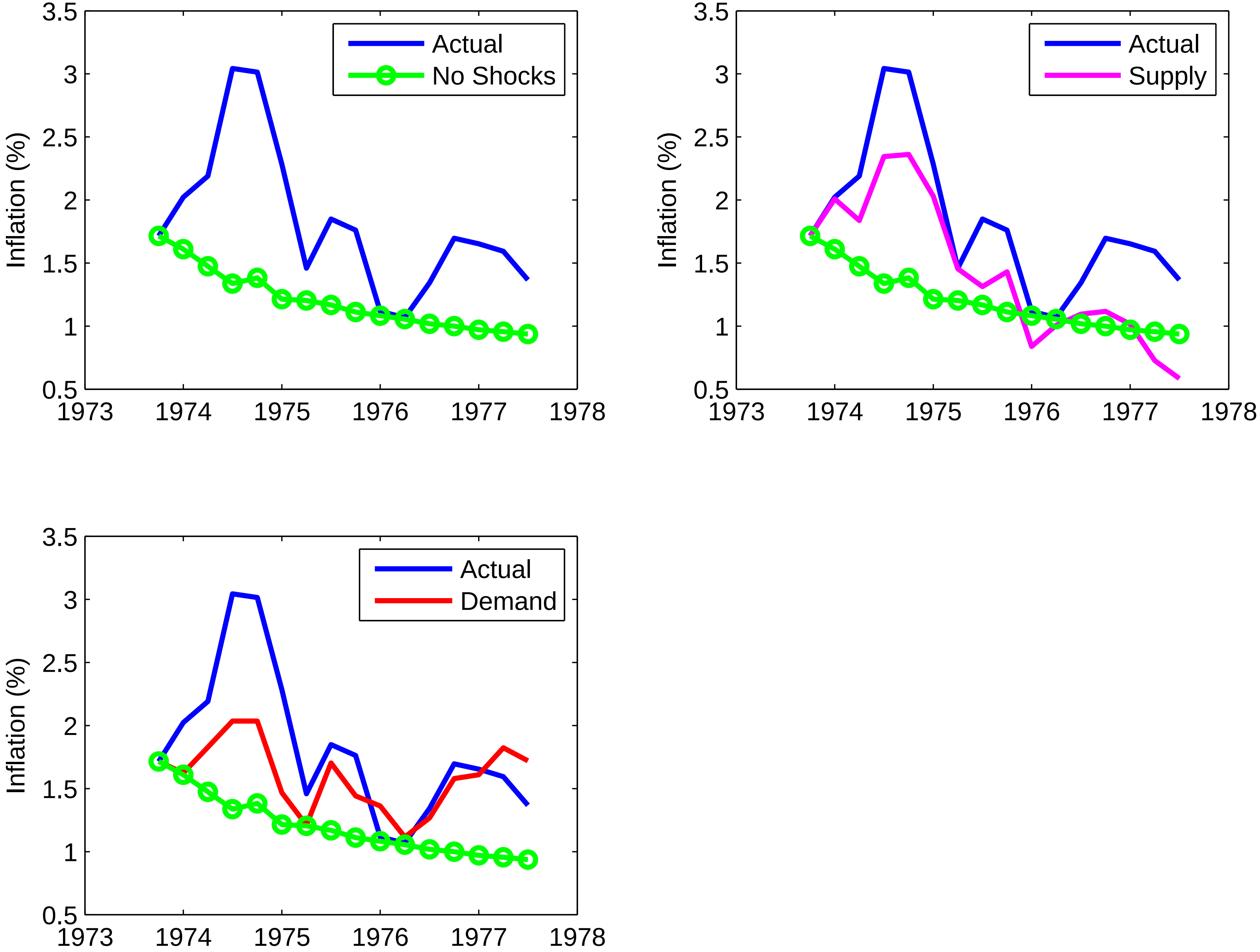


Figure 27: Historical Decomposition: 1990-1991 Recession

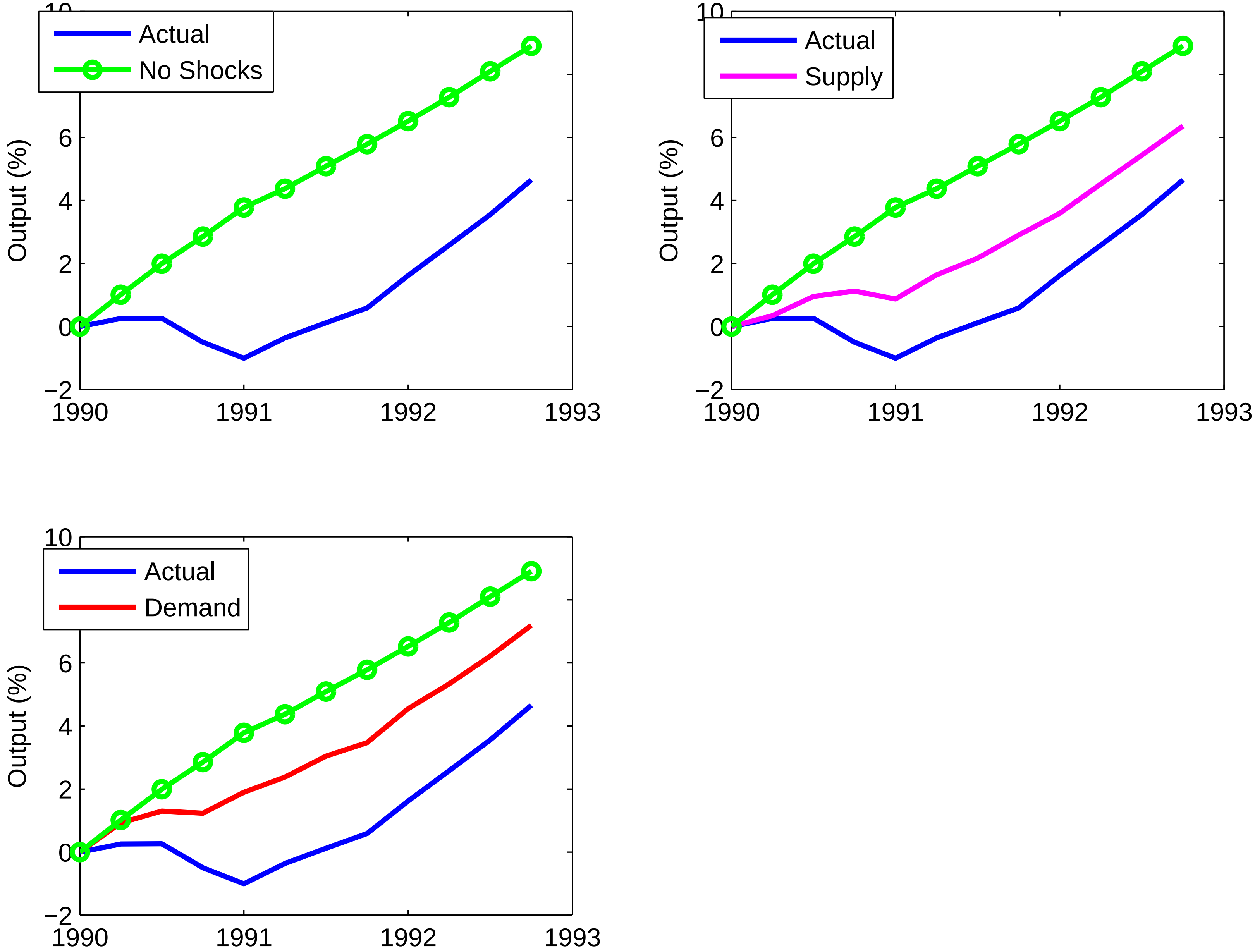


Figure 28: Historical Decomposition: 1990-1991 Recession

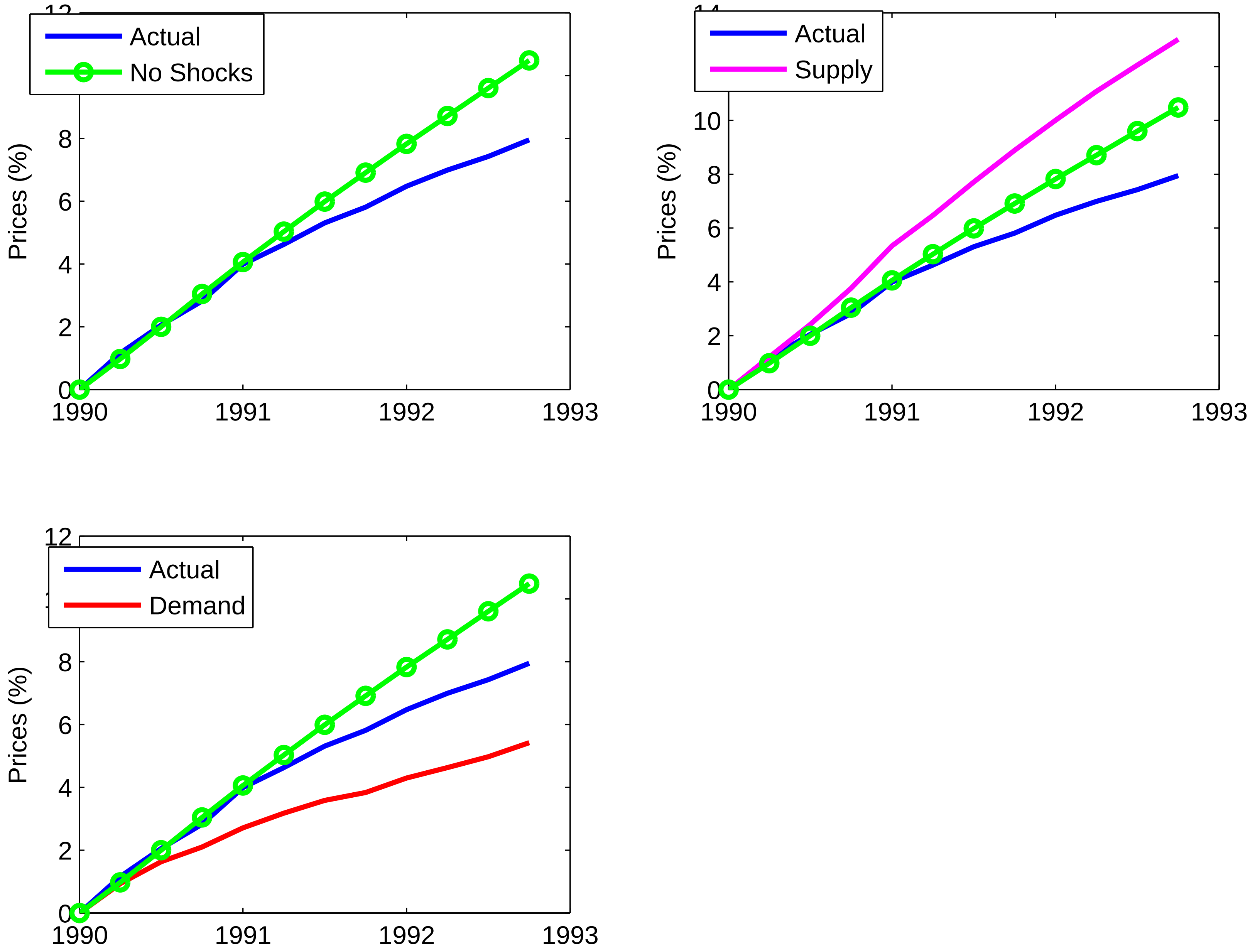
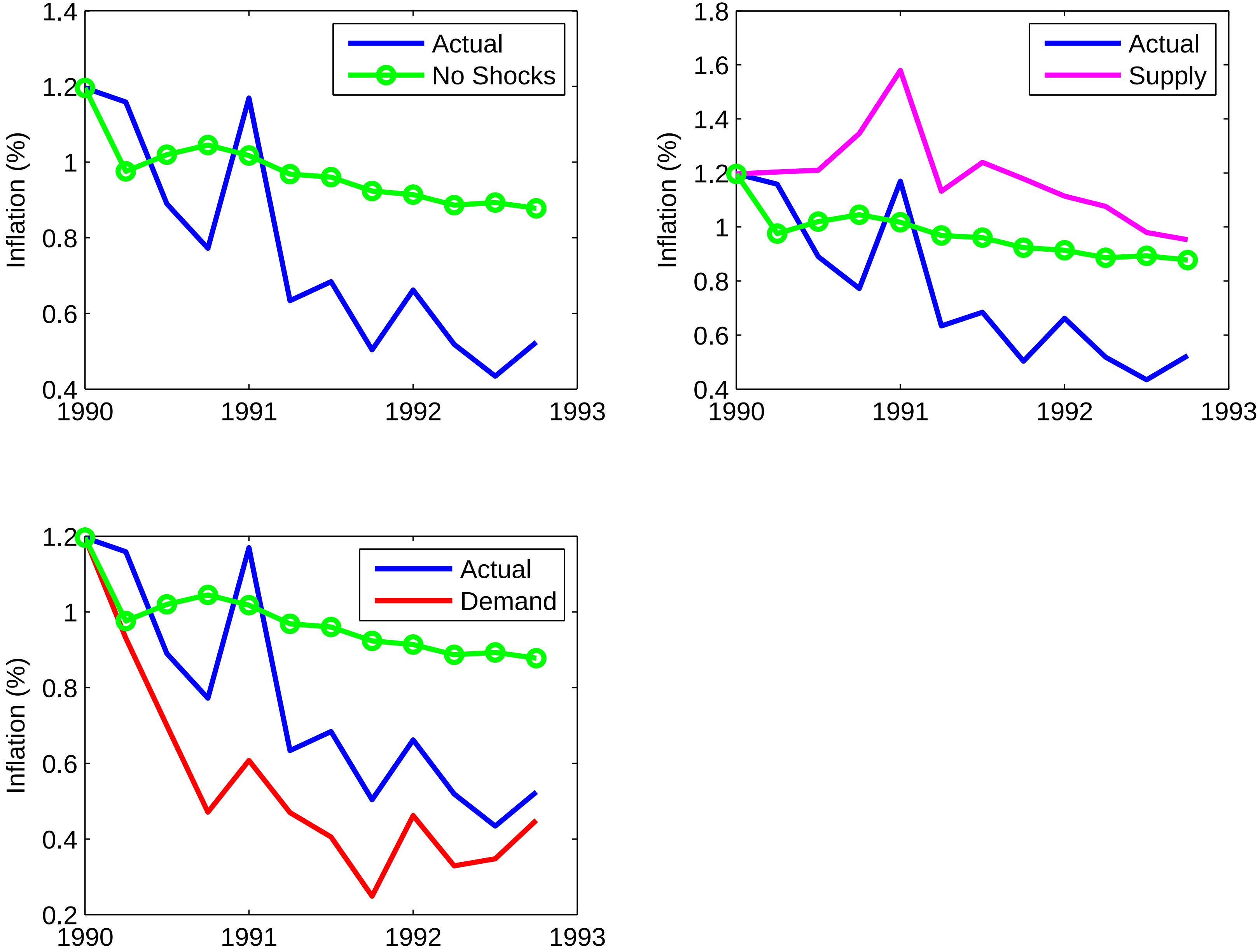


Figure 29: Historical Decomposition: 1990-1991 Recession



4 The Breakup of the Traditional View

- This traditional view of fluctuations has been seriously challenged in the late 60's and early 70's.
- Different lines of attack: inaccurate description (stagflation), theoretical internal inconsistencies (expectations?, general equilibrium consistency?, theory of price determination?).
- These attacks came from the so called New Classical School (Prescott, Lucas, Barro, Sargent, Kydland), following Friedman and Phelps on the Phillips Curve.

- Those first counter models were fully flexible – perfect competition – no voluntary employment model.
- Most macroeconomists will agree now that one can debate over the degree of price rigidities or competition , but that we need to use more micro-founded models and treat better dynamics and expectations, specifically when one is concerned with economic policy.
- The rest of the course will be devoted to the illustration of this claim.