Exploring relationships between Firms' Balance Sheets and the Macro Economy

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August 2004

Motivation

- Today, typical institutional set-up is an "independent" central bank assigned two tasks:
  - Price stability
  - Financial stability
- The analysis on these issues are typically separated
- Standard models used in monetary policy analysis often contain no financial frictions, representative agent approach
- In this paper, we offer a simple empirical model to analyze these issues in a joint framework, using both macro and micro data
  - Involves testing for links between the "real" and "financial" side of the economy (both directions)

What we do

1. Use reduced form methods (VARs) to examine if various financial indicators affect the real economy

2. Estimate a default-risk model at the firm level

   - Panel data, sample period $1990Q1 - 1999Q2$. All 'active' Swedish firms limited by shares, $\approx$ 8.000.000 observations
   - Using both firm-specific and macro variables as regressors

3. Estimate a dynamic panel VAR for balance sheet ratios

   - Include macro variables to test the relative importance of idiosyncratic/aggregate shocks

4. Once equipped with the empirical model, do some policy experiments

What we find

1. The real economy is not exogenous w.r.t. to the financial variable that we study. Our preferred financial indicator is statistically and quantitatively important

   - Using average default frequency as measure of financial stance
   - Other variables, e.g. average balance sheets ratios, term-structure, stock prices and bank lending do not seem to have predictive power for the real economy (conditional on the other variables in the VAR)
   - However, housing prices do have predictive power, in addition to the default frequency

2. The firm-level default-risk (logit) model can replicate the high/low default risk in the beginning/end of the 1990s

- Firm-specific variables does a good job in ranking the firms, but cannot explain the absolute level of default risk
- Macroeconomic variables are important for determining the absolute default risk at the firm level
- Estimation of the default risk model using aggregate data is not informative
- The so called "banking-crisis" episode in Sweden is not an unique event that cannot be explained with a model

3. The balance sheet ratios that we consider are surprisingly non-cyclical, most of the variation appear to be due to idiosyncratic shocks
   - In part, this reflects data problem, i.e. defaulted firms often do not report accounting data
4. Impulse response functions to a given aggregate shock are highly state-dependent
   - Non-linearities introduced by the Logit-model for default risk are quantitatively important
   - The macroeconomic stance appear more important than the distribution of firms balance sheet variables
5. In particular, the aggregate VAR model suggest that there is a trade-off for monetary policy between stabilizing inflation and the default frequency, whereas in the micro-macro model that trade-off is state-dependent, i.e. in "good"/"bad" times the trade-off appears to be low/high

Rest of the presentation

1. Measuring the financial stance of the economy
2. Testing for dependency of the macroeconomy on financial variables.
3. The default-risk model
4. Dynamic panel VAR for balance sheets variables
5. Putting it all together
6. The impulse response functions to an identified monetary policy shock
7. Predicting the "banking crisis" in Sweden using the micro-macro model and an aggregate VAR
8. Future work

1. Measuring the financial stance of the economy

- Default frequency highly correlated with credit-loss ratio, in particular at the lower frequencies. No clear lead-lag relationship.

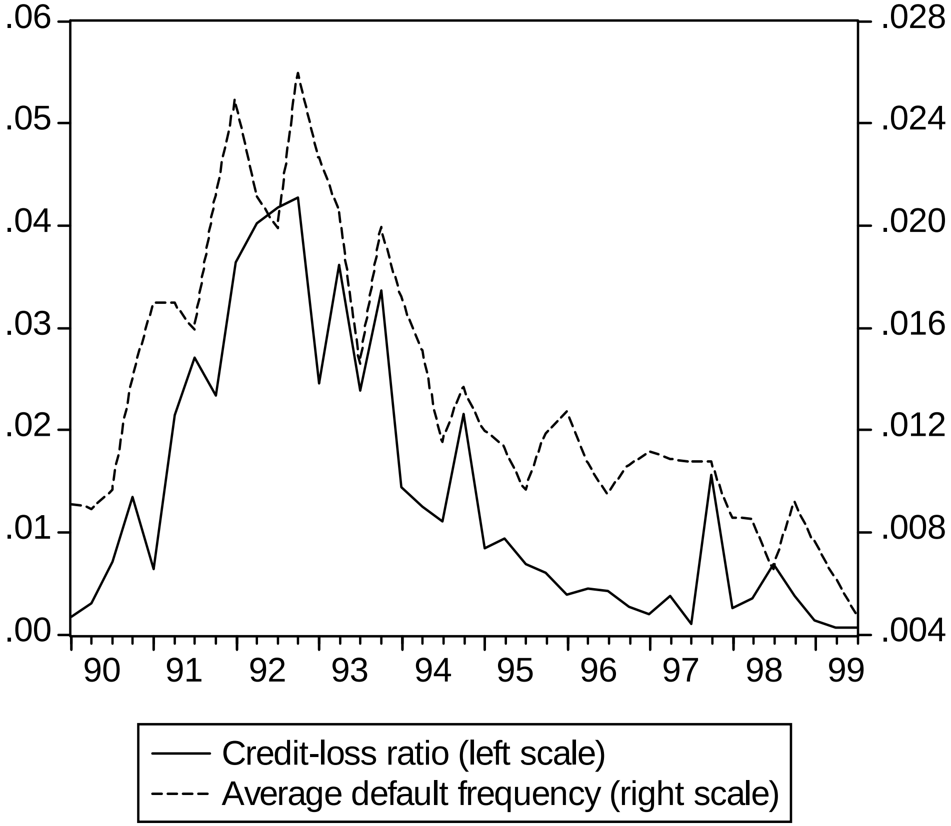


Figure: Average default frequency over time in the panel and credit losses by non-financial firms relative to loan stock.

2. Testing for dependency of the macroeconomy on financial variables

- Adopted the VAR estimated by Lindé (2002)

$$\begin{aligned} X_t &= C + \delta_1 D_{923} + \delta_2 D_{931013} + \tau T_t + \\ &\quad \sum_{i=0}^{2} \Upsilon_i Z_{t-i} + \sum_{i=1}^{2} \Gamma_i X_{t-i} + u_t^d \end{aligned}$$

where

$$X_t = \left[\; y_t^d \;\; \pi_t^d \;\; R_t^d \;\; q_t \; \right]'$$

and

$$Z_t = \left[\; y_t^f \;\; \pi_t^f \;\; R_t^f \; \right]'.$$

- Sample period: $1986Q3 - 2002Q4$.
- Data used in VAR depicted in Figure.

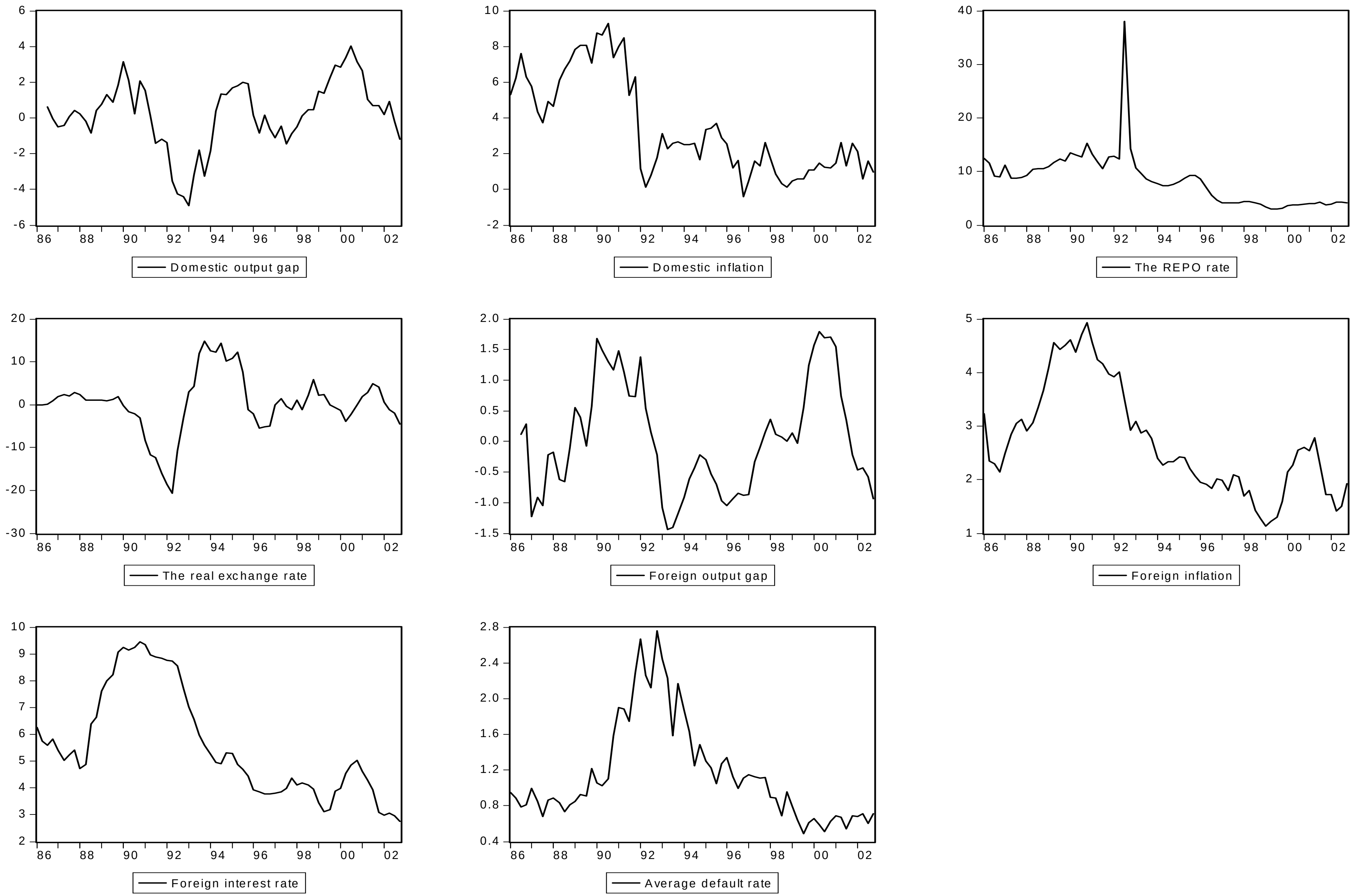


Figure: Variables used in the VARs.

- Augment the VAR with lags of the default frequency (df_t), use a Block-exogeneity test (multivariate Granger causality test) to find that df_t enter significantly, p-value 0.001.

- Also, shocks in df_t quantitatively important, account for 20 percent of the fluctuations in output.

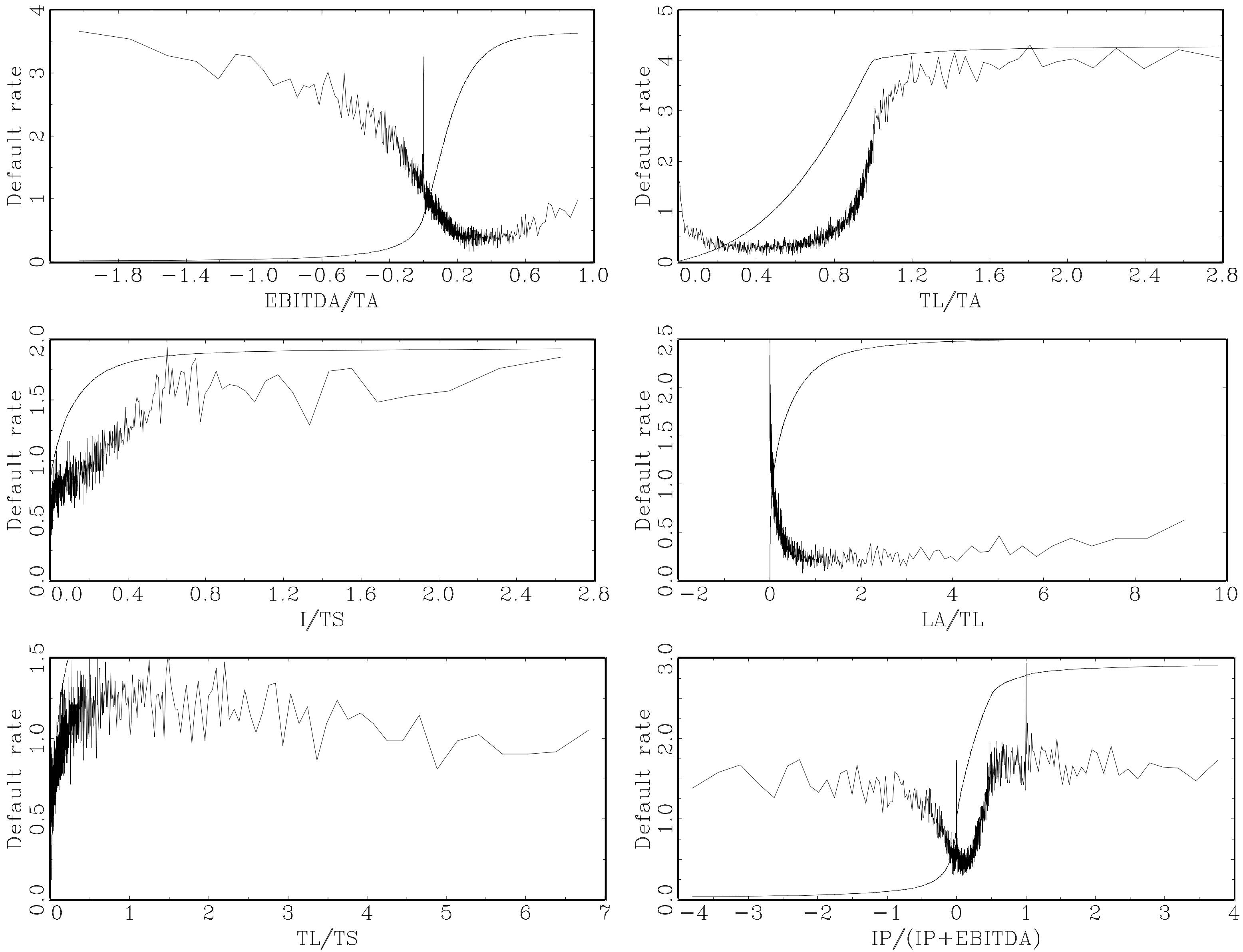
- Balance sheet variables, stock prices, bank-lending to Swedish public, term-structure ($r5m - r3m$) do not carry significant information for the macro-economy.

- But house prices do contain signficant information, interesting link to examine further.

- Conclusion: df_t seems to be an important link between the real and financial sector.

3. The default-risk model

- Estimate a simple logit default-risk model on firm level data, $1990Q1 - 1999Q2$. Use both firm-specific and macro variables in the model.
- Population: Firms limited by shares (Aktiebolag) that have delivered a financial statement and defaulted firms.
- Apply leading Swedish credit risk bureau (UC) definition of default. Typically, a firm only default once (It could in principle default more than once if it gets healthy in between.).
- Around $200,000$ firms every 38 quarter $\Rightarrow$ $8,000,000$ observations in the panel.
- Selection of balance sheet variables by graphing different balance sheet variables against default rates. Default rates and variable values are calculated as averages over an interval of $+/$- 5000 sorted observations. See figure.



Default rates and the cumulative distribution functions for the accounting data.

- Use two additional firm specific variables, remarks (type 8, 11, 16, 25, 31 collected in a single variable) and lack of financial statement (dummies).
- Truncate the balance sheet variables prior to estimation (upper and lower 1 percent of obs.).
- Replace missing values for balance sheets variables for defaulting/non-defaulting obs with mean for defaulting/non-defaulting firms. Have experimented with other methods as well (linear projection and bootstrapping), results not sensitive to how this is done.
- Report statistics for the firm specific variables in Table 1.
- Estimation results for the logit models reported in Table 2.

Table 1: Descriptive statistics for the micro data.

Part B: Truncated data

Firm type	N	μ	σ	Statistic min	1%	50%	99%	max
Non-defaulted	7549041							
EBITDA/TA	7471212	0.11	0.25	-1.05	-1.03	0.11	0.84	0.84
TL/TA	7474248	0.71	0.35	0.03	0.03	0.73	2.42	2.46
LA/TL	7451325	0.53	1.12	0	0	0.13	7.81	7.81
I/TS	7355762	0.12	0.29	0	0	0.01	2.13	2.13
TL/TS	7474248	0.58	2.08	0	0	0.08	14.74	18.61
IP/(IP+EBITDA)	7457030	0.15	0.76	-3.55	-3.55	0.10	3.91	3.91
PAYDIV (%)	7549041	13.15	33.80	0				1
REMARK1 (%)	7549041	0.33	5.77	0				1
REMARK2 (%)	7549041	3.06	17.21	0				1
TTLFS (%)	7549041	1.54	12.30	0				1
Defaulted	103568							
EBITDA/TA	67093	-0.03	0.35	-1.05	-1.05	0.03	0.84	0.84
TL/TA	67110	1.00	0.50	0.03	0.03	0.94	2.46	2.46
LA/TL	66729	0.21	0.82	0	0	0.02	4.87	7.81
I/TS	63138	0.18	0.38	0	0	0.03	2.13	2.13
TL/TS	67110	0.57	1.75	0	0	0.12	9.52	18.61
IP/(IP+EBITDA)	66670	0.24	0.99	-3.55	-3.55	0.23	3.91	3.91
PAYDIV (%)	103568	0.70	8.31	0				1
REMARK1 (%)	103568	14.90	35.61	0				1
REMARK2 (%)		40.60	49.11	0				1
TTLFS (%)	103568	33.42	47.17	0				1

Table 2: Logit estimation results of the default-risk model.[a]

Type of regressor	Model I Coefficient	Model I Std error	Model II Coefficient	Model II Std error	Model III Coefficient	Model III Std error
Constant	-4.76	0.018	-5.22	0.025	-5.88	0.053
Idiosyncratic variables[b]						
EBITDA/TA	-1.07	0.022	-1.10	0.028	-1.09	0.041
TL/TA	1.07	0.015	0.54	0.020	0.52	0.029
LA/TL	-0.10	0.014	-0.15	0.017	-0.16	0.025
I/TS	0.27	0.016	0.20	0.021	0.21	0.031
TL/TS	0.19	0.004	0.23	0.005	0.22	0.007
IP/(IP+EBITDA)	0.09	0.007	0.07	0.009	0.08	0.013
PAYDIV			-1.91	0.080	-1.85	0.123
REMARK1			1.73	0.032	1.89	0.046
REMARK2			2.66	0.020	2.74	0.030
TTLFS			3.32	0.019	3.27	0.028
Aggregate variables[c]						
Output gap - $y_{d,t}$					-0.110	0.007
Inflation rate - $\pi_{d,t}$					-0.005	0.008
Nominal interest rate - $R_{d,t}$					0.072	0.005
Real exchange rate - q_t					-0.006	0.002
Summary statistics[d]						
Mean log-likelihood	-0.0669		-0.0491		-0.0484	
Pseudo R^2	0.16		0.37		0.39	
Aggregate R^2	0.26		0.36		0.94	
Number of observations	$2,066,206$		$1,607,049$		$1,836,625$	

- Cross-section identifies accounting variables well, the time-dimension identifies the macro variables.

- OLS estimations on aggregate data produce very misleading estimates for accounting data

$$
\begin{aligned}
df_t = \; & \underset{(0.06)}{-0.23} \; \underset{(0.13)}{-0.23} \left(\frac{\mathsf{EBITDA}}{\mathsf{TA}}\right)_t + \underset{(0.06)}{0.30} \left(\frac{\mathsf{TL}}{\mathsf{TA}}\right)_t + \underset{(0.03)}{0.09} \left(\frac{\mathsf{LA}}{\mathsf{TL}}\right)_t \cdots \\
& \underset{(0.21)}{-0.94} \left(\frac{\mathsf{I}}{\mathsf{TS}}\right)_t + \underset{(0.08)}{0.19} \left(\frac{\mathsf{TL}}{\mathsf{TS}}\right)_t - \underset{(0.12)}{0.02} \left(\frac{\mathsf{IP}}{\mathsf{IP+EBITDA}}\right)_t \cdots \\
& \underset{(0.03)}{-0.05} y_{d,t} - \underset{(0.03)}{0.05} \pi_{d,t} + \underset{(0.03)}{0.12} R_{d,t} + \underset{(0.009)}{0.002} q_t + \hat{u}_{df,t}, \qquad (0.1)
\end{aligned}
$$

$R^2 = 0.93$, DW $= 2.10$, Sample: $1990Q1 - 1999Q2$ ($T = 38$)

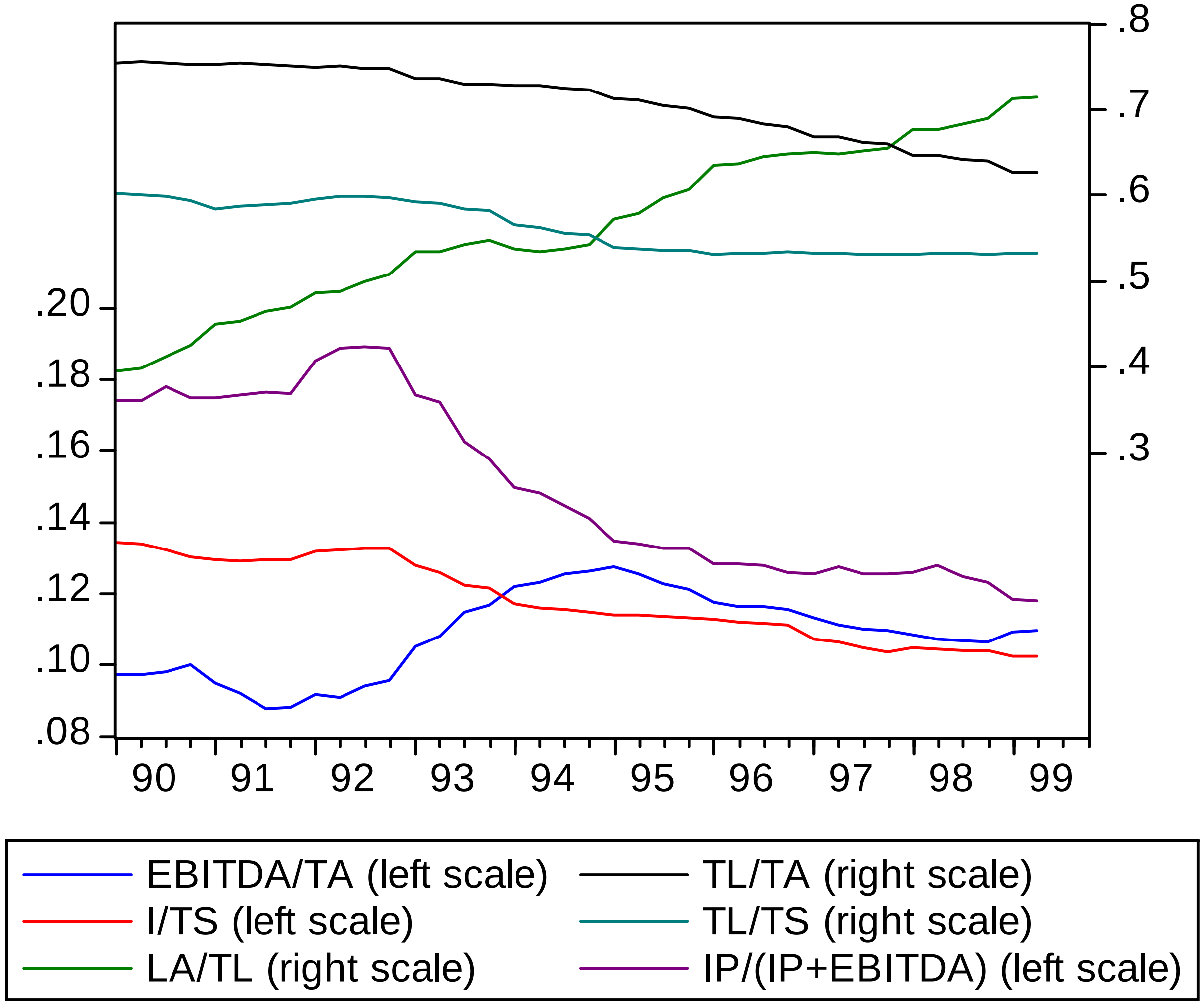


Figure: Quarterly average balance sheet variables over time (lagged one year as in the default risk model).

- Models able to reproduce aggregate default rate when macro variables are included. See figures.

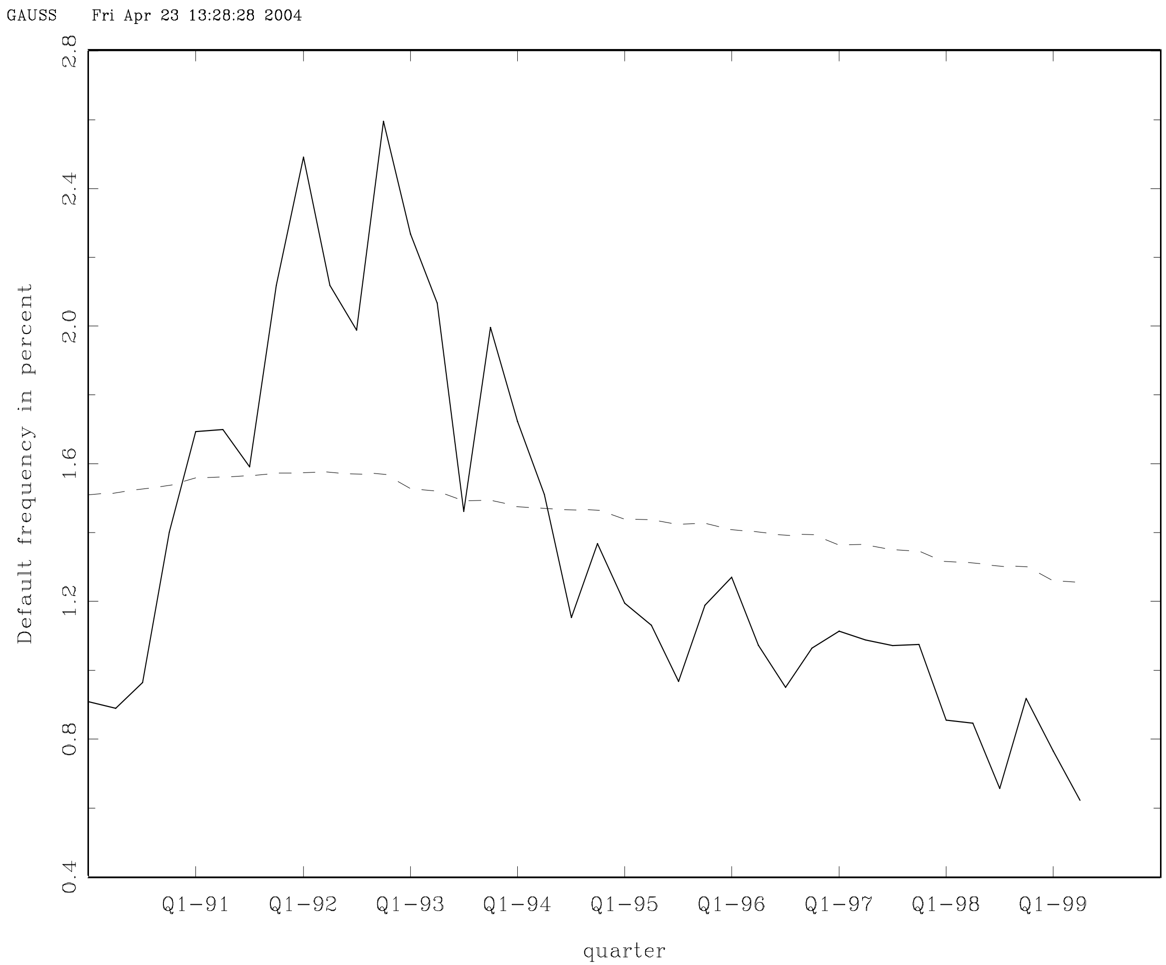


Figure: Actual and projected default rates at the aggregate level: Only idiosyncratic information included (Model II).

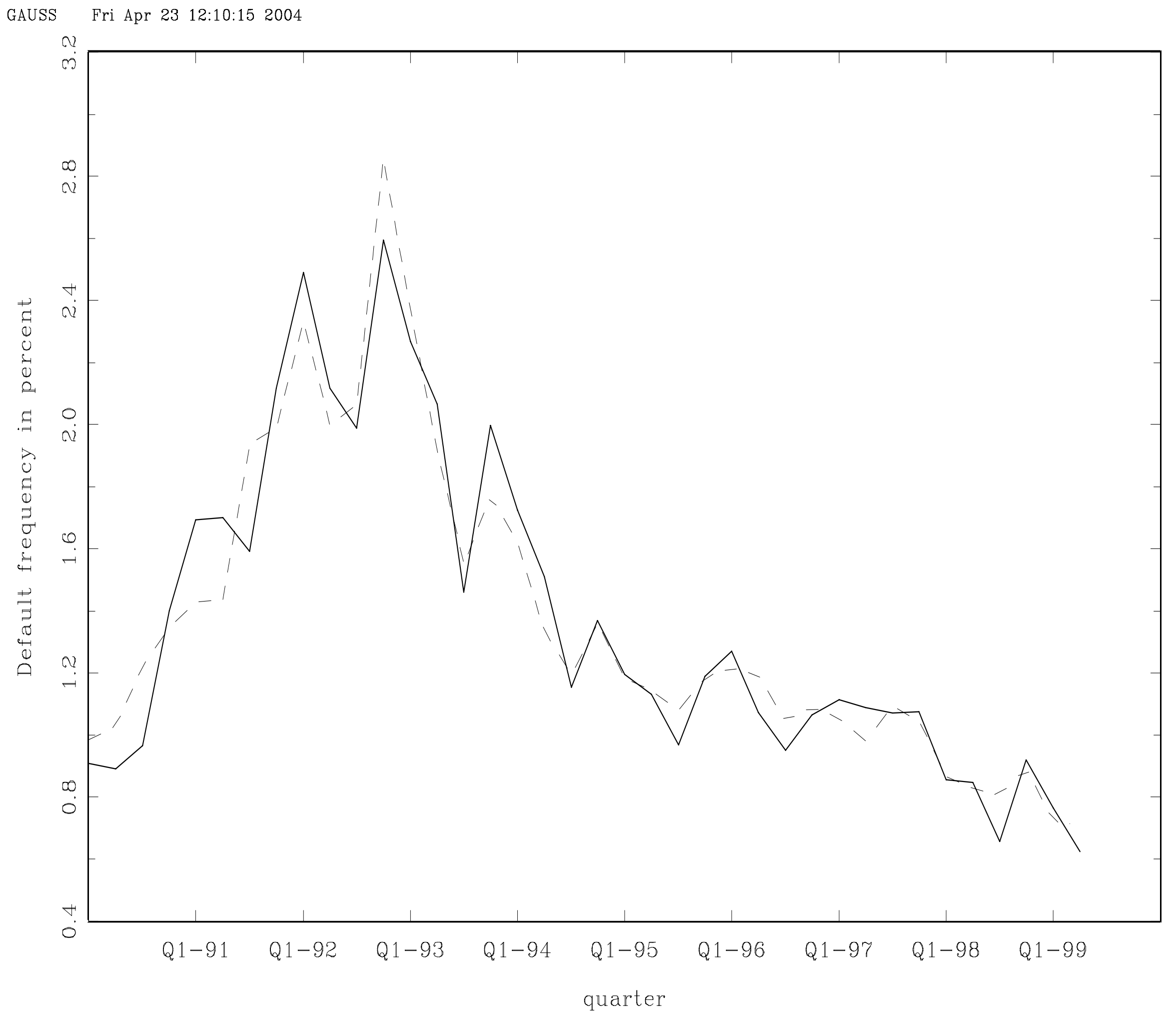


Figure: Actual and projected default rates at the aggregate level: Both idiosyncratic and aggregate information included (Model III).

4. Dynamic panel VAR for balance sheets variables

- Let $Y_{i,t} = \left[\text{EBITDA/TA}_{i,t} \ \text{TL/TA}_{i,t} \ \text{I/TS}_{i,t} \ \text{LA/TL}_{i,t} \right]'$ denote a 4×1 vector with the financial ratios for firm i.

- Let $Y_t = [\, Y_{1,t} \ \ . \ \ . \ \ . \ \ Y_{N_t,t} \,]'$ denote a $4 \times N_t$ matrix where N_t is the number of firms in the panel in quarter t.

- VAR model for the financial ratios

$$Y_t = \Theta_Y Y_{t-1} + \Theta_X X_{t-1} + u_t^y, \ \text{var}\,(u_t^y) = \Sigma_Y \tag{0.2}$$

where X_t is defined as $\left[\, y_t^d \ \ \pi_t^d \ \ R_t^d \ \ q_t \,\right]'$.

- Estimate (0.2) equation by equation with GMM (Arrelano and Bond, 1991).

- Find that essentially all the variation in the balance sheet ratios are due to idiosyncratic shocks, small role for aggregate shocks.
- By running the regressions

$$Y_{i,t} = \beta_0 X_t + \beta_1 X_{t-1} + ... + \beta_p X_{t-p} + \varepsilon_t,$$

  we obtain maximum $R^2 < 0.02$

- Figure below show average and fitted value of the regressions above

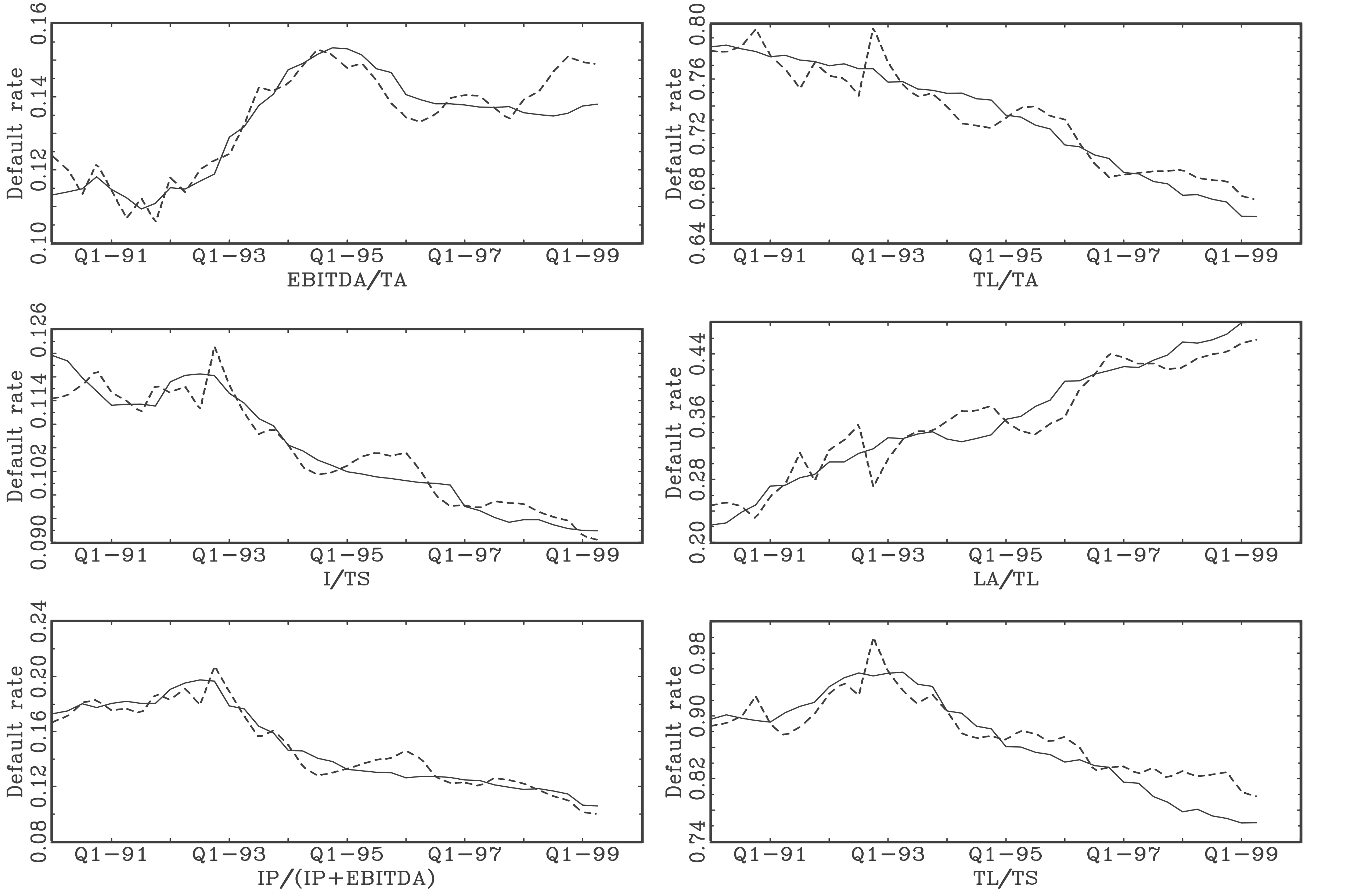


Figure: Actual (solid) and projected (dotted) balance sheet variables at the aggregate level explained by aggregate shocks.

5. Putting it all together

- VAR model for the foreign variables (exogenous w.r.t. to domestic variables)

$$Z_t = C_f + \tau_f T_t + \sum_{i=1}^{2} B_i Z_{t-i} + u_t^f \tag{0.3}$$

- VAR model for domestic variables

$$\begin{aligned} X_t &= C + \delta_1 D_{923} + \delta_2 D_{931013} + \tau T_t + \\ & \sum_{i=0}^{2} \Upsilon_i Z_{t-i} + \sum_{i=1}^{2} \Gamma_i X_{t-i} + \sum_{i=1}^{2} \Lambda_i df_{t-i} + u_t^d \end{aligned} \tag{0.4}$$

- Logit model

$$df_{i,t} = \frac{1}{1 + \exp\left(\beta_0 + \beta_F F_{i,t} + \beta_Y Y_{i,t} + \beta_X X_t\right)}$$

where $F_{i,t}$ fixed firm-specific information (Remark and delayed financial report dummies).

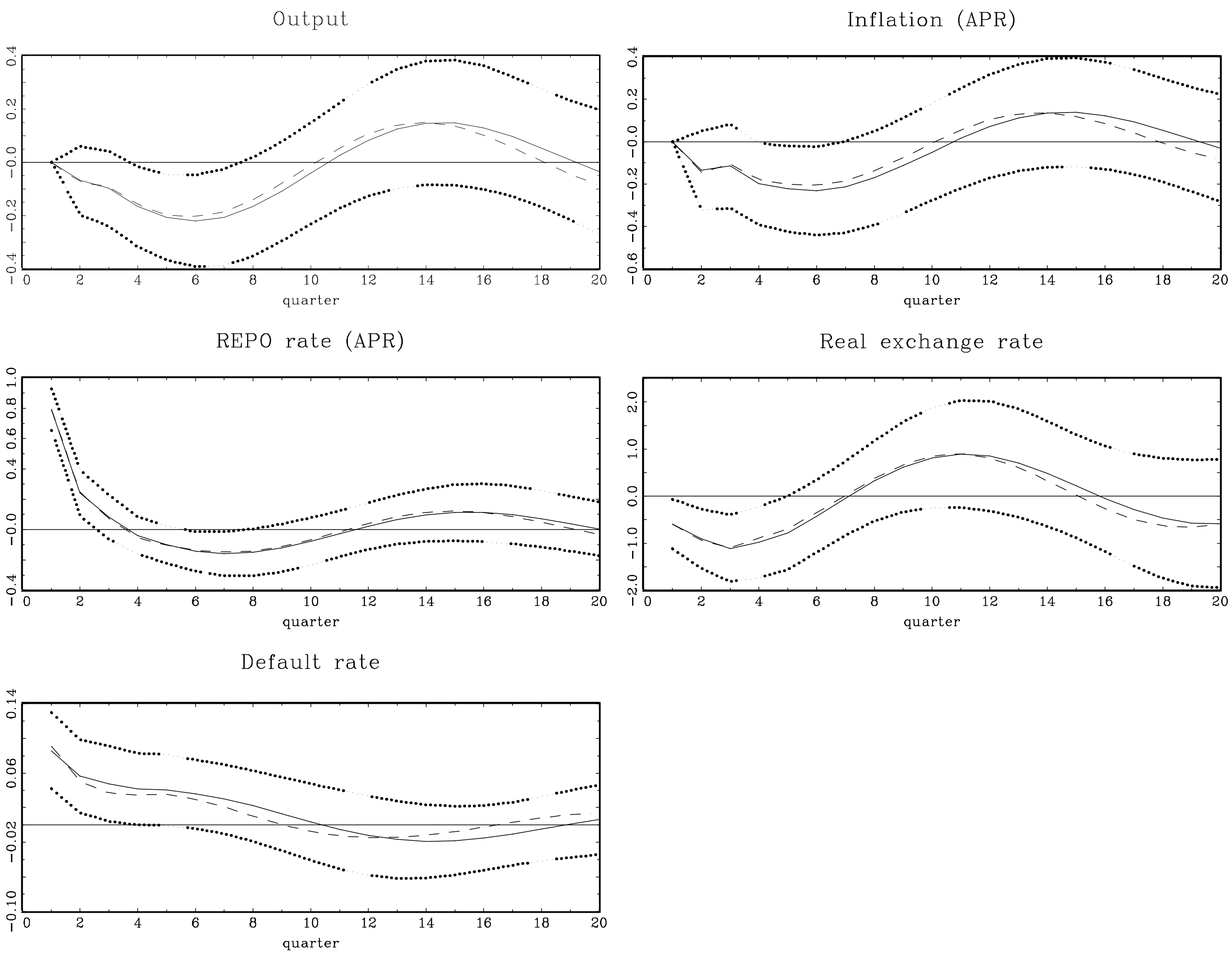
- Panel VAR for accounting variables

$$Y_t = \Theta_Y Y_{t-1} + \Theta_X X_{t-1} + u_t^y,\ \text{var}\left(u_t^y\right) = \Sigma_Y$$

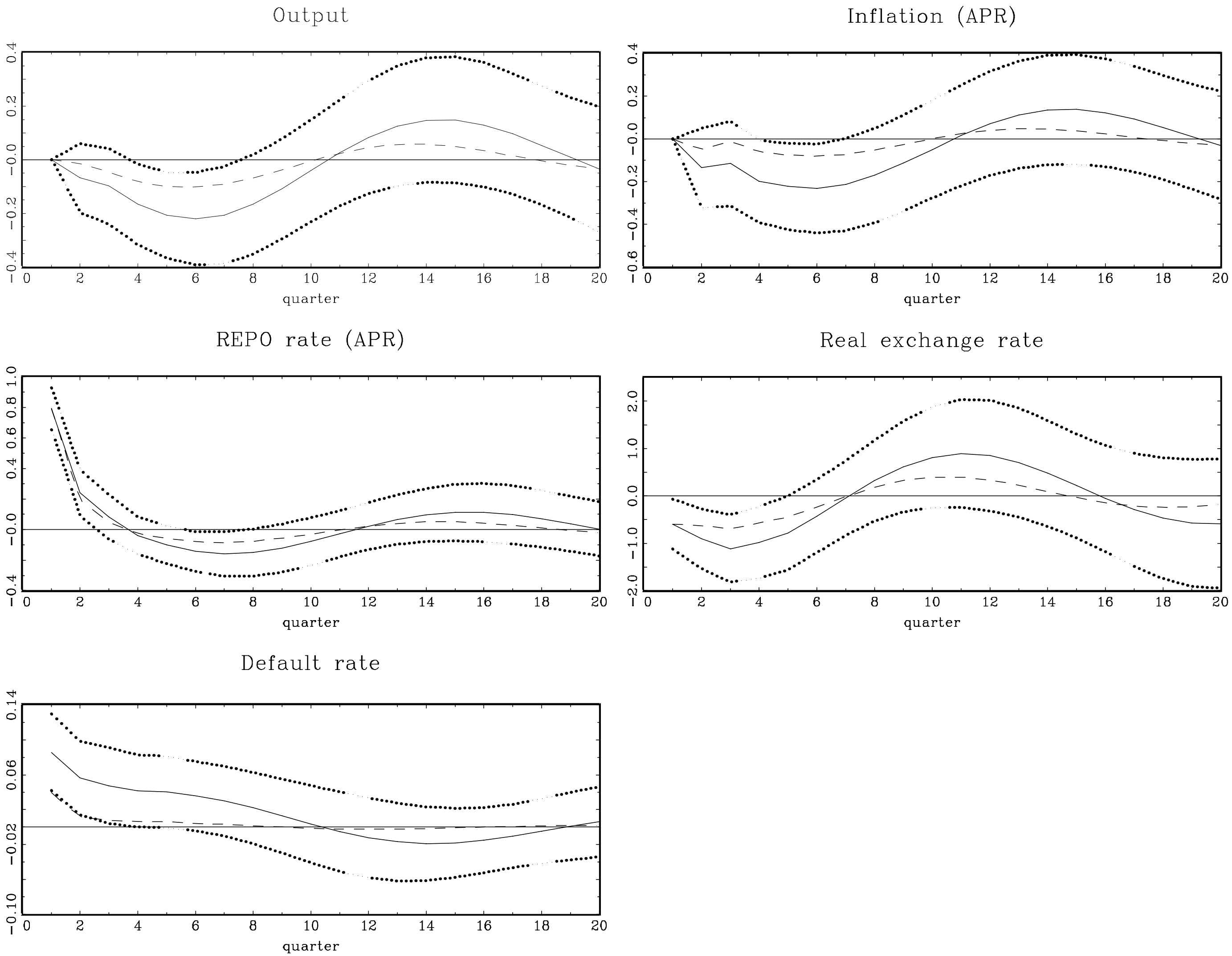
where $Y_t = \left[\, Y_{1,t} \ \ . \ \ . \ \ . \ \ Y_{N_t,t} \,\right]'$.

6. The impulse response functions to an identified monetary policy shock

- Study the trade-off between for policy makers to stabilize inflation and the default frequency.
- Adopt the following assumption; first goods markets clear, then interest rate is set, finally financial markets clear.
- First figure below reports the impulse response functions in the aggregate VAR (solid point estimates, and dotted lines indicate 95% CI) where the aggregate default frequency is endogenous. Dashed line shows the impulse response in the micro-macro model using the macroeconomic stance and firm portfolio $1991Q1$.
- Last figure below reports same thing but using the macroeconomic conditions and firm portfolio $1998Q1$ instead. Results very different, both for real variables and the default frequency in the micro-macro model.



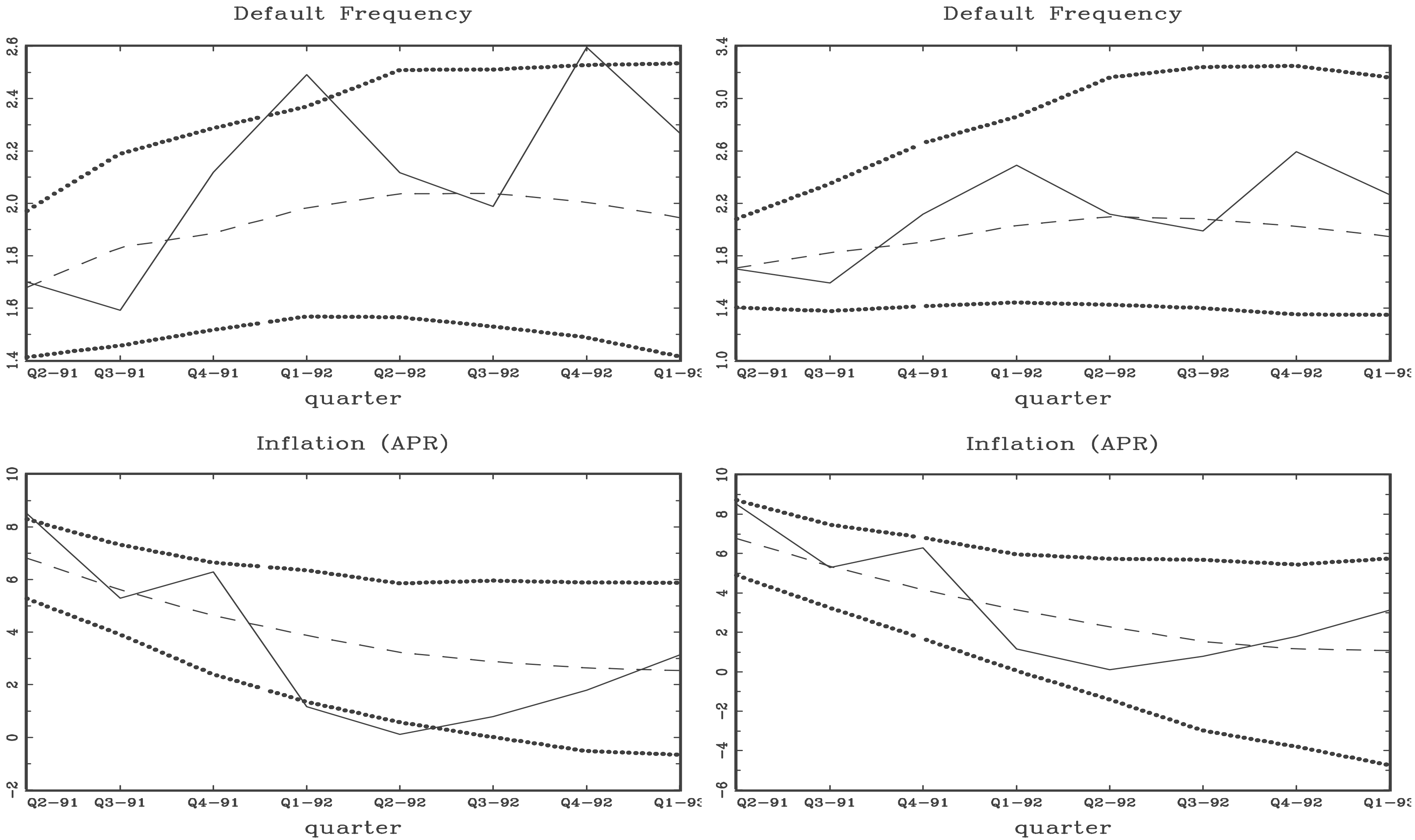
Impulse response functions in the estimated VAR model with the default rate endogenous (point estimates - solid line, dotted lines shows 95 percent confidence interval) and in the micro-macro model (dashed line) for $1991Q1$.



Impulse response functions in the estimated VAR model with the default rate endogenous (point estimates - solid line, dotted lines shows 95 percent confidence interval) and in the micro-macro model (dashed line) for $1998Q1$.

7. Predicting the "banking crisis" in Sweden using the micro-macro model and an aggregate VAR

- Does the micro-macro model perform differently in forecasting the than the aggregate VAR where the default rate is endogenous?
- Examine how the two models could predict (in sample) the "banking crisis" $1991 - 1992$. Dynamic forecast $1991Q1 - 1993Q1$
- Results reported in figure, left panel is aggregate VAR where average default frequency is included as an endogenous variable, right panel is the micro-macro model
- We see that point estimates similar, but uncertainty band more accurate for the micro-macro model



Forecasting the banking crisis $1991 - 1993$. Solid line actual outcome, dashed line median forecast and dotted lines represent 95% CI given by the forecast percentiles. Left panel shows outcome in aggregate VAR, right panel outcome in micro-macro model.

8. Future work

- Try to explain more of the variation in the default frequency with accounting variables
- Estimate different models for different branches/firm size
  - Different branches seem to display different degree of cyclical default risk variation
  - Portfolio composition effects might be important
- The model offer a simple framework for stress testing and consistent forecasting environment