

# The Dynamic Effects of Personal and Corporate Income Tax Changes in the United States

Mertens and Ravn (*AER*, 2013)

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Macro/PF Reading Group  
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# Context and Contributions

- A large literature has developed estimating the stimulus effects of tax changes on GDP and other macro variables.
  - These papers rely either on Structural Vector Autoregressions (SVARs) with parameter restrictions *or* the narrative approach as a source of identification.
  - Nearly all such papers also treat “tax revenue” as an undifferentiated concept, pooling together corporate tax changes, the income tax changes, etc.
- Mertens and Ravn make two key contributions:
  - They show that both approaches potentially introduce bias and develop a new method combining favorable aspects of both SVARs and the narrative approach.
  - They estimate separately the effects of personal income tax changes and corporate tax changes.

# Summary of Results

- Mertens and Ravn find that the effect of tax changes on output is large and differs substantially between personal and corporate tax changes.
  - A 1 pp. decrease in the average personal income tax rate (APITR) induces a 1.4% increase in GDP after 1 quarter and a peak increase of 1.8% after 3 quarters.
  - A 1 pp. decrease in the average corporate income tax rate (ACITR) induces a 0.4% increase in GDP after 1 quarter and a peak increase of 0.6% after 1 year.
  - Such cuts are associated with a -5.4% response in personal income tax revenue on impact but no statistically significant change in corporate tax revenue.
  - The findings correspond to a personal income tax multiplier of 2.0 on impact, rising to 2.5 after 3 quarters. The multiplier is not well-defined for corporate tax.

# Identification Strategy

- Main idea: exploit information contained in narrative accounts to identify structural shocks in an SVAR framework.
- Regression specification:  $\mathbf{Y}_t = \sum_{j=1}^p \delta_j \mathbf{Y}_{t-j} + \mathbf{u}_t$ ,  
where
  - $\mathbf{Y}_t$  is an  $n \times 1$  vector of observable variables
  - The reduced-form residuals are related to the structural shocks by  $\mathbf{u}_t = \mathbf{B}\varepsilon_t$
  - $\varepsilon_t$  is an  $n \times 1$  vector of structural shocks with  $E[\varepsilon_t] = 0$ ,  $E[\varepsilon_t \varepsilon_t'] = I$ ,  $E[\varepsilon_t \varepsilon_s'] = 0$  ( $s \neq t$ )
- In the SVAR literature,  $\varepsilon_t$  is treated as a vector of latent variables estimated on the basis of the prediction errors of  $\mathbf{Y}_t$  and by imposing identifying assumptions.
- Here, since  $E[\mathbf{u}_t \mathbf{u}_t'] = \mathbf{B}\mathbf{B}'$ , an estimate of the covariance matrix of  $\mathbf{u}_t$  provides  $n(n + 1)/2$  identifying restrictions – but more are needed.

# Identification Strategy

- Mertens and Ravn propose to obtain restrictions from proxies for the latent shocks (i.e., narrative evidence).
- Let  $\mathbf{m}_t$  be a  $k \times 1$  vector of proxy variables correlated with the  $k$  structural shocks of interest,  $\varepsilon_{1t}$ , but orthogonal to the other shocks,  $\varepsilon_{2t}$ :

$$E[\mathbf{m}_t \varepsilon'_{1t}] = \mathbf{\Phi}$$

$$E[\mathbf{m}_t \varepsilon'_{2t}] = 0$$

- The proxy variables can be used for identification of  $\mathbf{B}$  as long as these conditions are satisfied. (Note:  $\mathbf{\Phi}$  is unknown, nonsingular  $k \times k$  matrix.)
- Intuitively, the setting corresponds to a 2SLS IV regression of  $\mathbf{u}_{2t}$  on  $\mathbf{u}_{1t}$  using  $\mathbf{m}_t$  as instruments for  $\mathbf{u}_{1t}$ .
  - The above two conditions are the instrument validity and exogeneity conditions.

# Identification Strategy

- Partition  $B = \begin{bmatrix} \beta_1 & \beta_2 \\ n \times k & n \times (n-k) \end{bmatrix}$  and then  $\beta_1 = \begin{bmatrix} \beta'_{11} & \beta'_{21} \\ k \times k & k \times (n-k) \end{bmatrix}$ ,  $\beta_1 = \begin{bmatrix} \beta'_{12} & \beta'_{22} \\ (n-k) \times k & (n-k) \times (n-k) \end{bmatrix}$ .
- The “IV Conditions” then imply that  $\Phi\beta'_1 = E[\mathbf{m}_t \mathbf{u}'_t]$ .
- This  $n \times k$  system provides  $nk - k^2$  new identification restrictions, which can be expressed as  $\beta_{21} = (E[\mathbf{m}_t \mathbf{u}'_{1t}]^{-1} E[\mathbf{m}_t \mathbf{u}'_{2t}])\beta_{11}$ .
  - Since  $E[\mathbf{m}_t \mathbf{u}'_{1t}]^{-1} E[\mathbf{m}_t \mathbf{u}'_{2t}]$  is estimable, this constitutes a set of covariance restrictions that allow for identification
- In practice, estimation proceeds as follows:
  - (i) Estimate the reduced-form VAR by least squares
  - (ii) Estimate  $E[\mathbf{m}_t \mathbf{u}'_{1t}]^{-1} E[\mathbf{m}_t \mathbf{u}'_{2t}]$  from regressions of the VAR residuals on  $\mathbf{m}_t$
  - (iii) Impose the restrictions from above to estimate the objects of interest

# Data

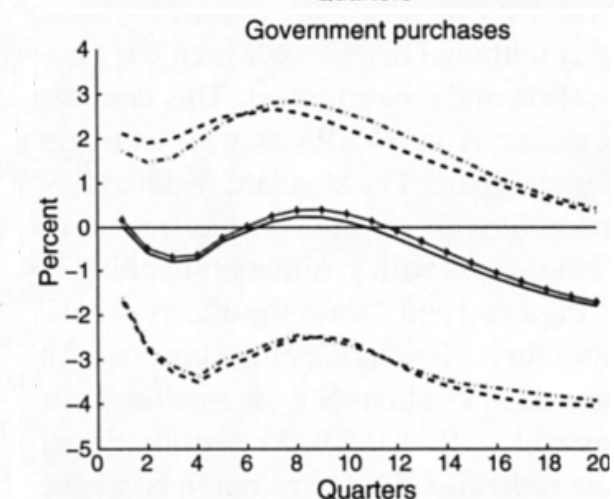
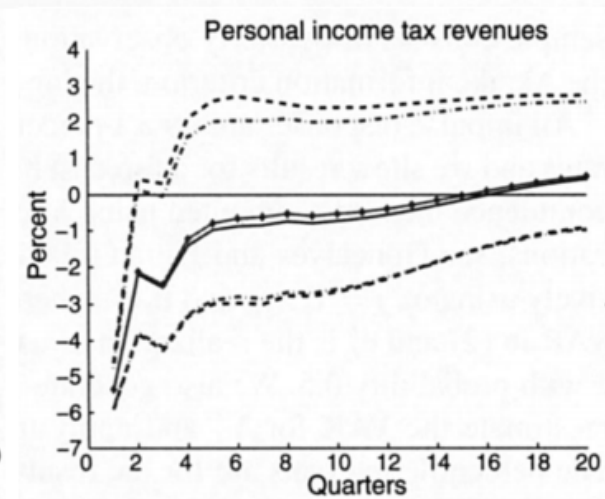
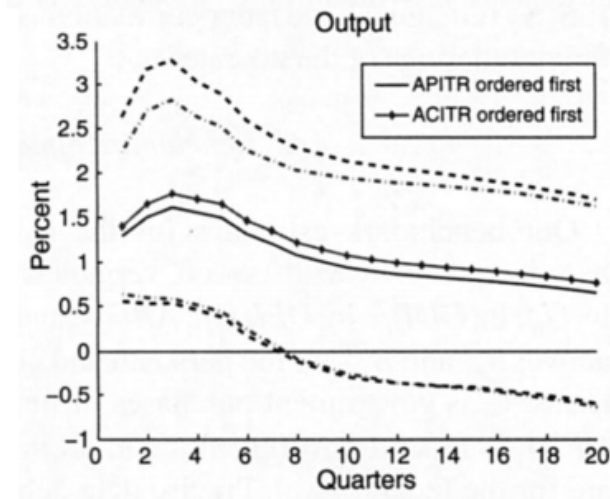
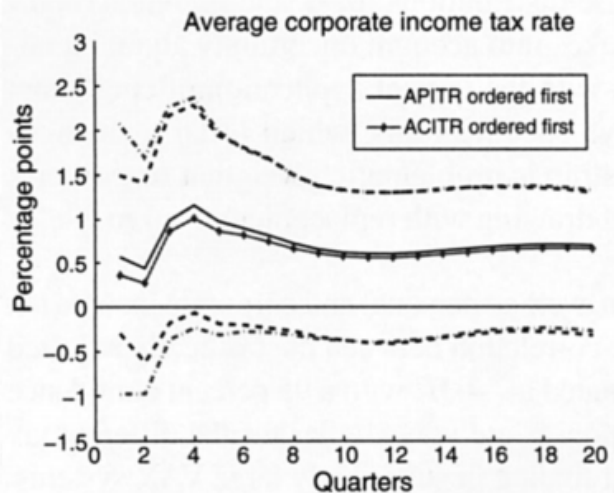
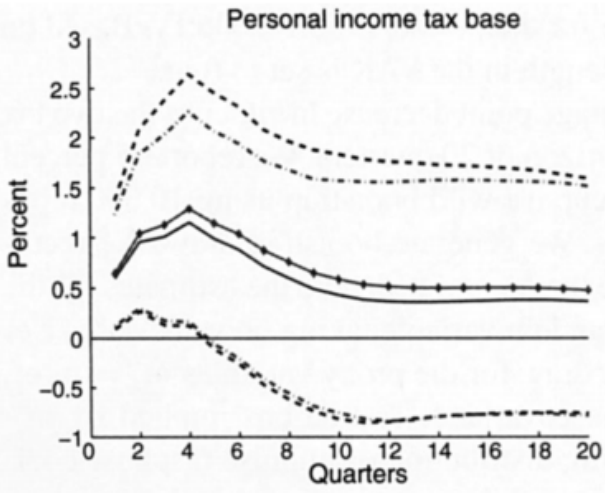
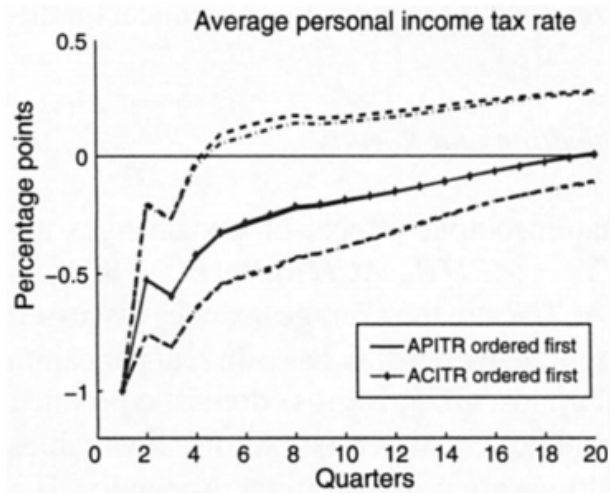
- Mertens and Ravn begin with the narrative series of tax changes compiled by Romer and Romer (2010).
- They decompose it into changes in corporate tax liabilities, income tax liabilities, and other tax liabilities – discarding the final group.
- They also omit tax changes from the series that they consider to be anticipated – i.e., changes with an implementation lag  $\geq 1$  quarter.
- They then convert the remaining dollar-value tax liability changes into corresponding average tax *rate* changes.
- They acquire their outcome variable series (output, tax base, debt, government purchases, etc.) from the standard NIPA tables.

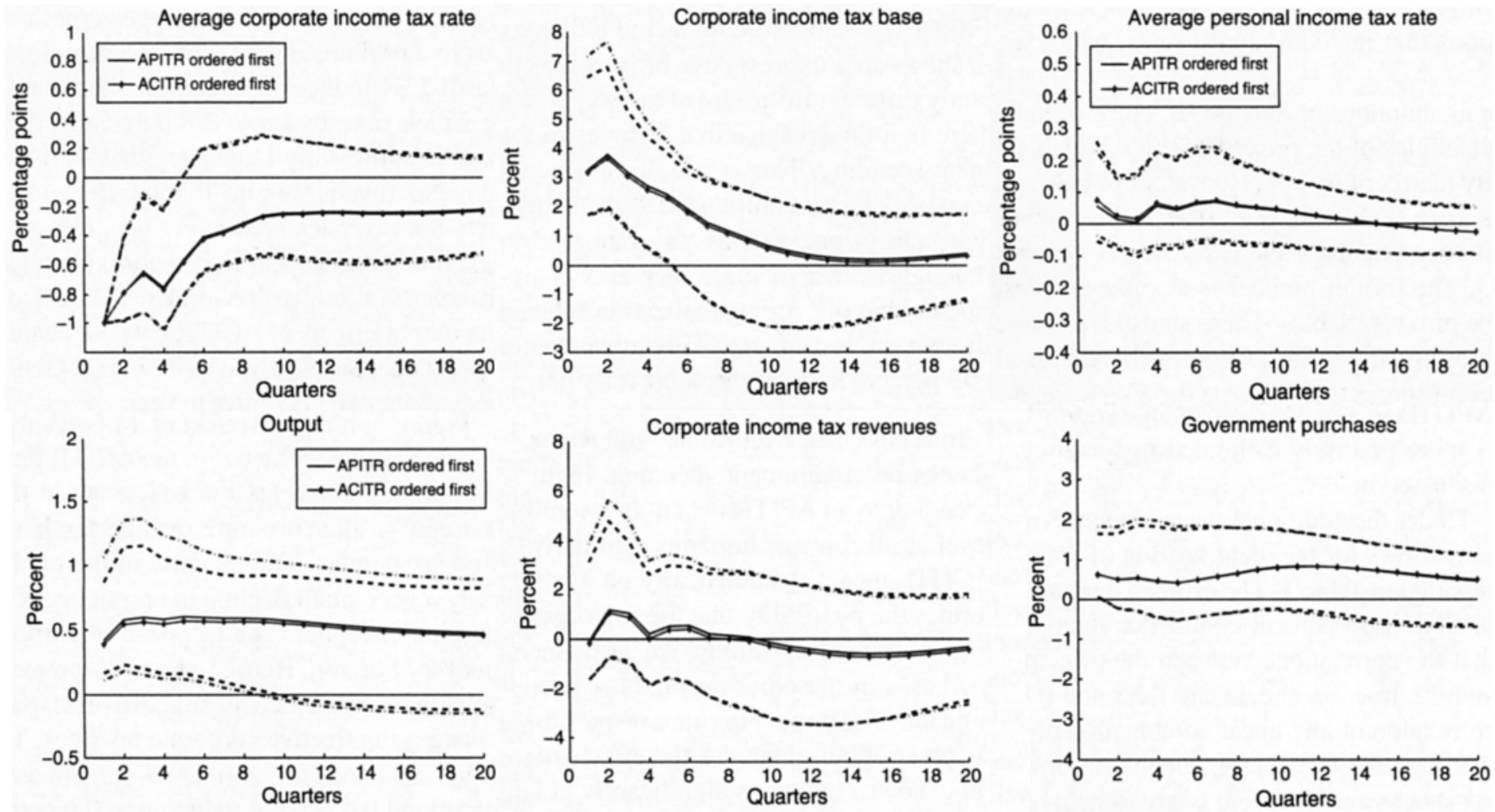
# Separating PIT and CIT Effects

- As Mertens and Ravn point out, they cannot evaluate the effects of PIT rate changes simply by running a regression that omits CIT rate changes.
  - The correlation between the PIT and CIT rate changes, conditional on a tax change taking place, is 0.42.
  - “For isolating the causal effects of a change in only one of the tax rates, it is thus important to control for changes in the other tax rate.”
- To this end, they parametrize  $\mathbf{u}_{1t} = \boldsymbol{\eta}\mathbf{u}_{2t} + \mathbf{S}_1\varepsilon_{1t}$  and  $\mathbf{u}_{2t} = \boldsymbol{\zeta}\mathbf{u}_{1t} + \mathbf{S}_2\varepsilon_{2t}$ ,
  - $\mathbf{u}_{1t}$  and  $\varepsilon_{1t}$  are the  $2 \times 1$  vectors of reduced-form and structural tax rate innovations, whereas  $\mathbf{u}_{2t}$  and  $\varepsilon_{2t}$  contain reduced-form residuals and other structural shocks
  - $\mathbf{S}_1$  is not necessarily diagonal, capturing potential interdependence of tax changes
  - In the appendix, Mertens and Ravn show that identification is indeed possible in this setting, with the assumptions already made and one other about ordering.

# Main Specification

- The benchmark specification is a VAR with seven variables:
  - $APITR_t, ACITR_t, \ln(B_t^{PI}), \ln(B_t^{CI}), \ln(G_t), \ln(GDP_t), \ln(Debt_t)$
- Lag length in the VAR is set to four based on the Akaike Information Criterion (AIC).
- Narrative tax shocks are embedded in the VAR residual term, and their effect is estimated using the previously-described procedure.
- 95% confidence intervals are computed using a recursive wild bootstrap with 10,000 replications (Goncalves and Kilian, 2004).





# Extensions and Robustness

- Under some additional assumptions, Mertens and Ravn can use their model to derive the correlation between the principal components of the narrative tax changes and the *true* tax shocks: 0.55 (PIT) and 0.83 (CIT)
  - Indicative of non-trivial measurement error.
  - But required assumption of independent random censoring seems questionable.
- Including monetary policy and inflation controls doesn't alter the main results in a significant way.
  - At short to medium time horizons, neither does re-estimating the SVAR in first-differences or with a quadratic time trend.
  - Nor does including measures of expected future taxes derived from municipal bond prices (see Leeper, Walker, and Yang, 2011) or expert projections of future military spending (see Fisher and Peters, 2010).

# Comparison with Existing Results

- Compared to traditional narrative-approach results (short-run multiplier 1 to 1.3), Mertens and Ravn find substantially larger effects. They argue that:
  - Traditional narrative approaches don't account for changes in the *tax base* resulting from tax shocks, thereby overestimating true  $\Delta T$ .
  - Estimators used with the traditional narrative approach don't allow for the presence of random measurement error.
    - Not as convincing since the bias from this wouldn't necessarily be downward.
- Compared to traditional SVAR results (short-run multiplier 0.3 to 1), Mertens and Ravn find substantially larger effects in the short- and medium-run.
- Mertens and Ravn have some similarities in approach to Barro and Redlick (2011) (short-run tax multiplier 1.1), who use average *marginal* rate changes.
  - They argue that the difference in estimated multiplier is partially due to Barro and Redlick not omitting preannounced tax changes, potentially leading to downward bias.

# ATR vs. AMTR

- Running a specification using AMTR instead of ATR produces similar results.

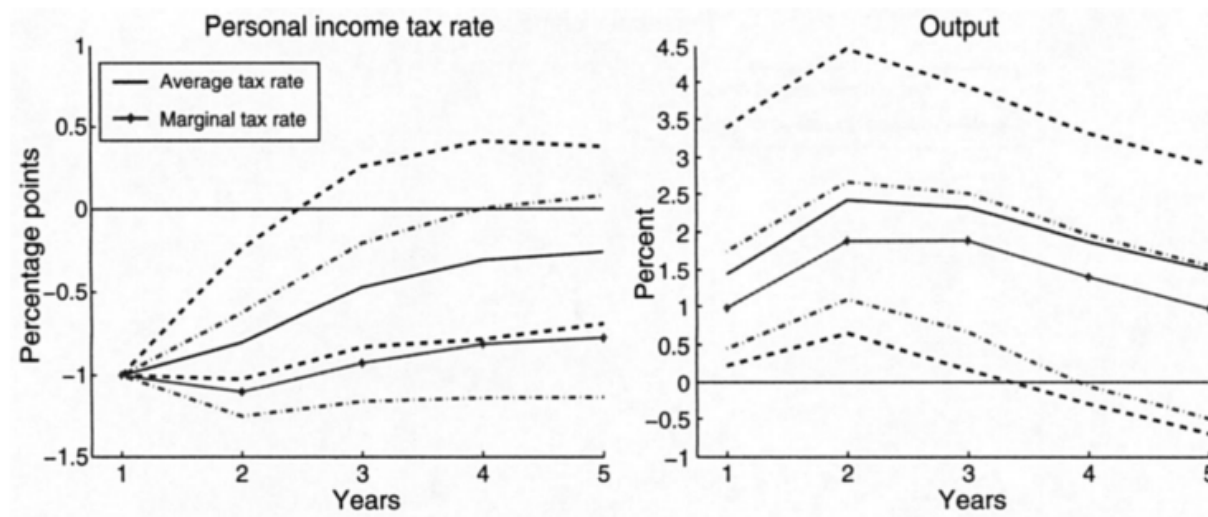
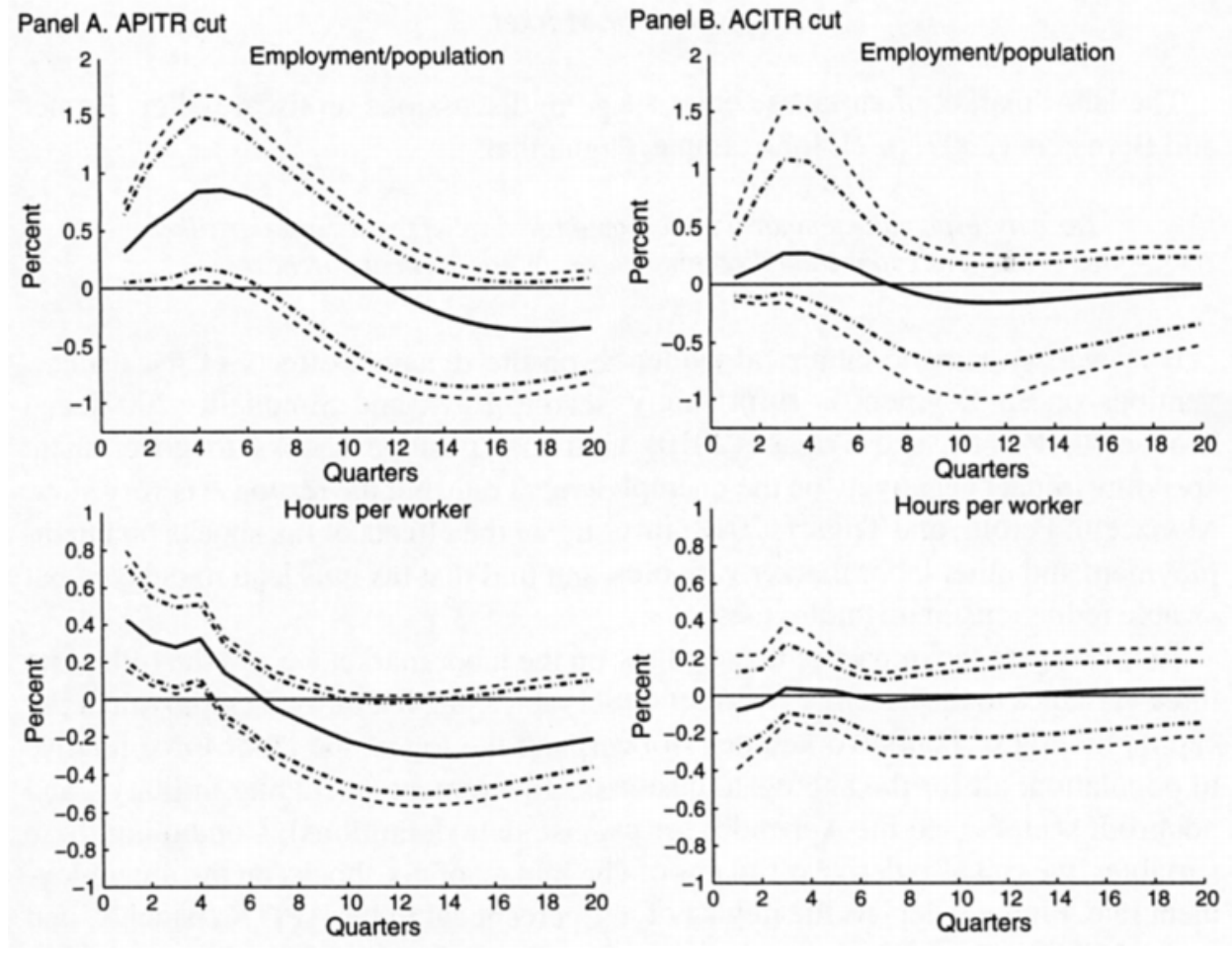


FIGURE 8. ANNUAL VAR: MARGINAL VERSUS AVERAGE PERSONAL INCOME TAX RATE CHANGES

# Effects on Other Variables

- Mertens and Ravn are also interested in estimating the effects of PIT and CIT changes on labor market variables and the components of GDP.
- In response to a PIT change,
  - They find evidence of short-run extensive-margin (EPOP) and intensive-margin (Hours Worked) responses but none of new entry into the labor force.
  - Evidence of increased durable-goods consumption.
- In response to a CIT change,
  - They find no evidence of labor market response.
  - Evidence of increased investment and marginal evidence of decreased consumption.



# Conclusion

- Mertens and Ravn develop a novel way of combining the strengths of the narrative approach and SVARs.
- They decompose the universe of post-war tax changes into PIT rate changes and CIT rate changes.
- They estimate a large, significant, and robust short-run stimulus effect of PIT rate cuts on GDP and a much smaller effect of CIT rate cuts.
  - Significant effects of PIT rate cut on tax base (+), revenues (-), debt (+), EPOP (+), hours worked (+), and durable-goods consumption (+).
  - Significant effects of CIT rate cut on tax base (+) and investment (+).
- Effects are much larger than most results in the previous literature.
  - Mertens and Ravn argue that this is due to bias inherent in the uncorrected SVAR and narrative approaches.