Endogenous Uncertainty and the Macroeconomic Impact of Shocks to Inflation Expectations

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Research Question

What is the macroeconomic impact

of a shock that increases

short-term inflation expectations?

Research Question

1. This question is important

2. Surprisingly, the literature is silent

Important

- Exogenous changes in inflation expectation do affect fundamental economic decisions by agents, as households spending and firms investment, employment and pricing decisions (see Coibion et al., 2019-2022)

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- Expectations about future inflation are associated with worse expected macroeconomic outcomes. (Coibion et al 2019-2022, D'Acunto et al 2022, Jain et al, 2022)
- **Inflation is back!**

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- D'Acunto et al. (2022) survey concludes agents' expectations are biased and volatile in the time series, which suggests that inflation expectations might be subject to shocks
- We take a macroeconomic perspective by assessing the macroeconomic effects of an exogenous change of short-term inflation expectations

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- large literature on 'expectational shocks' in macroeconomics $\rightarrow$ where exogenous changes in expectations are assumed to drive economic fluctuations, through belief, sentiment, confidence or news shocks
- *"There is a widespread belief that changes in expectations may be an important independent driver of economic fluctuations."* Beaudry and Portier (2004, Abstract)

A parallel

- Angeletos et al. (2018)
  - Shock to short-run expectations to real variables, reduced-form shock to capture a sentiment shock
  - Their short-run expectational shock different from optimism / pessimism → expected long-term TFP increases
  - Similarly, our shock is different from a 'de-anchoring' shock

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  - Similarly, our shock is different from a 'de-anchoring' shock
- Problem: Identification of these expectational shocks: news from sentiment (e..g, Levchenko and Pandalai-Nayar, 2018, Nam and Wang, 2019, Chahrour and Jurado, 2021)
  - Similar challenge: a contribution of the paper is to propose a novel identification mechanism based on endogenous uncertainty

Our Contribution

Using **SVAR** and third-order solution of a rich medium-scale **DSGE model with firm heterogeneity and firm dynamics** to:

- **Empirically**. study the impact of inflation expectations shocks $\rightarrow$ robust to sign restriction (Canova and Paustian 2011), also on uncertainty variables, and narrative sign restriction (Antolin-Diaz and Rubio-Ramirez 2018) identifications

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- **Theoretically 2**. Inspecting the role of firm dynamics (Frictional vs Frictionless Entry model, both solved at the third order)
- **Theoretically 3**. study asymmetry of the effects of the shocks: IRFs matching using IRFs to positive and negative shocks to inflation expectations

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expectations and uncertainty graphs

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- **Uncertainty matters!** It amplifies recessionary effects of the shock
- Uncertainty is **particularly important in the presence of firm dynamics**
- The effect of the shock are asymmetric: positive shocks -that increase inflation expectations- more important than negative shocks => **larger effects in recession**

expectations and uncertainty graphs

Related Literature

- **Expectation Shocks**
  - **Milani (EJ, 2011)**: NK model with *learning* shows that expectation shocks have an important role in business cycle.
  - **de-anchoring' shock** to long-term inflation expectations, e.g., **Clark and Davig, 2011; Diegel and Nautz, 2021; Neri, 2021** or to the inflation target of the central bank, e.g., **Ireland, 2007; Cogley et al., 2010; Haque, 2019).** $\rightarrow$**That's not our shock!**
- **Endogenous Uncertainty**
  - **Ludvigson et al. (AEJMacro, 2021):** Macroeconomic uncertainty plays an important role in recessions, by substantially amplifying downturns caused by other shocks
  - **Mumtaz and Theodoridis (JME, 2020):** Study the dynamic effects of monetary policy shocks on macroeconomic volatility

Theoretical Model

Baseline model as in Fasani, Mumtaz and Rossi (2022).
Four agents: households, firms, a monetary and a fiscal authority.
Main ingredients are:

- those of a medium-scale as in Christiano et al. (2005):
  - sticky nominal wages and prices as in Rotemberg (1982);
  - external habits in consumption;
  - convex investments adjustment costs and capacity utilisation for capital;
- Firm heterogeneity and endogenous entry/exit dynamics ==> Key to micro-found the equity return and get amplification
- Inflation Forecast ==> follows the RE hypothesis, but this forecast is hit by AR(1) shock.

Endogenous Uncertainty

As in Basu and Bundick (2017), volatility/measured uncertainty in the model refers to heteroskedastic response of a variable, say x_t,

$$\tilde{\sigma}_{x,t} = 100 \log \left(\frac{\sigma_{x,t}}{\sigma_x} \right) \quad (1)$$

where

$$\sigma^2_{x,t} = var_t(x_t) = E_t[x_{t+1} - E_t x_{t+1}]^2, \quad (2)$$

with σ_x the stochastic steady-state standard deviation of the variable x_t. With this measure in hands we build up a measure of:

- **output uncertainty**: volatility of expected real GDP
- **inflation uncertainty**: volatility of expected inflation
- **equity return uncertainty**: volatility of expected return on equity.

DSGE-Montecarlo simulations

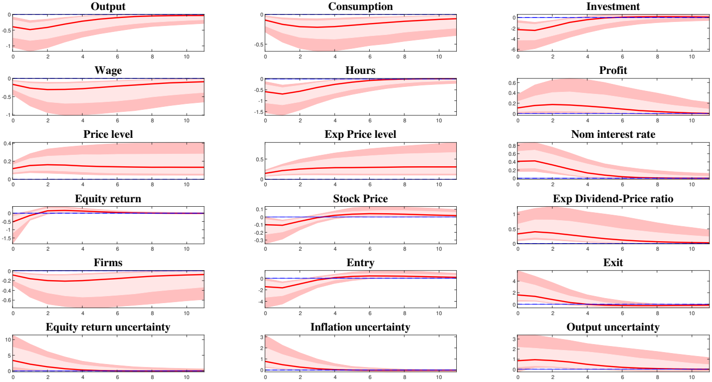

Figure: Dynamic responses to an inflation expectation shock. Montecarlo simulation of the model as in Canova and Paustian (2011).

DSGE-Montecarlo simulations

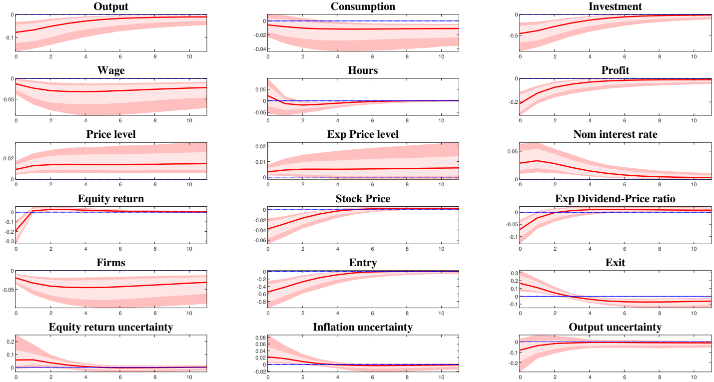

Figure: Dynamic responses to a supply shock. Montecarlo simulation of the model as in Canova and Paustian (2011).

SVAR Evidence

A VAR with 8 variables + sign restrictions to identify inflation expectation shocks.

$$Y = \begin{bmatrix} \text{log(RGDP)} \\ \text{log(1-q ahead forecast of GDP Deflator)} \\ \text{log(GDP Deflator)} \\ \text{Equity return} \\ \text{Dividend-to-price ratio} \\ \text{log(VXO)} \\ \text{log(1-q ahead forecast Dispersion of RGDP)} \\ \text{log(1-q ahead forecast Dispersion of GDP Deflator)} \end{bmatrix}$$

Sources:

- Forecasts: SPF - Philadelphia FED
- Equity return: Center for Research in Security Prices
- Divident to Price ratio: Shiller (2005)
- RGDP, GDP deflator, VXO: FRED-QD database corr with CPI and PCE

Sign Restrictions

Sign restrictions to SVAR are provided by Montecarlo simulations of DSGE model.

	Expectations Shock	Supply shock
log(real GDP)	−	−
log(SPF GDPD 1-q ahead forecast)	+	/
log(GDPD)	/	+
log(Equity returns)	−	−
Dividend to price ratio	+	−
log(VXO)	+	+
log(SPF Dispersion of RGDP forecast)	+	−
log(SPF Dispersion of GDPD forecast)	+	+

Table: Sign Restrictions. SPF → Survey from Professional Forecasters, GDPD → GDP Deflator, RGDP → real GDP

Narrative + Sign Restriction

- **Paul Volcker** was **nominated to fight inflation** and **this was publicly known during the nomination process and thus before Volcker actually took office**. Volcker's speech

- We impose a **Narrative sign restriction** in the spirit of Antolin-Diaz and Rubio-Ramirez (2018).

- **Narrative sign restriction:** Negative Inflation Expectations shock in Q3/1979

SVAR Evidence

VAR IRFs to Supply Shock

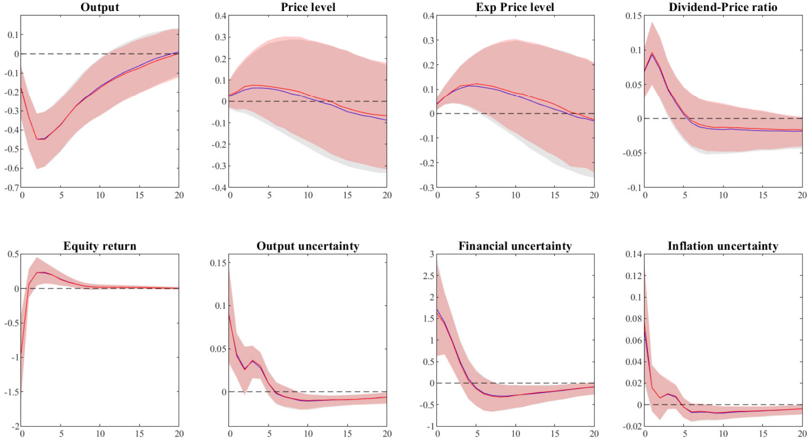

Figure: VAR responses to **inflation expectation shock** (68% percentile): in grey only sign restrictions, in red sign restrictions plus narrative

DSGE Estimation

With SVAR-IRFs in hands we estimate different specifications of our DSGE models to investigate

- **contribution of uncertainty**:third-order (*TO*) vs first-order (*FO*) solution
- **contribution of firm dynamics**: frictional (*TO*) vs frictionless (*TO no firms*) firm entry
- **asymmetric effects in shock transmission**: simulating positive (*TO*) and negative (*TO negative*) shocks to inflation expectations

RE solution of the model is obtained using third-order Taylor series approx. around the deterministic steady state.

Then, IRFs are computed in deviation from the stochastic steady state as in Fernández-Villaverde et al. (2015).

DSGE Estimation: contribution of uncertainty

Estimated Parameters		TO	FO
"Deep" parameters			
γ_p	Rotemberg Adjust. Cost - Price	18.9	19.1
γ_w	Rotemberg Adjust. Cost - Wage	112.8	42.6
γ_i	Investments Adjustment Cost	5.78	7.28
Shock persistence and Std.			
σ_π	Std. of Inflation Expect. shock	0.0003	0.0006
ρ_π	Persist. Inflation Expect. shock	0.7680	0.5448
Taylor rule			
ϕ_π	Coefficient Inflation	3.96	4.55
ϕ_y	Coefficient Output	0.0450	0.0189
ϕ_{dy}	Coefficient Output growth	0	0.0025
ϕ_R	Interest rate smoothing	0.3890	0.7776
Value Function		44.94	61.45

Table: Parameter Estimates through IRFs matching. FO $\rightarrow$ First Order solution; TO $\rightarrow$ Third Order solution

Notation:

DSGE Estimation: contribution of uncertainty

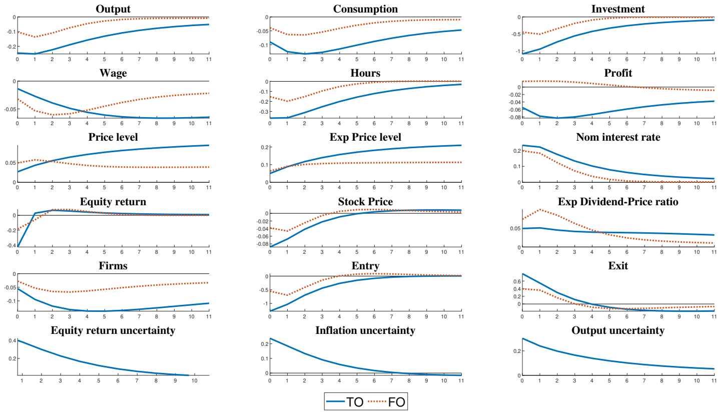

Figure: Dynamic responses to inflation shock using estimated parameters: FO vs TO model). DSGE versus VAR IRFs

DSGE Estimation: contribution of firm dynamics

Estimated Parameters		*TO*	*TO no firms*
"Deep" parameters			
γ_p	Rotemberg Adjust. Cost - Price	18.9	32.32
γ_w	Rotemberg Adjust. Cost - Wage	112.8	95.42
γ_i	Investments Adjustment Cost	5.78	2.11
Shock persistence and Std.			
σ_π	Std. of Inflation Expect. shock	0.0003	0.0006
ρ_π	Persist. Inflation Expect. shock	0.7680	0.4988
Taylor rule			
ϕ_π	Coefficient Inflation	3.96	1.98
ϕ_y	Coefficient Output	0.0450	0.0055
ϕ_{dy}	Coefficient Output growth	0	0.0943
ϕ_R	Interest rate smoothing	0.3890	0.5551
Value Function		44.94	62.24

Table: Parameter Estimates through IRFs matching. TO no firms → Third Order solution of model with no firm dynamics; TO → Third Order solution of baseline model

DSGE Estimation: contribution of firm dynamics

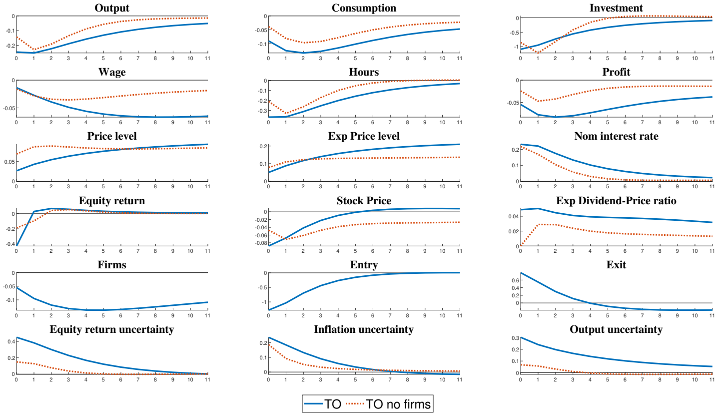

Figure: IRFs to inflation expectations shock using estimated parameters TO vs TO no firms model) DSGE versus VAR IRFs

DSGE Estimation: asymmetric effects

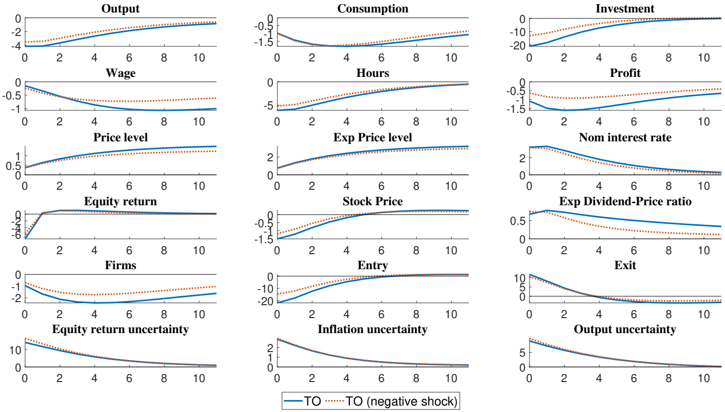

Figure: Simulating large shocks using TO calibration: positive (inflationary) versus negative (deflationary) shock (negative IRFs multiplied by -1.)

DSGE Estimation: asymmetric effects

Estimated Parameters		Shock(+)	Shock(−)
"Deep" parameters			
γ_p	Rotemberg Adjust. Cost - Price	18.9	34.70
γ_w	Rotemberg Adjust. Cost - Wage	112.8	92.59
γ_i	Investments Adjustment Cost	5.78	6.11
Shock persistence and Std.			
σ_π	Std. of Inflation Expect. shock	0.0011	0.0006
ρ_π	Persist. Inflation Expect. shock	0.7680	0
Taylor rule			
ϕ_π	Coefficient Inflation	3.96	2.83
ϕ_y	Coefficient Output	0.0450	0.0233
ϕ_{dy}	Coefficient Output growth	0	0
ϕ_R	Interest rate smoothing	0.3890	0.7100
Value Function		44.94	70.61

Table: Parameter Estimates through IRFs matching. Notation: Shock (-) → Negative shock; Shock (+) → Positive shock.

DSGE Estimation: asymmetric effects

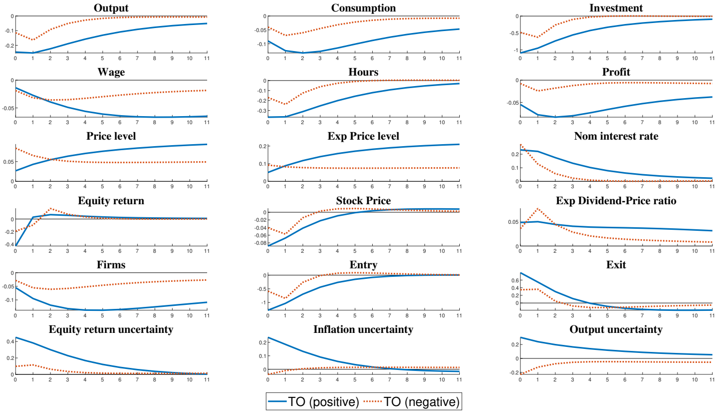

Figure: Re-estimating the model: positive (inflationary) versus negative (deflationary) inflation expectations shock (negative IRFs multiplied by -1.) DSGE versus VAR IRFs

DSGE Estimation: asymmetric effects

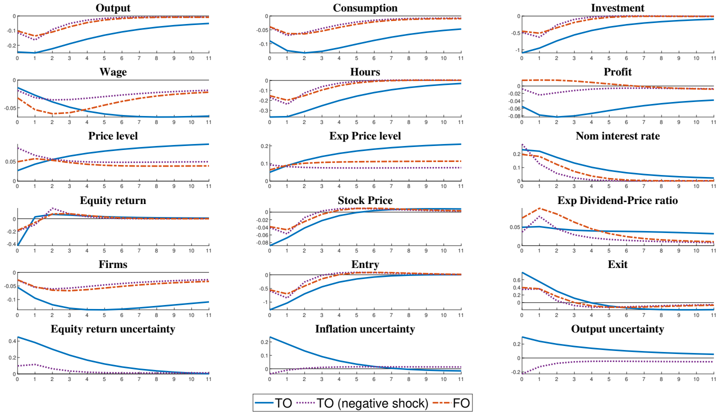

Figure: Dynamic responses to inflation shock using estimated parameters: FO vs TO with positive (inflationary) inflation expectation shock, and TO with negative (deflationary) inflation expectations shock

Local projections: asymmetric effects

- **We test asymmetric effects of inflation expectations shocks in data through local projection analysis.**
- We retrieve the structural shock estimated in our linear VAR model and regress several macroeconomic variables over it.
- **To keep track of asymmetric effects**, as in Tenreyro and Thwaites (2016) we estimate $\left[\beta_h^+, \beta_h^-\right]$, with $h \in [0, H]$ estimated from the following equation:

$$y_{t+h} = \tau t + \alpha_h^b + \beta_h^+ \max[0, \varepsilon_t] + \beta_h^- \min[0, \varepsilon_t] + \gamma' \mathbf{x_t} + u_t,$$

where $\mathbf{x_t}$ are lagged variables in linear VAR.

Local projections: asymmetric effects

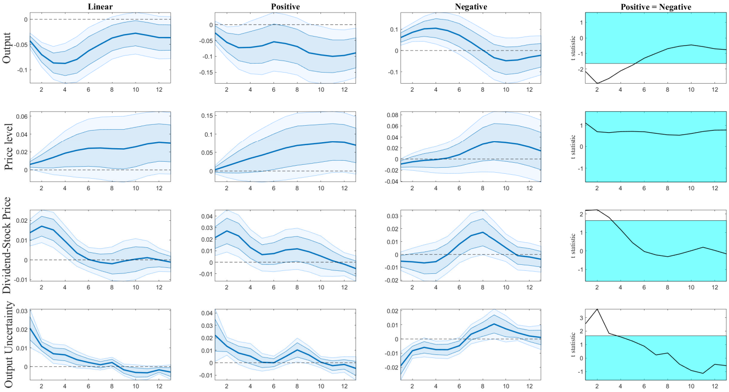

Figure: IRFs to inflation expectation shocks that increases inflation expectations by 1%. T-statistics tests the hypothesis of no differences between coefficients (Tenreyro and Thwaites 2016).

Conclusions

- **Shocks that increase inflation expectations are stagflationary**
- Shocks to inflation expectations **generate sizeable uncertainty** in output, inflation and equity return.
- **The increased uncertainty** transmits to the macroeconomic variables and **amplifies the negative effect of the shock**
- **Firm dynamics** is also essential in the transmission
- Inflation expectations shocks have **asymmetric effects**: shocks that increase inflation expectations have stronger effects than shock that decreases inflation expectations

Appendix I

I have spoken out and I expect to continue to speak out on the need for stability, broadly conceived — thinking of it in terms of our domestic inflation, thinking of it in terms of the value of the dollar internationally.

I speak out of a very strong conviction that this sense of stability is necessary in order to assure the prosperity and growth of our economy at home and to deal with those problems of unemployment, poverty and all the others. I don't think we can build on a sense of instability—accelerating inflation, instability of the dollar abroad—if we want to deal constructively with those problems of the domestic economy. [1]

back

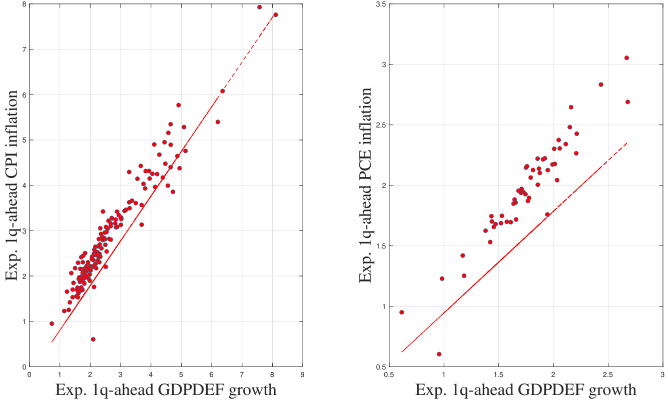

Figure: Correlation $(GDPDEF, CPI) = 0.9620$, correlation $(GDPDEF, PCE) = 0.9475$. Both are statistically significant at 1% back

Appendix II

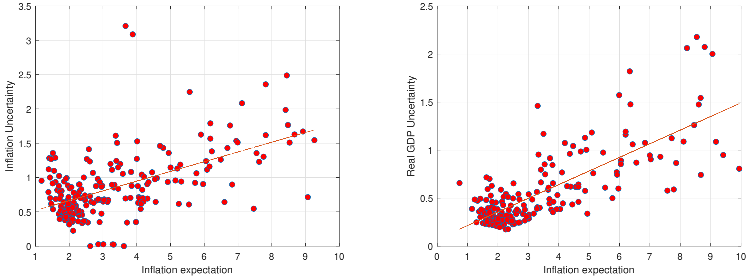

Figure: **Left**: Mean one-quarter ahead inflation expectations of the SPF and inflation uncertainty from the SPF, i.e., standard deviation of individual point forecasts on GDP price index. **Right**: Mean one-quarter ahead inflation expectations of the SPF and GDP uncertainty from the SPF, i.e., standard deviation of individual point forecasts on real GDP.

back

Appendix III

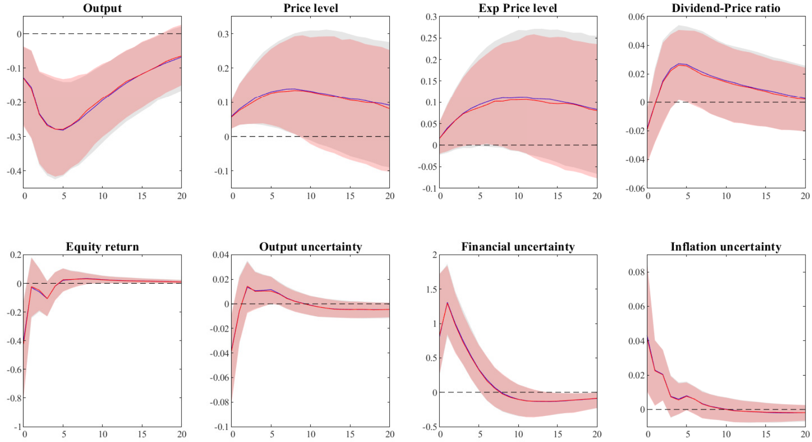

Figure: VAR responses to **supply shock** (68% percentile): in grey only sign restrictions, in red sign restrictions plus narrative back

Appendix IV

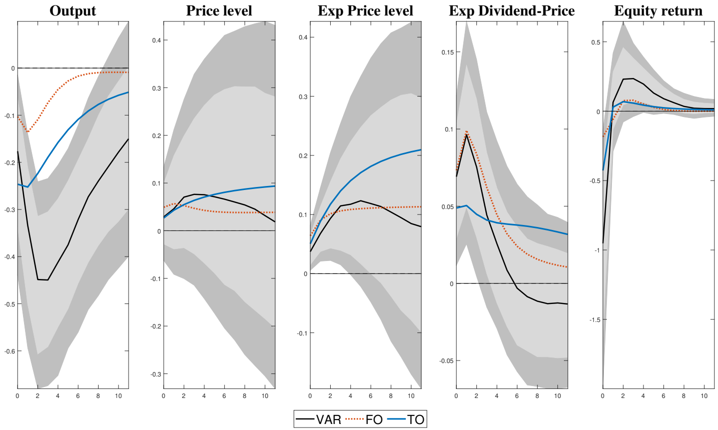

Figure: IRFs to inflation expectations: VAR-IRFs vs. IRFs implied by the estimated models, FO vs TO model. back

Appendix V

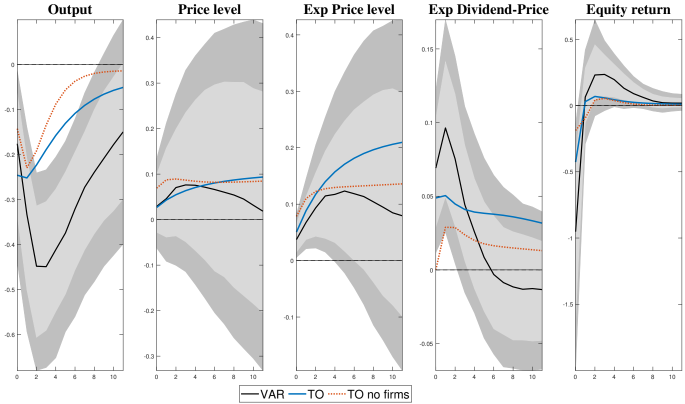

Figure: IRFs to inflation expectations shock of the matched series and those implied by the estimated models, TO vs TO no firms model. back

Appendix VI

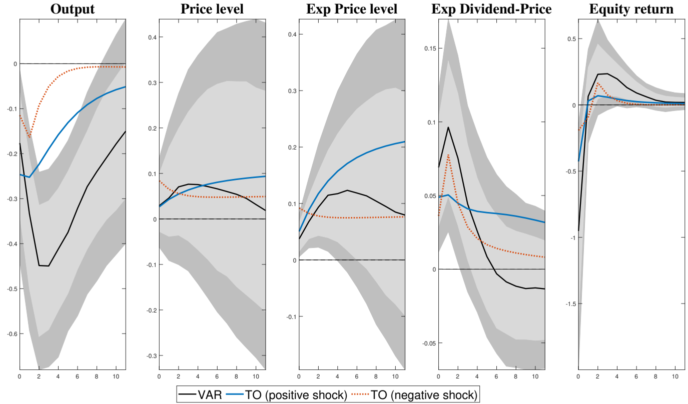

Figure: IRFs to inflation expectations shock of the matched series and those implied by the estimated models, TO (positive) vs TO (negative) model. back

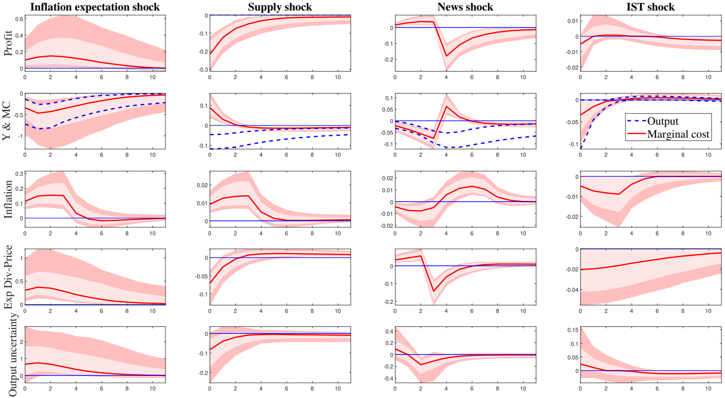

Figure: Dynamic responses to different shocks. Montecarlo simulations of the model as in Canova and Paustian (2011).

VAR 1971-2007: inflation expectation shock

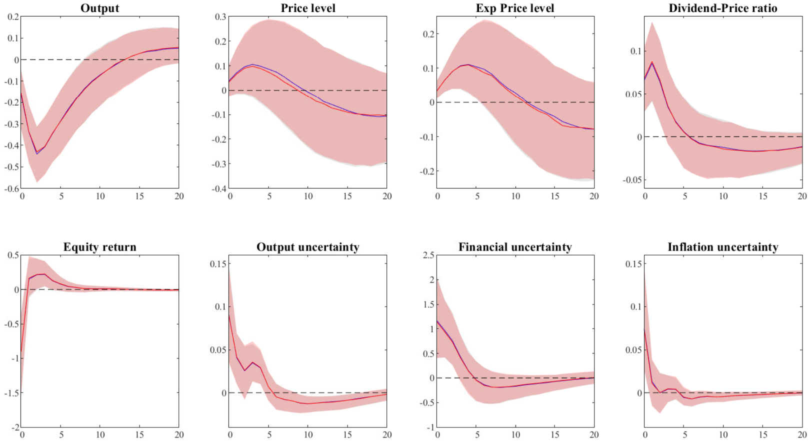

Figure: VAR responses to **inflation expectation shock** (68% percentile): in grey only sign restrictions, in red sign restrictions plus narrative

VAR 1971-2007: negative supply shock

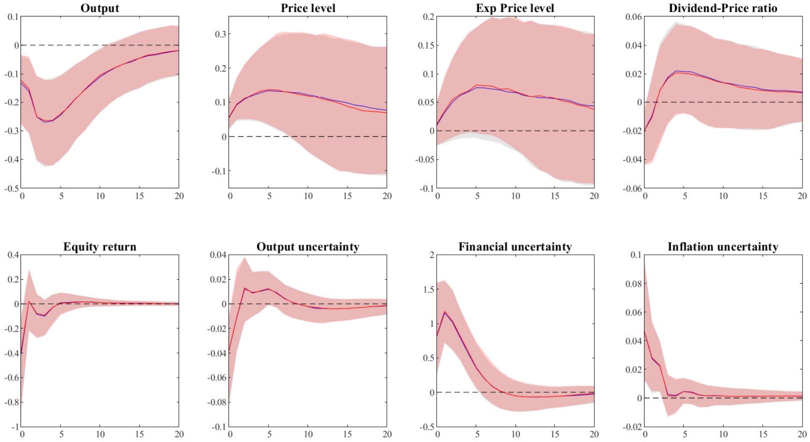

Figure: VAR responses to **supply shock** (68% percentile): in grey only sign restrictions, in red sign restrictions plus narrative