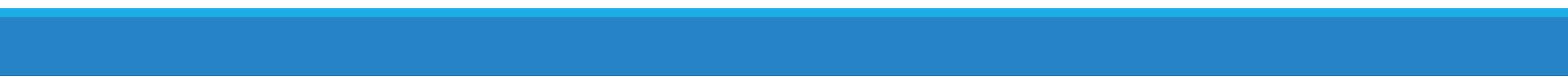


Optimal Inflation and the Phillips Curve

MICHAEL MCLEAY (BOE)

SILVANA TENREYRO (LSE AND BOE)



The Phillips Curve

EE 4G 21:05 8%

The Phillips curve, dead or alive?

Premium

Debate may not make much difference to practical policy

MARTIN SANDBU + Add to myFT

JULY 25, 2019 by Martin Sandbu

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As I [wrote last week](#), the announced death of the Phillips curve drew strange bedfellows to its wake. From Trump economic advisers to the left wing of the Democratic party, some policymakers have welcomed the seeming

myFT Updated 9:04pm

Roger E. A. Farmer @farmerrf
Our new paper on the failed Phillips Curve is now published:
The Phillips curve, dead or alive?
Martin Sandbu, Financial Times

Ricardo Reis @R2Rsquared
To which I would add: "Either way, the Phillips curve has come a long way since
Yes, There Is a Trade-off Between Inflation and Unemployment
N. Gregory Mankiw, The New York Times

Ocasio-Cortez, Trump Adviser Unite to Trash the Phillips Curve
Reade Pickert and Katia Dmitrieva, Bloomberg News

Olivier Blanchard @ojblanchard1
Logical fallacy: it is not because a relation is complex and shifting that you can dismiss it. 😞 A complete macro model must have an equation reflecting wage formation in labor market. And it is highly unlikely that wage determination depends in no way on state of labor market.

Roger E. A. Farmer @farmerrf
Oh but you can @ojblanchard1. And w time again, you must replace it. That's false theory: the Natural Rate Hypothe @warwicknewsroom @MESandbu @g

Ivan Werning @IvanWerning
Phillips Curve "Wars" are back!
Some say it's dead; others, alive and kickin'.
People often talk past each other. (Surprise!) Let me try to explain one big reason why.
I'll use some analogies from basic micro. (1/n)

Ivan Werning @IvanWerning · Jul 26
So why all the disagreements and sometimes nasty fighting?

Ivan Werning @IvanWerning · Jul 26
I think it doesn't help that "Phillips Curve" is a loose term that means different things to different people or different things in different contexts. (2/n)

Ivan Werning @IvanWerning · Jul 26
Is it a...
A. direct correlation we should see in the data?
B. relation or concept within a model, much like a demand curve is in basic micro? (or both?)

Ivan Werning @IvanWerning · Jul 26
Historically it was born as a correlation (A) but it's about time we focus on it as a concept (B). (3/n)

Ivan Werning @IvanWerning · Jul 26
Why? We know a correlation (A) can break down even if the concept is useful (B).

Ivan Werning @IvanWerning · Jul 26
In micro a demand curve is a concept that we think of and sometimes draw, CETERIS PARIBUS. (4/n)

Ivan Werning @IvanWerning · Jul 26
If we scatter plot quantity Q of a good against its price P we understand we might get no clear relation or even an upward sloping one. (Cowles identification problem).

Lots of debate among the media, academics and market participants about a key aspect of monetary policy transmission: the **Phillips curve**.

Is there a Phillips curve?

❑ Inflation follows a seemingly exogenous process, unrelated to measures of slack. E.g.,

- ✓ Atkeson and Ohanian (2001)
- ✓ Stock and Watson (2007, 2009)
- ✓ Hall (2011)
- ✓ Dotsey, Fujita and Stark (2017),
- ✓ Cecchetti, Feroli, Hooper, Kashyap, and Schoenholtz (2017)
- ✓ Forbes, Kirkham and Theodoridis (2017)
- ✓ Uhlig (2018)

❑ The Phillips Curve has flattened (or even disappeared). E.g.,

- ✓ Ball and Mazumder (2011)
- ✓ IMF (2013)
- ✓ Blanchard, Cerutti and Summers (2015)
- ✓ Summers (2017)
- ✓ Andolfatto (2017)
- ✓ Blinder (2018)

❑ Critical for the conduct of monetary policy

- ✓ Draghi (2017)
- ✓ Carney (2017)
- ✓ Powell (2018)

Stock taking by (some) academics

Harald Uhlig (Chicago), 2018:

“Inflation, in essence, dances to its own music”

Bob Hall (Stanford), 2013:

“Prior to the recent deep worldwide recession, macroeconomists of all schools took a negative relation between slack and declining inflation as an axiom. Few seem to have awakened to the recent experience as a contradiction to the axiom.”

- This disconnect between inflation and slack poses a challenge to New Keynesian models, for which the Phillips curve is a key building block.

If there is no Phillips curve...

- ❑ This disconnect between inflation and slack poses a challenge to New Keynesian models, for which the Phillips curve is a key building block.

Does the disconnect pose a challenge to the NK model?

- ❑ On the contrary: this disconnect is exactly what a New Keynesian model with a welfare-optimizing Central Bank would predict

A simple model of optimal inflation and the PC

Galí (2008); Woodford (2003); Clarida, Galí and Gertler (1999)

$$Loss = E_0 \sum_{t=0}^{\infty} \beta^t (\pi_t^2 + \lambda x_t^2)$$

Under discretion

$$\min \pi_t^2 + \lambda x_t^2$$

s.t.:

$$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t + u_t \quad (\text{PC})$$

Solution: Targeting rule

$$\pi_t = -\frac{\lambda}{\kappa} x_t \quad (\text{TR})$$

Optimal inflation and the PC

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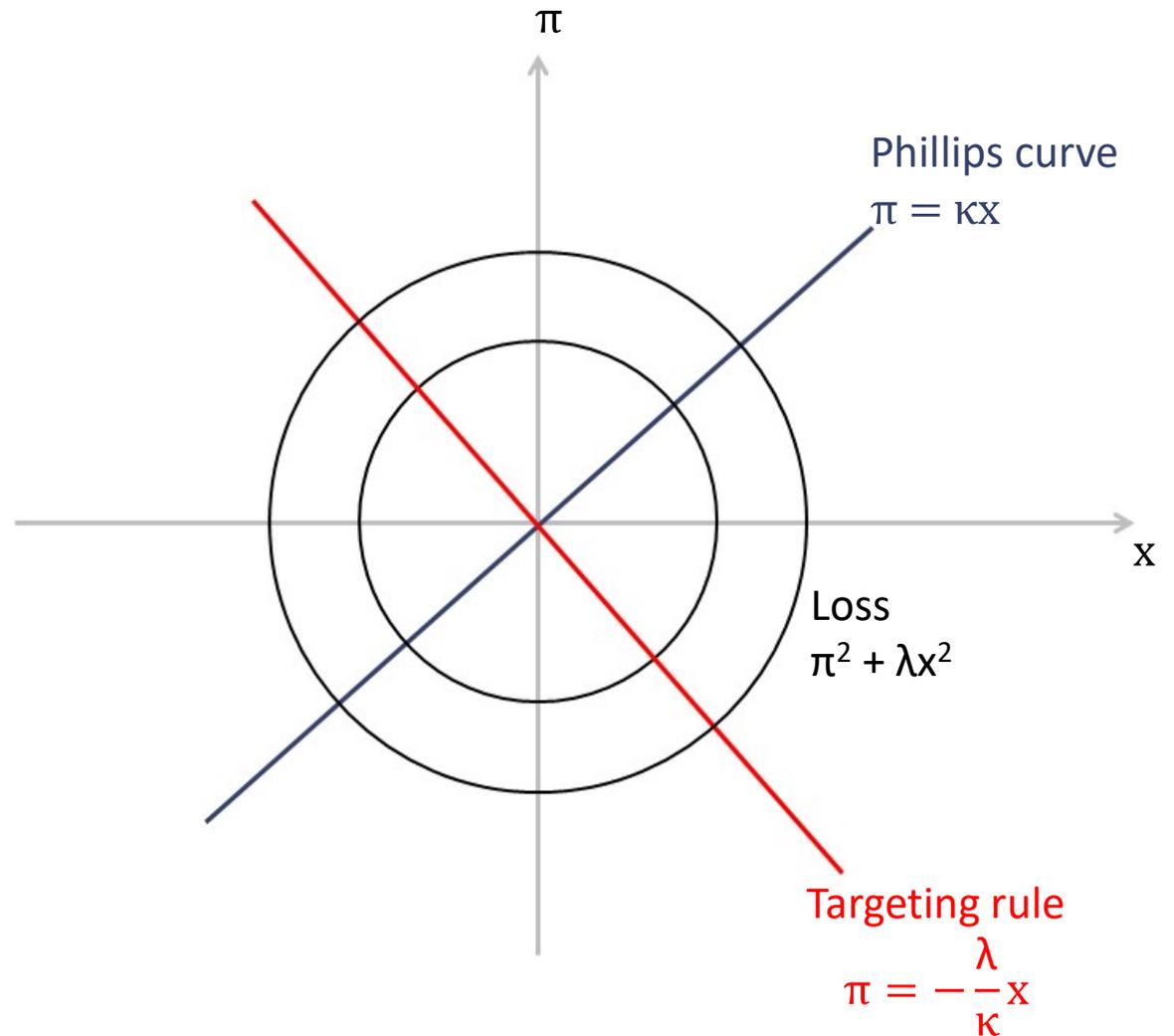
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Identification

$$\min \pi_t^2 + \lambda x_t^2$$

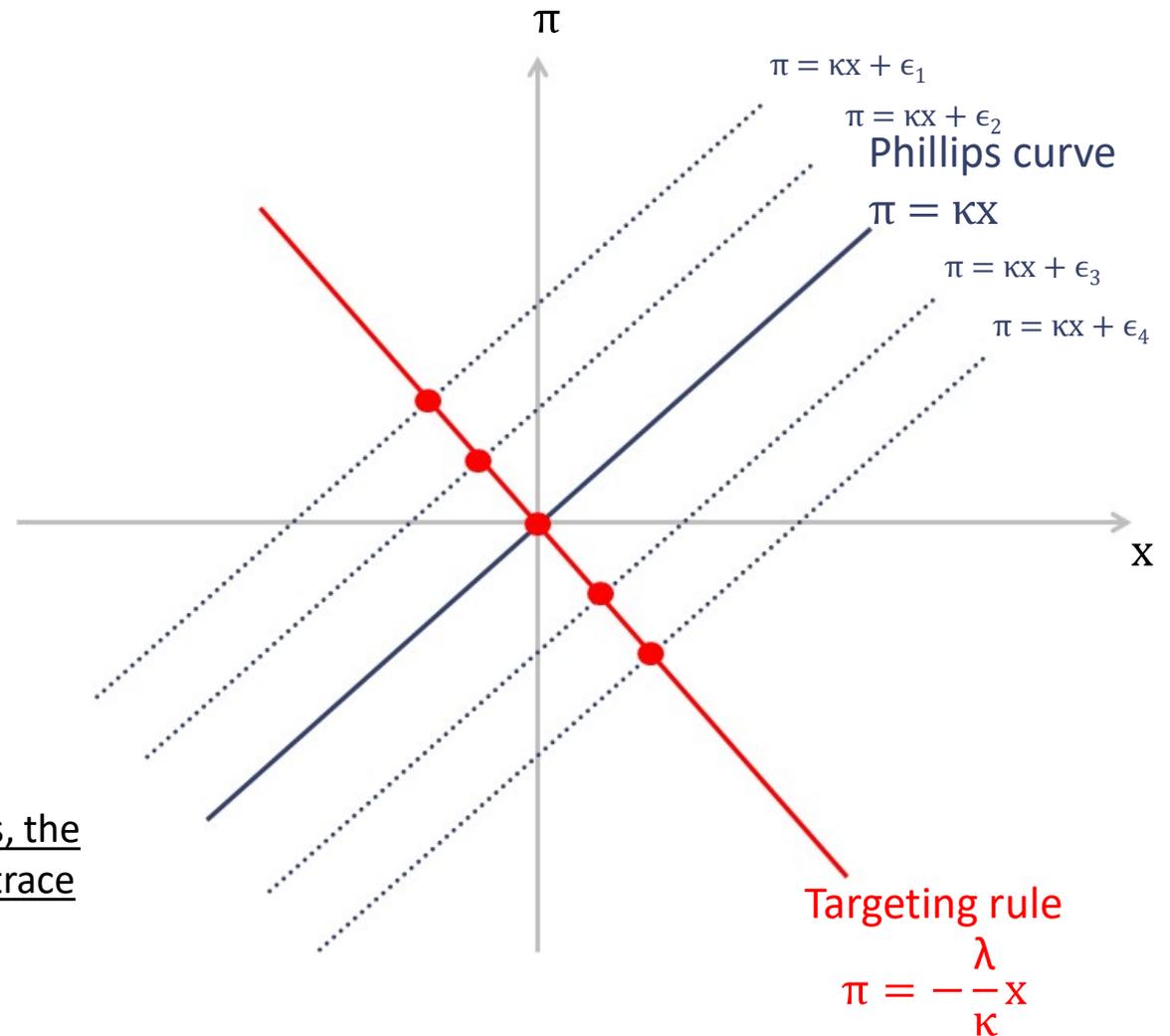
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Solution: Targeting rule

$$\pi_t = -\frac{\lambda}{\kappa} x_t \quad (\text{TR})$$

1. If monetary policy successfully offsets all other shocks, the data only show the response to the cost shocks, which trace out the wrong slope.



Identification

$$\min \pi_t^2 + \lambda x_t^2$$

s.t.:

$$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t + u_t \quad (\text{PC})$$

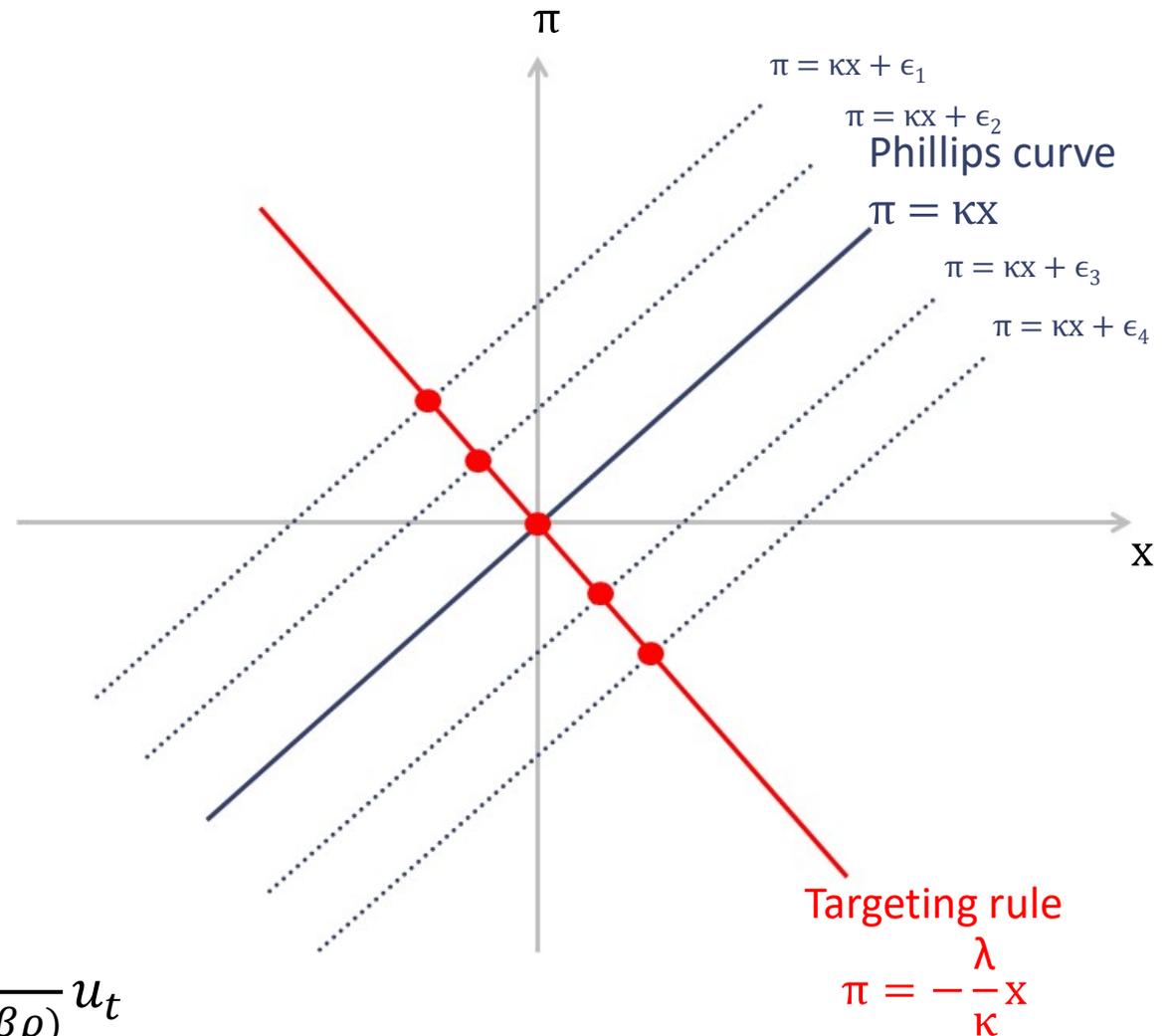
Solution: Targeting rule

$$\pi_t = -\frac{\lambda}{\kappa} x_t \quad (\text{TR})$$

2. Observed Inflation inherits properties of exogenous shock process:

$$\pi_t = f(u_t)$$

$$\text{If } u_t = \rho u_{t-1} + v_t, \quad \pi_t = \frac{\lambda}{\kappa^2 + \lambda(1-\beta\rho)} u_t$$



Identification under commitment

Under commitment:

$$\min E_0 \sum_{t=0}^{\infty} \beta^t (\pi_t^2 + \lambda x_t^2)$$

s.t.:

$$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t + u_t \quad (\text{PC})$$

Solution: Targeting rule

$$p_t = -\frac{\lambda}{\kappa} x_t \quad (\text{TR})$$

Observed inflation: inherits properties of exogenous shock process:

$$\pi_t = f(u_t, u_{t-1}, u_{t-2}\dots)$$

Remarks

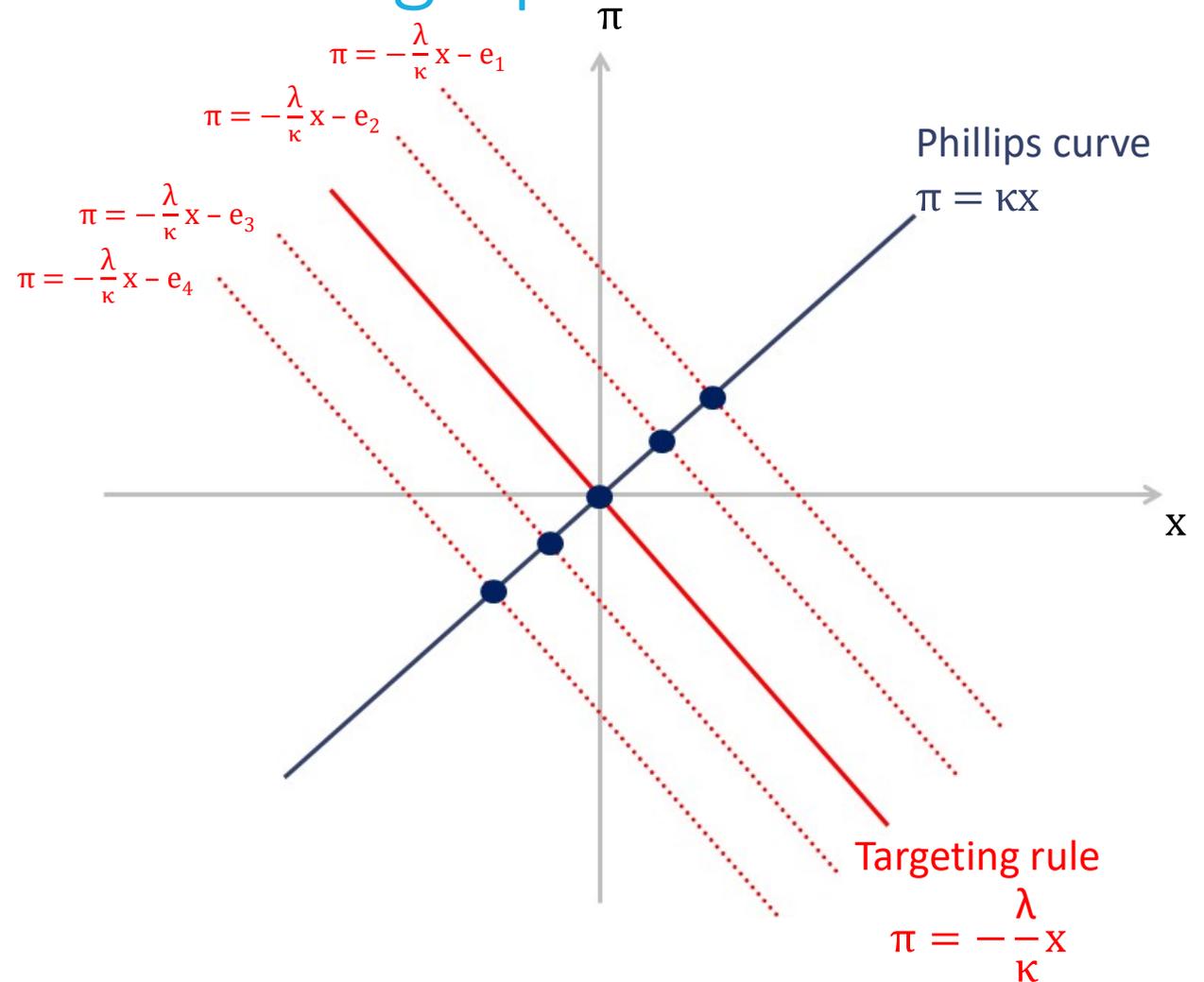
1. Framework implies that equilibrium inflation rates should be uncorrelated with slack, as long as central banks are doing a sensible job
 - ✓ Challenge for econometricians, not for the framework
2. The point is independent of inflation expectations. Even in a setting in which expectations play no role, **the structural relationship between slack and inflation can be masked by the conduct of monetary policy**
 - ✓ The point is conceptually distinct from most articulations of the “Fed view” on why the Phillips curve flattened. They focus on the anchoring of inflation expectations weakening the reduced-form correlation between slack and inflation (e.g. [Williams, 2006](#); [Mishkin, 2007](#); [Bernanke, 2007, 2010](#)).
 - ✓ But the anchoring of inflation expectations strengthens our point on the endogeneity of monetary policy.

Identification in graphs

$$\pi_t = -\frac{\lambda}{\kappa} x_t - e_t \quad (\text{TR})$$

Identification improves as

$$\frac{\text{Var}(e_t)}{\text{Var}(u_t)} \text{ increases}$$



Identification in a big NK Model (COMPASS)

❑ **Big NK model at the BoE**

- ❑ There is no single structural PC relation between inflation and slack. Multiple PC.
 - ✓ Still helpful for a policy maker to think about an average PC relation following demand shocks.
 - ✓ There is an underlying structural aggregate supply relation in the larger model.
 - ✓ The average PC gets closer to the underlying structural supply relation in a way that is more robust to model specification.

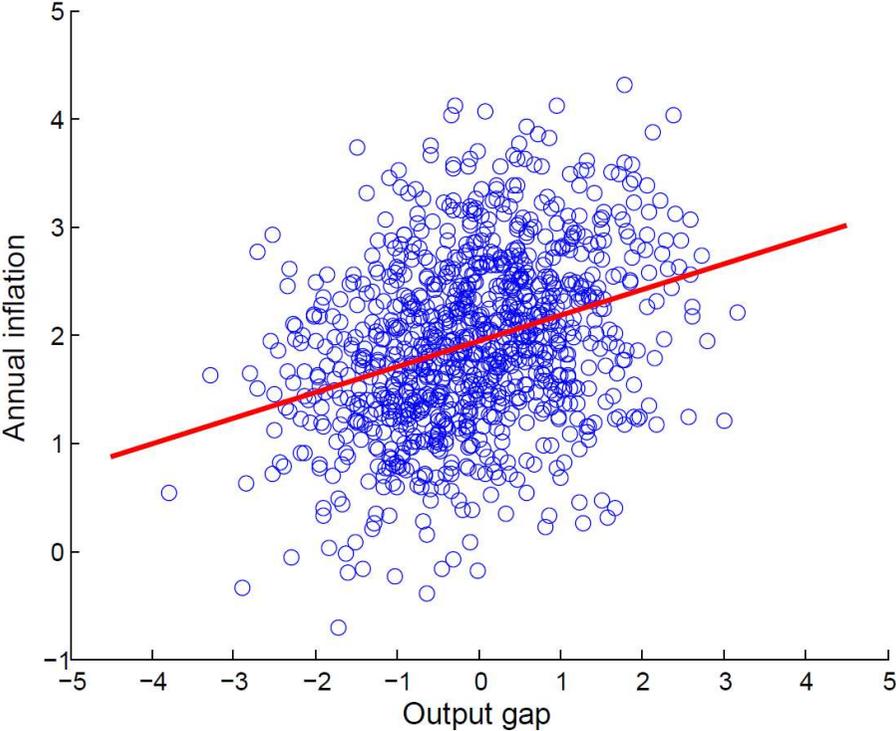
- ❑ Within COMPASS, run a stochastic simulation using all (18) shocks in the model.

- ❑ Exercise: Naïve estimation of the Phillips curve

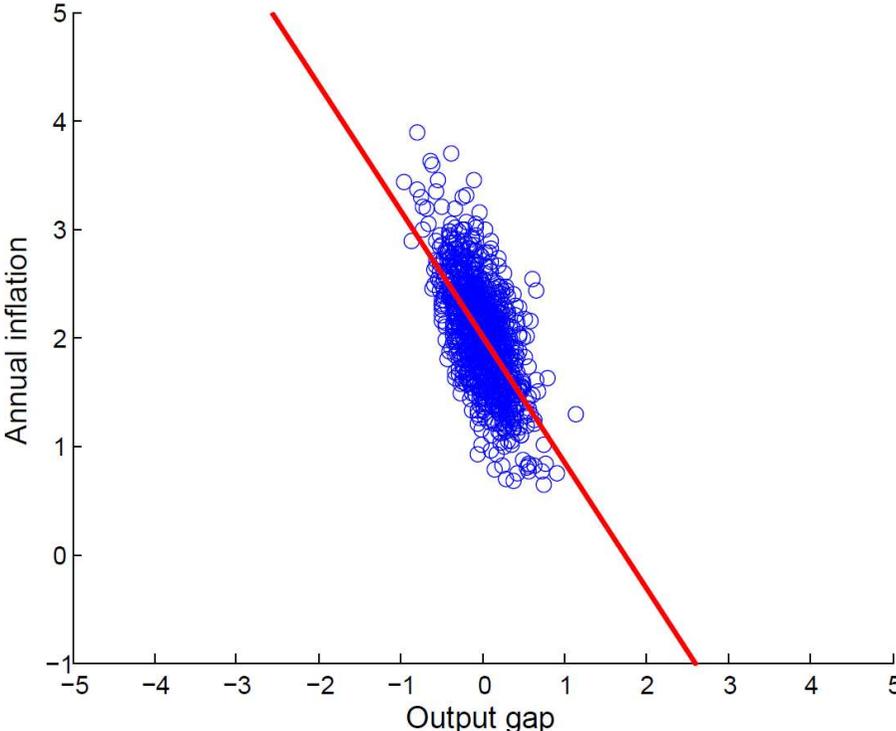
- ❑ Two possibilities:
 - i) (estimated) Taylor rule
 - ii) discretionary optimal monetary policy (minimises loss function)

Naïve Phillips Curve in a big NK Model (COMPASS)

Taylor Rule



Optimal Policy



Phillips Curve in a big NK Model (COMPASS)

- ❑ Big NK model economy.
- ❑ Two assumptions on monetary policy
- ❑ **Separately conditioning on demand or supply shock**

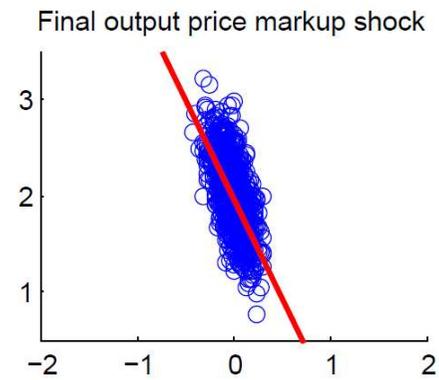
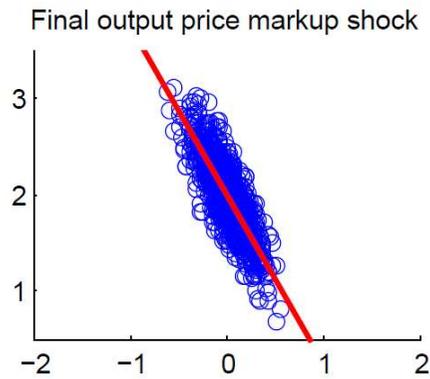
	Taylor Rule	Optimal Monetary Policy
Supply Shock		
Demand Shock		

Naïve Phillips Curve in a big NK Model (COMPASS)

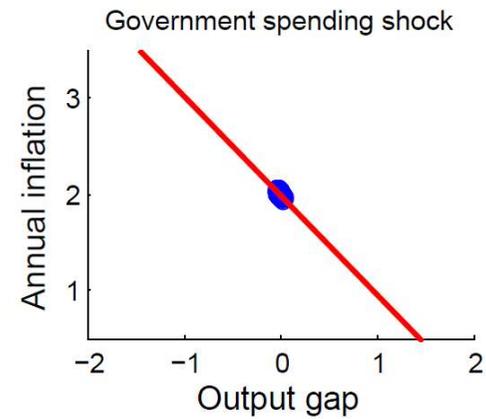
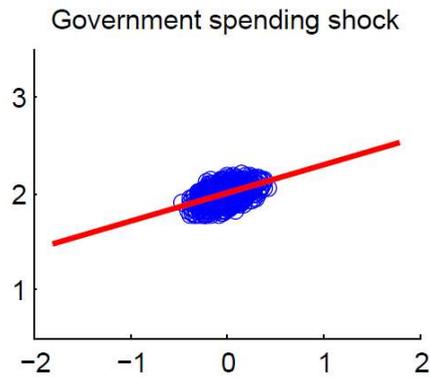
Taylor Rule

Optimal Policy

Supply shock



Demand shock



Identification strategies

❑ Control for supply shocks ([Gordon, 1982](#))

- ✓ Neither simple nor sufficient

❑ Instrumental variables

- ✓ Lagged variables as instruments

✓ Monetary policy shocks ([Christiano, Eichenbaum and Evans, 1999](#); [Romer and Romer, 2004](#))

- Structural PC correlation can be recovered ([Barnichon and Mesters, 2019](#))
- MP shocks ideal IV: move output gap; not fully undone by MP. But some limitations ([Boivin and Giannoni 2006](#), [Ramey 2016](#)).

❑ Regional data ([Fitzgerald and Nicolini, 2014](#); [Kiley, 2015](#); [Babb and Detmeister, 2017](#))

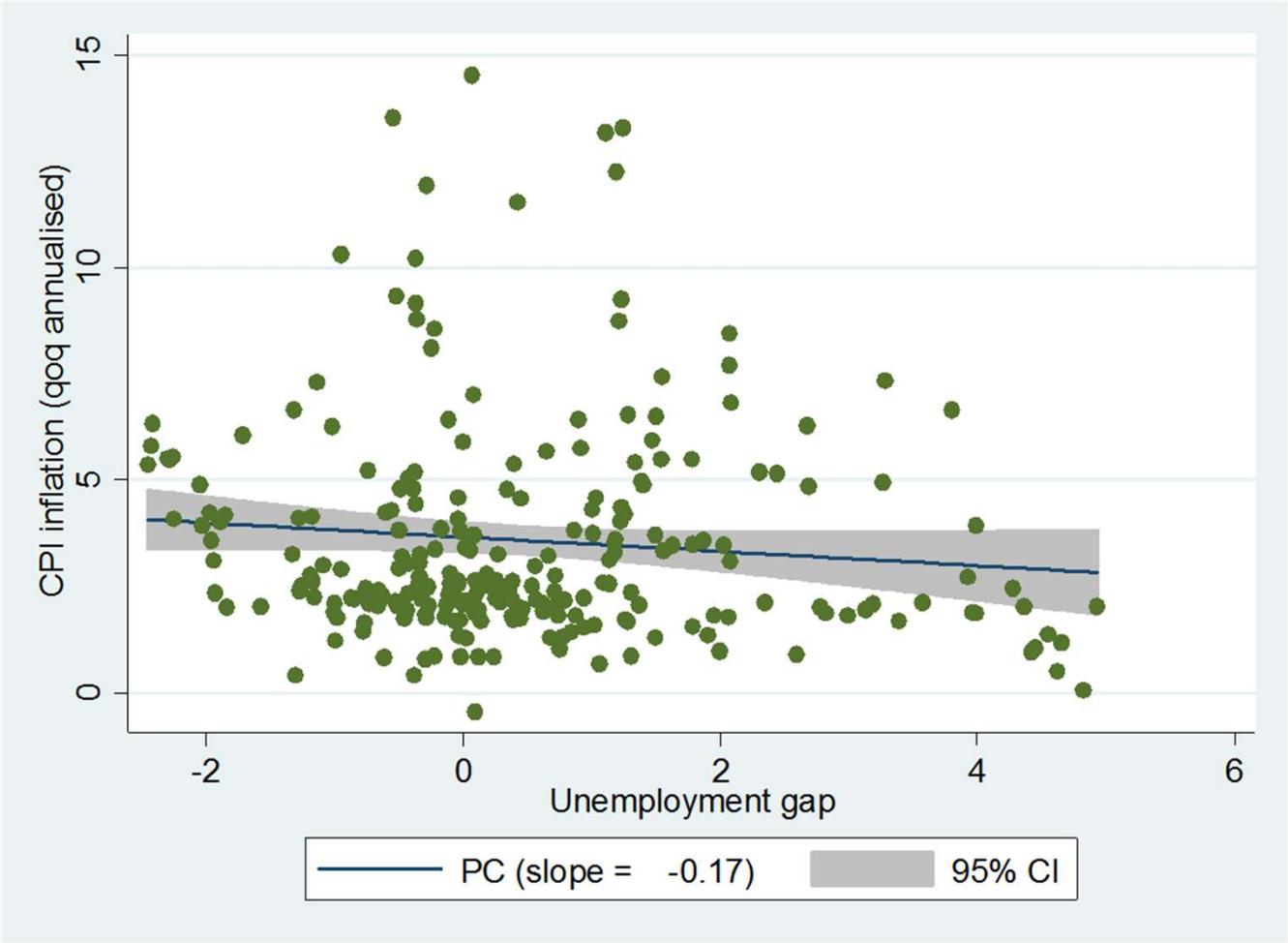
- ✓ MP does not offset regional demand shocks, so each region finds itself in a different segment of the PC.
- ✓ Time-FE can absorb aggregate demand and supply shocks (e.g., oil shocks) and area-FE, regional diffs.

From model to data

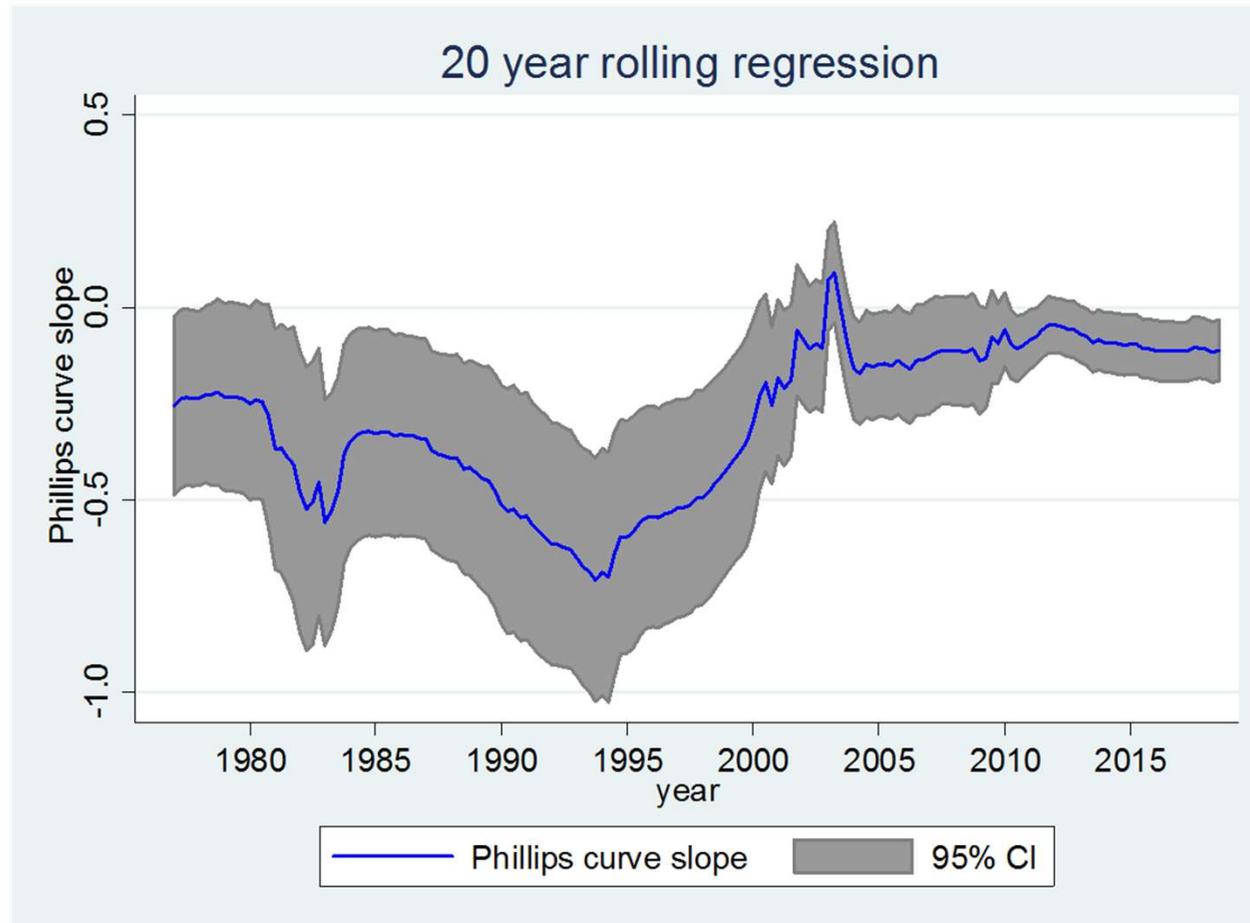
Note: unemployment gap instead of output gap.

PC in U_t is negatively sloped $U_t - U_t^* = -\theta x_t$

The PC: Aggregate US Data (1957-2018)



The PC: Standard OLS estimates suggest flattening



$$\text{OLS equation: } \pi_t = \alpha + \beta(U_t - U_t^*) + \sum_{i=1}^3 \gamma_i \pi_{t-i} + \xi_t$$

Regional panel data

- Use data on US cities: 23 metro areas; see also [Kiley \(2013\)](#); [Babb and Detmeister \(2017\)](#).
- Semi-annual sample from 1990 H1 to 2018 H1 for most metro areas.

Data series	Description (and source)	Comments
Core inflation	Log change in CPI less food and energy (BLS via FRED).	NSA. Monthly data averaged over each half a year.
Unemployment rate	Unemployed as percentage of civilian labour force (BLS).	NSA. Monthly data averaged over each period. Some discrepancies in metro area definitions with CPI data.
Inflation expectations	12-month ahead price inflation expectations (Michigan Consumer Survey)	Geographical split into only 4 regions (North-Central, Northeast, South and West). Cities' expectations assumed to be equal to the region average.

Regional

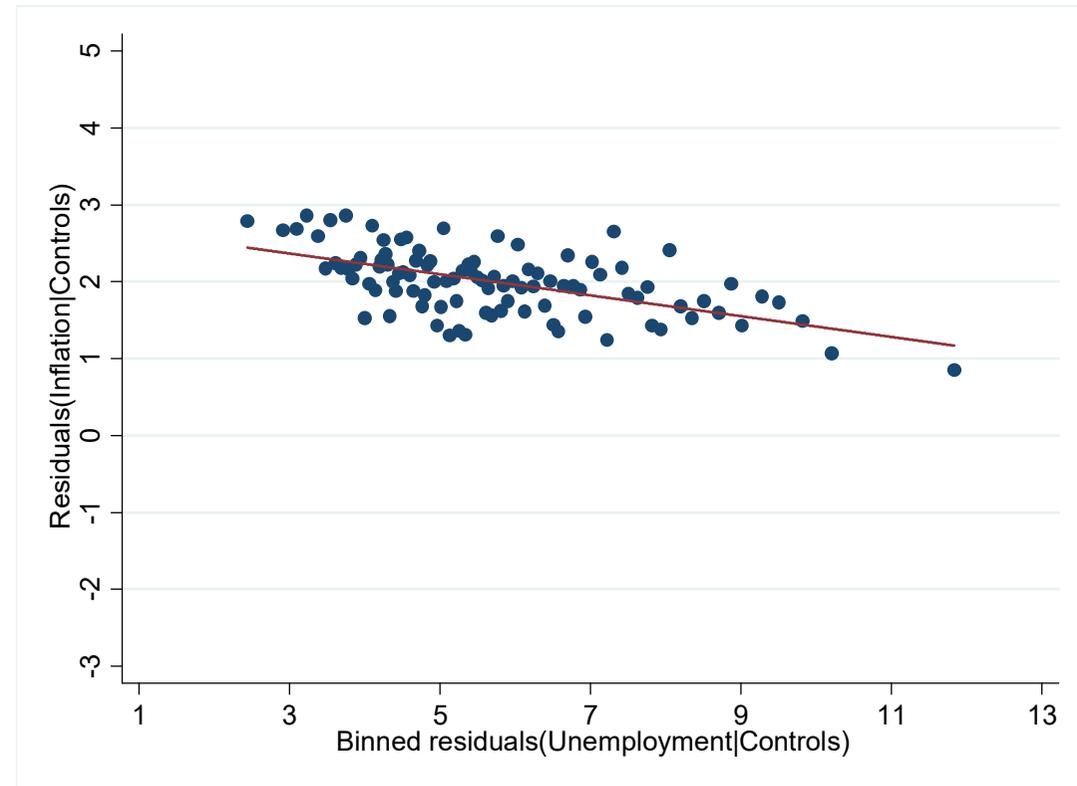
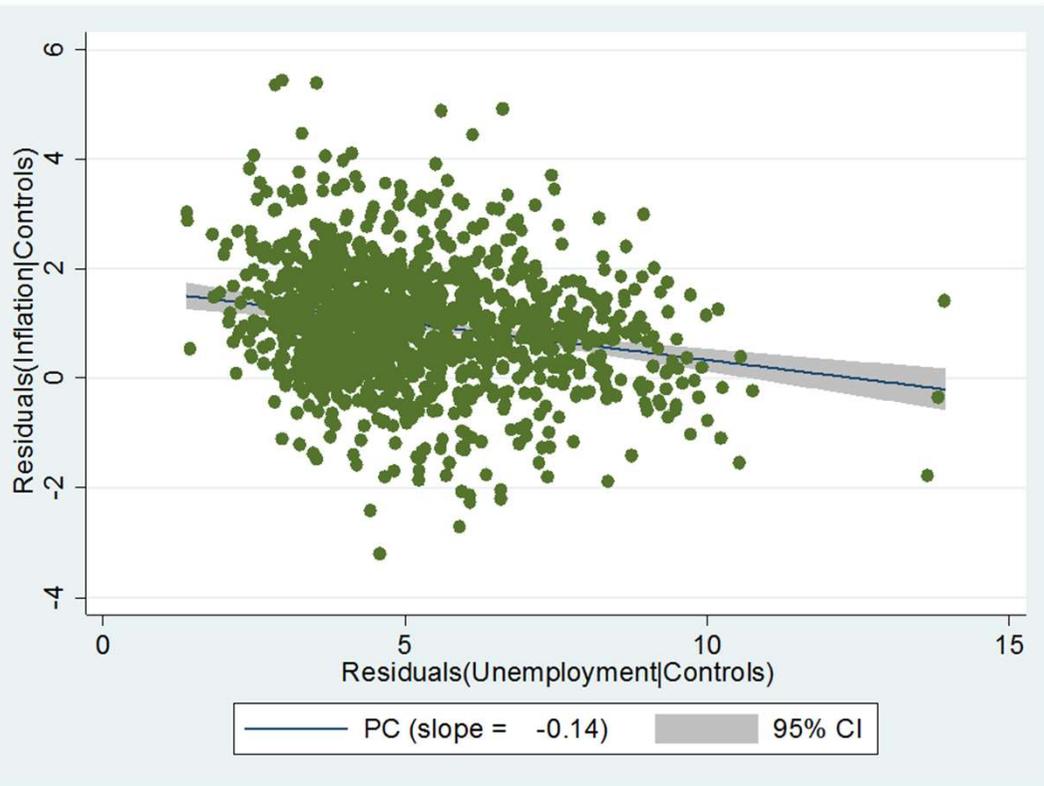
Table 3: US Metro area Phillips curve: 1990-2018

Regression	(1) Pooled OLS	(2) Metro area FE only	(3) Year FE only	(4) Year and Metro area FE
Unemployment rate	-0.136*** [0.022]	-0.148*** [0.025]	-0.271*** [0.043]	-0.367*** [0.066]
Constant	1.708*** [0.277]	1.911*** [0.296]	5.435*** [0.606]	6.655*** [0.776]
Inflation expectations	0.278*** [0.064]	0.273*** [0.065]	-0.027 [0.155]	-0.067 [0.145]
Core CPI inflation <i>First lag</i>	0.280*** [0.048]	0.270*** [0.051]	0.110** [0.049]	0.073 [0.050]
Observations	1,174	1,174	1,174	1,174
R-squared	0.260	0.298	0.359	0.410
Metro area FE	No	Yes	No	Yes
Year FE	No	No	Yes	Yes
Seasonal dummies	Yes	Yes	Yes	Yes

Robust standard errors (clustered by metro area) in brackets
 *** p<0.01, ** p<0.05, * p<0.1

□ Pooled OLS suggests flat Phillips curve.

Pooled data



❑ Pooled OLS gives more precision than aggregate data (Kiley, 2013), but slope still flat.

Regional

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□ Metro area FE (different U* across regions).

Regional

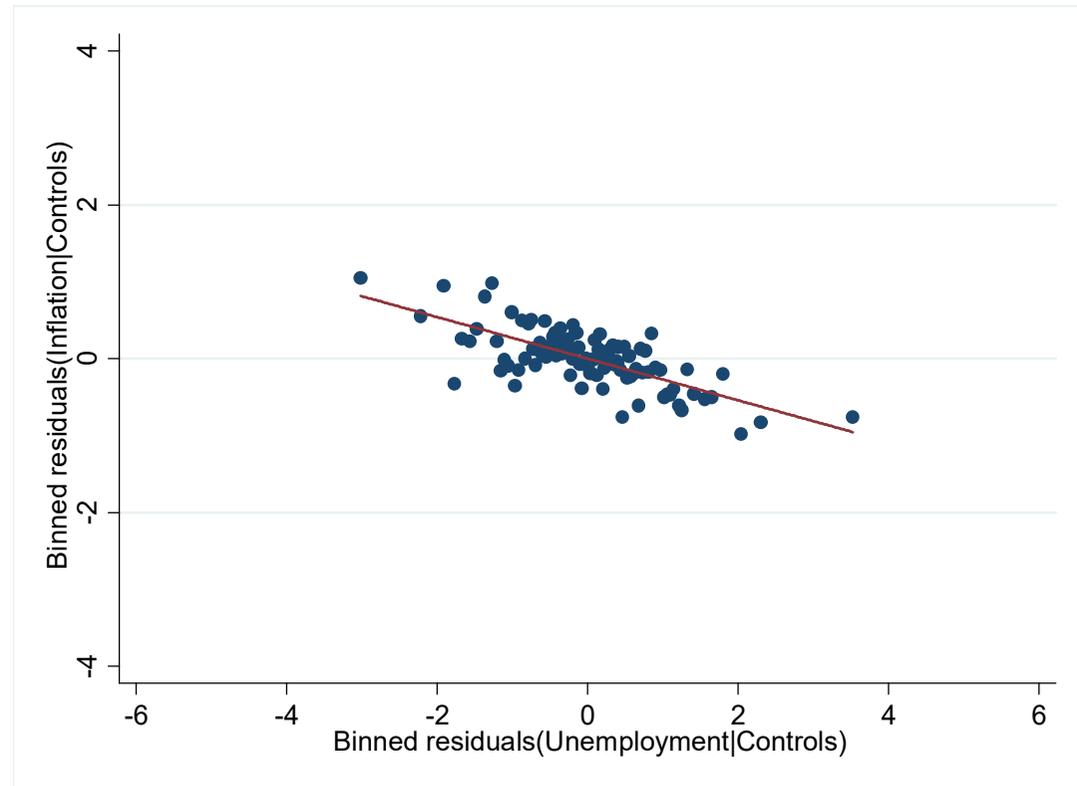
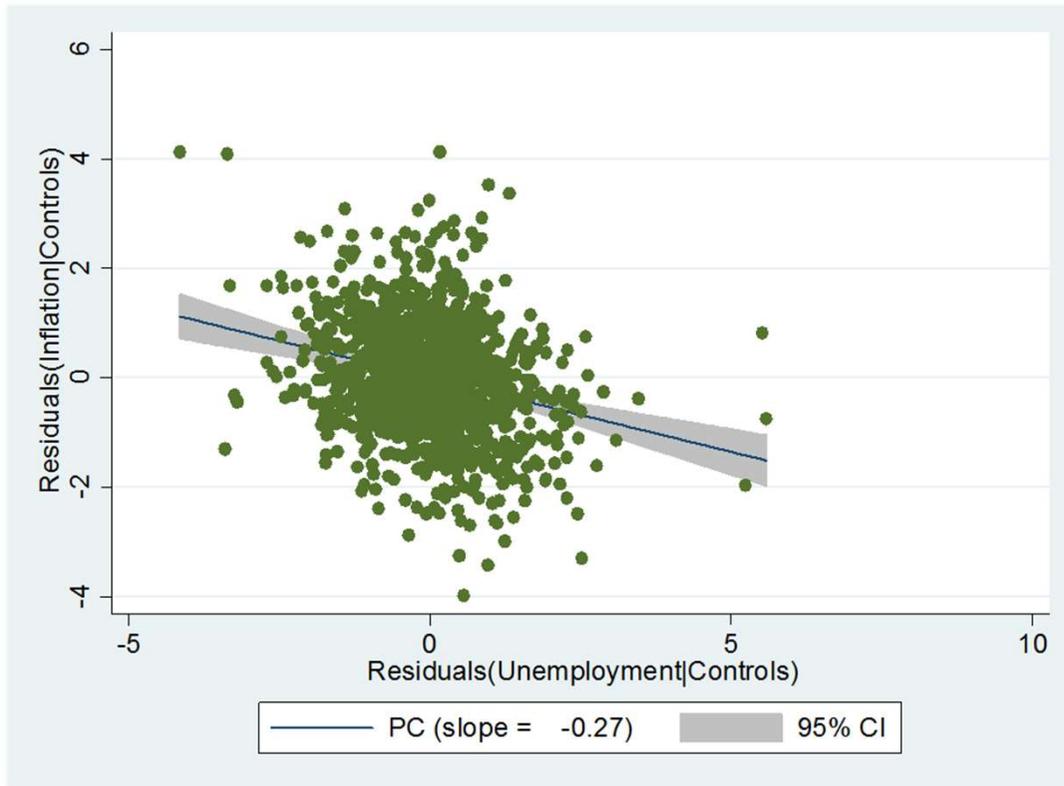
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□ Year FE: aggregate shocks.

Pooled with Time FE



□ Steeper slope with year FE: controlling for aggregate monetary policy and supply shocks.

Regional

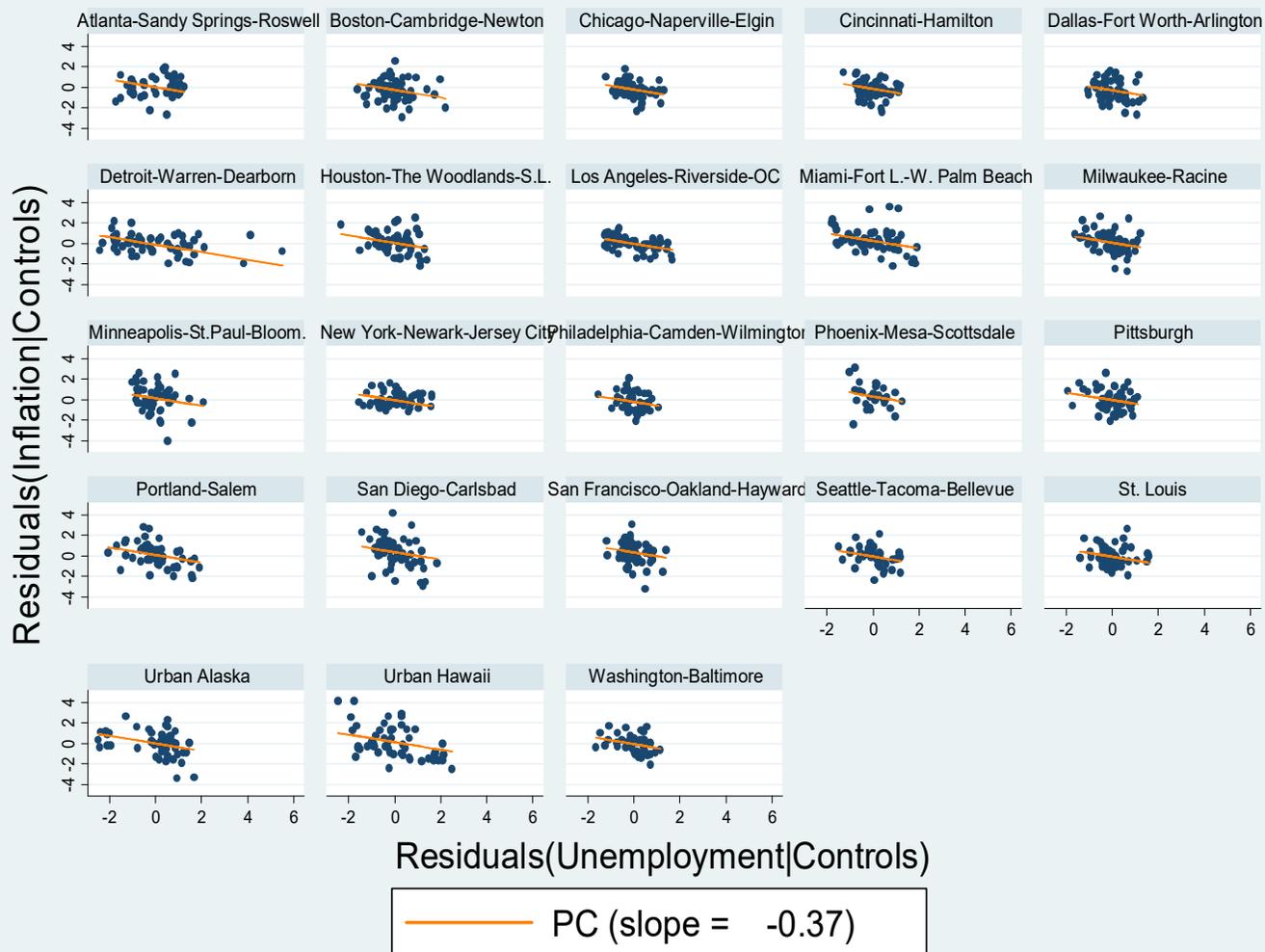
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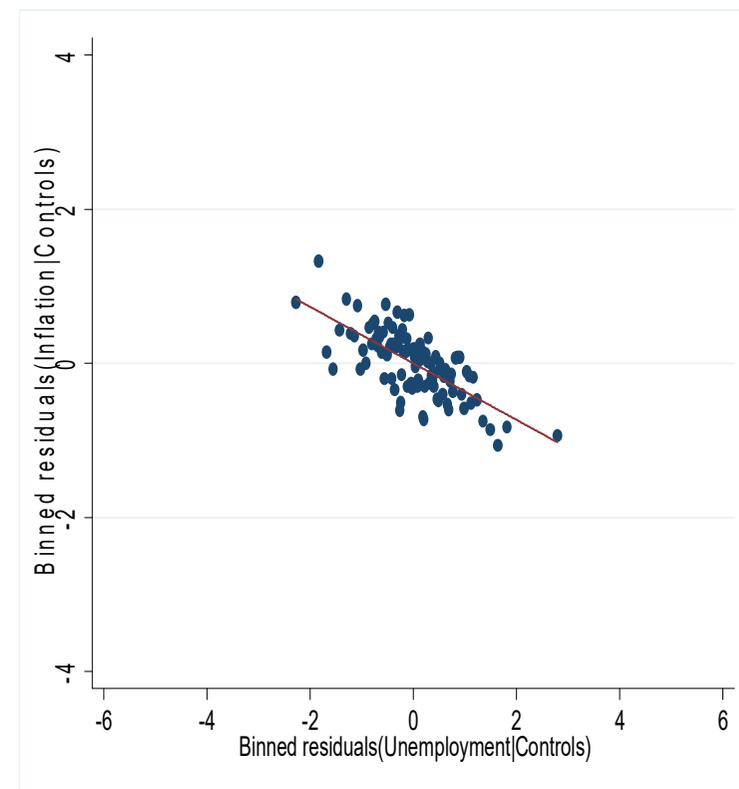
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□ Nearly **3 times** the naïve slope once area and time FE are included.

Time and metro-area FE



- Slope higher still with metro area fixed effects.
- Need both sets to also control for cross-sectional variation in U^* .



Remarks

- ❑ The **correlation** between inflation and unemployment has fallen.
- ❑ Much of the debate suggests this poses a challenge to models relying on **Phillips Curve theories** of inflation.
- ❑ On the contrary: this is exactly what models based on PC theories with **flexible inflation targeting** central banks would predict
- ❑ The reduced form PC is a mix of supply and demand factors. For each individual episode of inflation and unemployment moving in the same direction, theory suggests
 - ❑ Cost-push or supply shocks. Great recession: shock to financial frictions and productivity fall increased costs and unemployment.
 - ❑ Changes in the natural rate of unemployment, U^* could have increased both unemployment and costs.

The Phillips curve in the UK

- Wage Phillips curve more visible in the data. (Robust relation in the UK.)
- How wage or cost inflation translates on price inflation depends on:

productivity growth, inflation in costs other than labour costs, and the composition of the CPI basket.

In the UK, before Covid, wage inflation led to somewhat less price inflation than in past. Tenreyro (2020):

1. Productivity growth has been much higher in sectors with a disproportionate weight on the CPI basket (e.g., high productivity growth in retail—Amazonification). To be accentuated by switch to online during Covid.
2. Growth in costs of other input has been weaker (e.g., commercial real estate rent inflation very weak; other structural phenomena: fall in tele communication costs and surge of “zero-cost” inputs). Some trends to be accentuated by increased working from home.