SIMPLE DSGE MODELS OF "MONEY" PART II

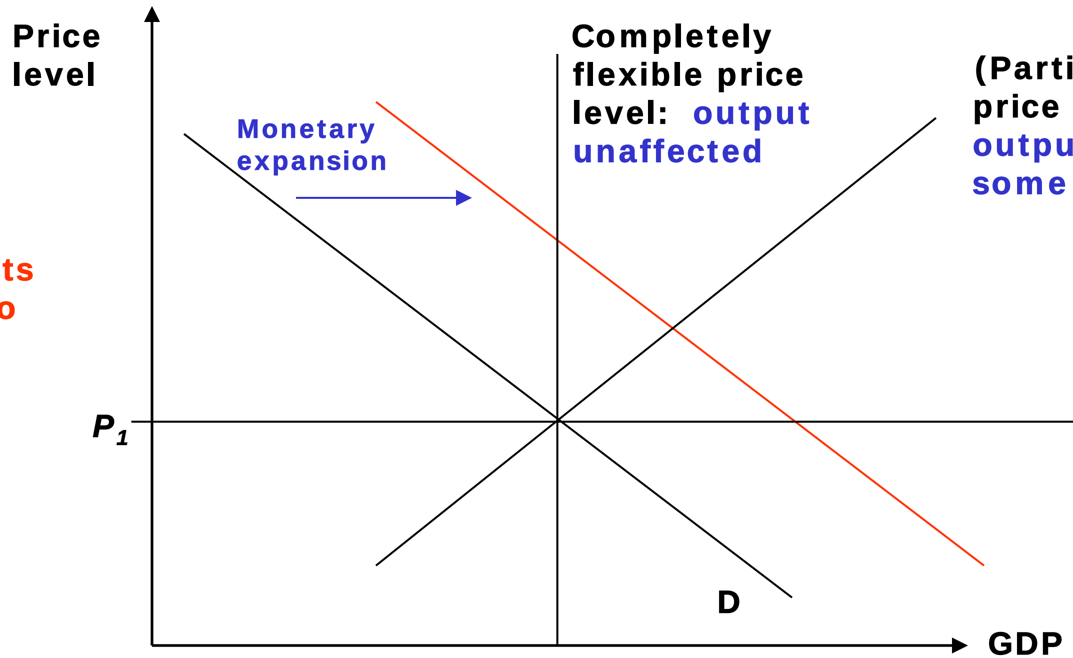
OCTOBER 8, 2013

BUSINESS CYCLE IMPLICATIONS OF MONEY

- ❒ **Stylized fact: high cyclical correlation of monetary aggregates and output**

- ❒ **Conventional Keynesian view: nominal rigidities (in price and/or wage level) cause monetary shifts to have real effects**

Question: How far can we go in explaining link between monetary shifts and real effects without appealing to nominal rigidities?



BUSINESS CYCLE IMPLICATIONS OF MONEY

- **Embed CIA framework in standard RBC model**
  - **…with quasi-linear utility…**
- **Can approximate and simulate using "usual" methods**
  - **Cooley and Hansen use LQ (linear-quadratic) approximation…**

TABLE 1—STANDARD DEVIATIONS IN PERCENT AND CORRELATIONS WITH OUTPUT FOR U.S. AND ARTIFICIAL ECONOMICS

Constant money growth rate; only z_t shocks

	Quarterly U.S. Time Series[a] (1955.3–1984.1)		Economy with Constant Growth Rate ($\bar{g} = 0.99–1.15$)[b]	
Series	Standard Deviation	Correlation with Output	Standard Deviation	Correlation with Output
Output	1.74	1.00	1.76 (0.22)	1.00 (0.00)
Consumption	0.81	0.65	0.51 (0.07)	0.87 (0.02)
Investment	8.45	0.91	5.71 (0.74)	0.99 (0.00)
Capital Stock	0.38	0.28	0.48 (0.09)	0.07 (0.07)
Hours	1.41	0.86	1.34 (0.18)	0.98 (0.00)
Productivity	0.89	0.59	0.51 (0.07)	0.87 (0.03)
Price Level: CPI	1.59	−0.48	0.51 (0.07)	−0.87 (0.02)
Price Level: GNP Deflator	0.98	−0.53		

RATIO of SD(hours) / SD(productivity) = 2.6 – inherited from Hansen-Rogerson quasi-linear preferences….

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Business cycle dynamics same as Hansen (1985, Table 1)!

Better be the case with the Friedman Rule (almost) in place!….BUT note they do not report dynamics of i_t…

Business Cycle Implications of Money

- Exogenous AR(1) governs money growth rate
  - Set parameters (persistence and S.D. of shock) to match first and second moments of empirical $M1$ process

	Low average money growth Economy with Autoregressive Growth Rate ($\bar{g}=1.015$)[b]		High average money growth Economy with Autoregressive Growth Rate ($\bar{g}=1.15$)[b]	
Series	Standard Deviation	Correlation with Output	Standard Deviation	Correlation with Output
Output	1.73 (0.22)	1.00 (0.00)	1.74 (0.22)	1.00 (0.00)
Consumption	0.62 (0.07)	0.72 (0.07)	0.65 (0.07)	0.70 (0.05)
Investment	5.69 (0.76)	0.97 (0.01)	5.69 (0.77)	0.97 (0.01)
Capital Stock	0.48 (0.10)	0.06 (0.07)	0.48 (0.10)	0.06 (0.06)
Hours	1.33 (0.17)	0.98 (0.01)	1.33 (0.17)	0.98 (0.01)
Productivity	0.50 (0.07)	0.87 (0.03)	0.50 (0.07)	0.87 (0.03)
Price Level	1.70 (0.34)	−0.27 (0.16)	1.93 (0.27)	−0.25 (0.16)

- Result: volatility of nominal money reflected entirely in nominal prices and consumption
  - Makes some sense…the binding CIA constraint… $c_t = \frac{M_t}{P_t}$
  - Dynamics of other variables virtually unaffected

A PHILLIPS CURVE?

- Tradeoff between inflation and unemployment the centerpiece of monetary theory and policy circa 1970

- Can CIA model deliver it?
  - Short-run Phillips Curve: No mention of cyclical correlation between π_t and labor
  - Long-run (i.e., deterministic steady state) Phillips Curve: negative relation between inflation and employment
    - And thus with output, consumption, investment
    - (Steady-state!) inflation is a tax on consumption, hence substitute into leisure

- Empirical evidence may support "upward-sloping" *long-run* (i.e., steady state, i.e., *time-averaged*) Phillips Curve
  - But is this the same as the "…operational Phillips Curve…" (p. 745)? Likely not…

WELFARE COSTS OF INFLATION

- **Another enduring question: What are the welfare gains of moving from a high-inflation to a low-inflation environment?**
  - **Particular interest in this question in many developing countries and U.S. circa 1970-1980**

Standard practice since Lucas (1987 *Models of Business Cycles*)

- **Typical method: compute extra percentage of consumption representative agent would require in high-inflation environment to be just as well off (utility) as in low-inflation environment (without the consumption compensation)**
  - **Applied to steady state, compute ζ such that**

$$\frac{u\left((1+\varsigma)\bar{c}^{\text{"BAD" POLICY}}, \bar{n}^{\text{"BAD" POLICY}}\right)}{1-\beta} = \frac{u\left(\bar{c}^{\text{"GOOD" POLICY}}, \bar{n}^{\text{"GOOD" POLICY}}\right)}{1-\beta}$$

"Consumption equivalents"

WELFARE COSTS OF INFLATION

❒ Cooley and Hansen results

TABLE 2—STEADY STATES AND WELFARE COSTS ASSOCIATED WITH VARIOUS ANNUAL GROWTH RATES OF MONEY

Define "good policy" benchmark as Friedman Rule

		Annual Inflation Rate				
Quarterly Constraint		−4 Percent	0.0 Percent	10 Percent	100 Percent	400 Percent
	$g=$	β	1.0	1.024	1.19	1.41
Steady State:	Output	1.115	1.104	1.077	0.927	0.783
	Consumption	0.829	0.821	0.801	0.690	0.582
	Investment	0.286	0.283	0.276	0.238	0.201
	Capital Stock	11.432	11.318	11.053	9.511	8.027
	Hours	0.301	0.298	0.291	0.250	0.211
100ζ Welfare Costs:	$\Delta C/C\times 100$	0.0	0.144	0.520	4.014	10.215
	$\Delta C/Y\times 100$	0.0	0.107	0.387	2.984	7.596
Monthly Constraint						
	$g=$	β	1.0	1.008	1.06	1.12
Steady State:	Output	0.387	0.386	0.383	0.364	0.345
	Consumption	0.286	0.285	0.283	0.269	0.255
	Investment	0.101	0.101	0.100	0.095	0.090
	Capital Stock	12.663	12.624	12.524	11.910	11.272
	Hours	0.303	0.302	0.300	0.285	0.270
100ζ Welfare Costs:	$\Delta C/C\times 100$	0.0	0.040	0.152	0.981	2.137
	$\Delta C/Y\times 100$	0.0	0.030	0.112	0.724	1.578

A common benchmark result in the literature – i.e., Lucas (2000), Lagos and Wright (2005), others compare with it

WELFARE COSTS OF *VARIABLE* POLICY

- **Not studied by Cooley and Hansen**
- **Typical method: compute extra percentage of consumption representative agent would require in variable-money-growth environment to be just as well off (utility) as in constant-money-growth environment (without the consumption compensation)**
  - **Applied to dynamics, compute *ζ* such that**

$$\sum_{t=0}^{T} \beta^{t} u\left((1+\varsigma)c_t^{\text{VARIABLE POLICY}}, n_t^{\text{VARIABLE POLICY}}\right) = \frac{u\left(\bar{c}^{\text{CONSTANT POLICY}}, \bar{n}^{\text{CONSTANT POLICY}}\right)}{1-\beta}$$

In practice, choose *T* large enough so that $\beta^T \approx 0$

  - **Obtain $\{c_t, n_t\}_{t=0}^{T}$ through simulation**

OTHER ANALYSIS

- In presence of other distorting taxes (labor- and capital-income), welfare cost of moderate (long-run) inflation about double

With other distorting taxes (1991 *JMCB*)

Without other distorting taxes (1989 *AER*)

Also has revenue consequences (consolidated fiscal-monetary budget) – basis for Ramsey models ala Lucas and Stokey (1983), Chari and Kehoe (1999)

TABLE 1

WELFARE AND REVENUE CONSEQUENCES OF ALTERNATIVE POLICIES

Inflation Rate	Seigniorage	Seigniorage/GNP	Welfare Cost of Inflation (%GNP)	Change in Total Revenue	Seigniorage/Total Revenue	Welfare Cost of Policy (%GNP)
Economy with Capital and Labor Income Taxation $\alpha = 0.84$						
0.0	0.0	0.0	0.2794	0.0	0.0	16.843
5.0	0.0094	0.0083	0.6257	0.0066	0.0239	17.259
10.0	0.0180	0.0161	0.9628	0.0126	0.0448	17.664
20.0	0.0333	0.0304	1.6117	0.0232	0.0792	18.443
50.0	0.0681	0.0652	3.3860	0.0463	0.1464	20.575
Economy with Only Inflation Tax						
0.0	0.0	0.0	0.1048	0.0	1.0	0.1048
5.0	0.0143	0.0077	0.2392	0.0143	1.0	0.2392
10.0	0.0275	0.0150	0.3751	0.0275	1.0	0.3751
20.0	0.0508	0.0282	0.6488	0.0508	1.0	0.6488
50.0	0.1040	0.0605	1.4661	0.1040	1.0	1.4661
Economy with Capital and Labor Income Taxation $\alpha = 0.50$						
0.0	0.0	0.0	0.1669	0.0	0.0	16.707
5.0	0.0056	0.0049	0.3719	0.0039	0.0143	16.954
10.0	0.0107	0.0095	0.5717	0.0075	0.0270	17.194
20.0	0.0198	0.0178	0.9556	0.0138	0.0485	17.655
50.0	0.0405	0.0374	1.9992	0.0275	0.0923	18.909

SUMMARY

- **Business cycle dynamics of real variables little-affected by exogenous fluctuations in money growth rate**
  - **Not a very strong "monetary propagation" mechanism**

- **Business cycle dynamics of nominal variables (π_t, i_t) not in line with empirical evidence (*Frontiers* chapter)**

- **Welfare costs of moderate (≈ 10 percent) long-run inflation ≈ 0.4 percent of long-run consumption**
  - **Can double if economy is distorted by other taxes**
  - **All stemming from (easing) the transactions (CIA) friction**
    - **New Keynesian models: source of welfare gains from lowering inflation (reduces relative-price distortions) very different**

- **Long-run upward-sloping Phillips Curve**
  - **New Keynesian models: emphasis on *short-run* Phillips Curve**

Other General Issues

- Which assets provide liquidity services?
  - Money
  - (Some) bonds?
  - Which to include in CIA constraint?

- Timing?
  - Do money/asset markets meet before or after goods markets?
  - Carlstrom and Fuerst (2001 *JME*) demonstrate precise timing of monetary models can be crucial for some results

- Money growth rules vs. interest rate rules?
  - Non-New Keynesian models typically use money growth rule
    - But see Gavin, Kydland, and Pakko (2007 *JME*) for recent example using interest rate rule
  - New Keynesian models typically use interest rate rule