The Dynamic Consequences of Technology and Discount Factor Shocks in Medium-Scale RANK vs TANK Models

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Presentation for the Research Module Macroeconomics at the University of Bonn

24th January 2023

Roadmap

1. Introduction and Related Literature
2. The Models
3. The Shocks
4. Results
5. Conclusion

Introduction

Go to related literature

- aim: contrast a representative-agent to a two-agent framework
  $\Rightarrow$ RANK vs TANK
- two household types in TANK: standard agents and **hand-to-mouth** agents
- analyse how dynamics after aggregate shocks are altered
- two shocks: to technology and to the **discount factor**

Key Results

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2. underlying heterogeneity of individual-level responses is interesting feature of TANK

3. two parameters are key in shaping the quantitative differences between RANK and TANK

The Models

- building on Gust et al. (2012) and Boehl (2022) with price indexation
- crucial difference RANK vs TANK: household sector

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- building on Gust et al. (2012) and Boehl (2022) with price indexation
- crucial difference RANK vs TANK: household sector
- RANK: representative, consumption-smoothing agent with access to investment, bonds, profits, etc. resulting in standard labour supply and Euler equation:

$$w_t = \chi n_t^{\eta}(c_t - hc_{t-1}) \tag{2.1}$$

$$1 = \beta_{t+1}\frac{R_t}{\pi_{t+1}}\frac{(c_t - hc_{t-1})}{(c_{t+1} - hc_t)} \tag{2.2}$$

plus standard budget constraint ▸ Go to budget constraint

The TANK Model (I)

- unit-mass population, of which a share $(1 - \lambda)$ are standard, consumption-smoothing households

- these **unconstrained** agents behave just as RANK agents
  $\Rightarrow$ identical equations (2.1), (2.2), budget constraint

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- unit-mass population, of which a share $(1 - \lambda)$ are standard, consumption-smoothing households
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- a share λ is **hand-to-mouth** and consume only current-period labour income with no access to consumption-smoothing tools

The TANK Model (II)

– hand-to-mouth households are characterised by labour supply and budget constraint:

$$w_t = \chi(n_t^H)^{\eta}(c_t^H - hc_{t-1}^H) \tag{2.3}$$

$$c_t^H = w_t n_t^H \tag{2.4}$$

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- hand-to-mouth cannot save or dissave in the face of shocks

- consumption of hand-to-mouth tied exclusively to labour market
  $\Rightarrow$ labour market of great importance for TANK dynamics

The TANK Model (III)

– final step for TANK model is economy-wide aggregation:

$$c_t = (1-\lambda)c_t^U + \lambda c_t^H \tag{2.5}$$

$$n_t = (1-\lambda)n_t^U + \lambda n_t^H, \tag{2.6}$$

where:

c_t, n_t: aggregate consumption and employment

c_t^U, n_t^U: unconstrained agents' consumption and employment

c_t^H, n_t^H: hand-to-mouth agents' consumption and employment

The Discount Factor Shock

– the discount factor evolves according to:

$$\beta_t = \beta_{ss} \left(\frac{\beta_{t-1}}{\beta_{ss}} \right)^{\rho_\beta} \exp(\varepsilon_{\beta,t}) \tag{3.1}$$

where $\varepsilon_{\beta,t} = 0.02$ in $t = 1$, $\beta_{ss} = 0.98$, $\rho_\beta = 0.8$

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– what can one expect to happen?
  – contraction in today's consumption, output, labour hours, wages, inflation, interest rates (both models)
  – unconstrained agents in TANK should act similar to agents in RANK
  – hand-to-mouth will most likely be hit somewhat stronger as they cannot smooth consumption

Results

– calibration: mostly used the given values, but following Kaplan et al. (2018) and Debortoli and Galí (2018): $\lambda = 0.3$ and $\eta = 1$

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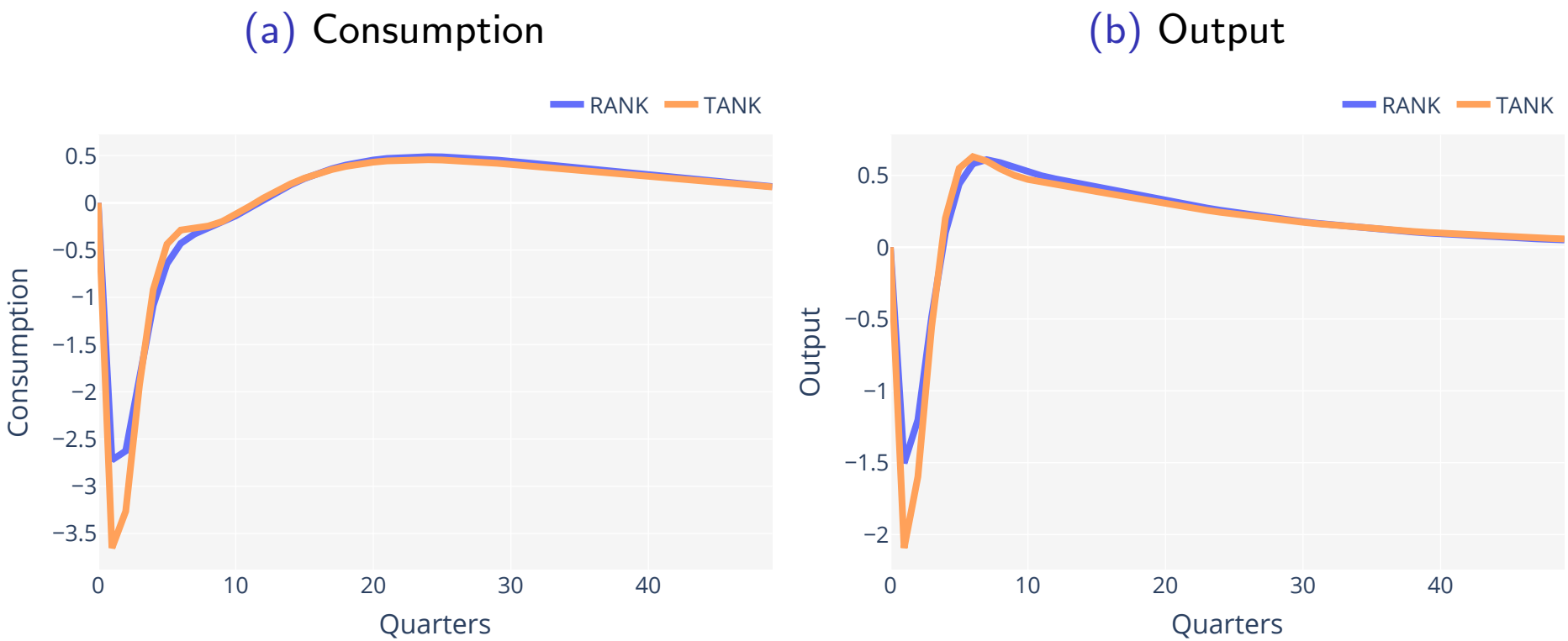
- roadmap for the results:
  1. responses to a discount factor shock

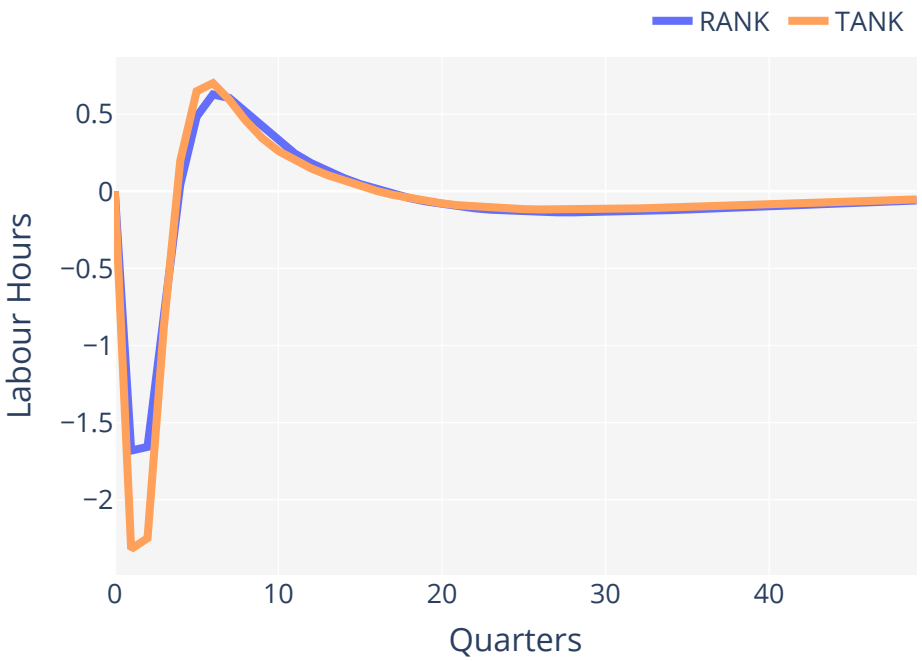
     ▸ Go to technology shock

  2. influence of λ and η on quantitative differences

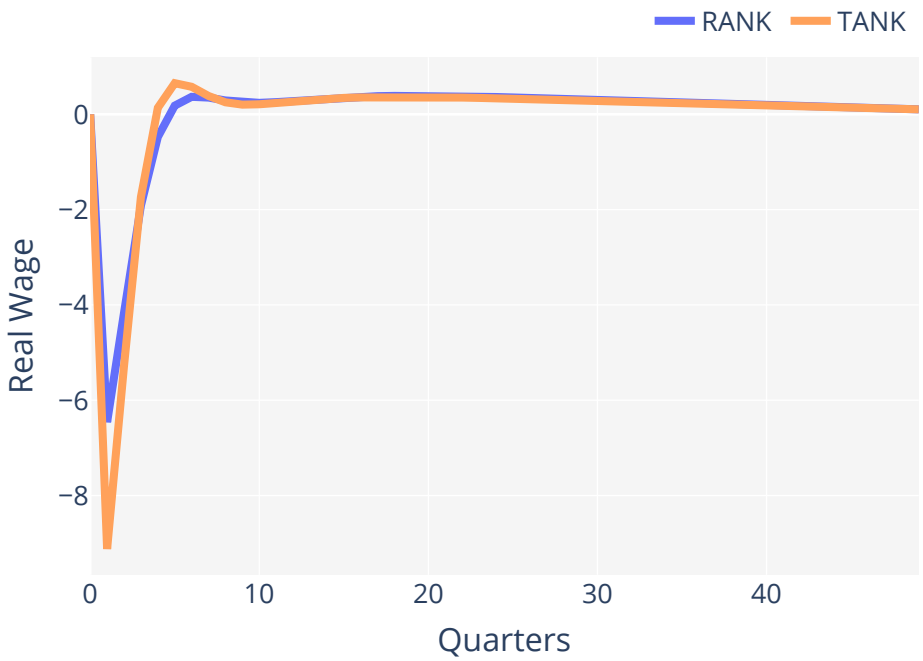
Figure: Aggregate Responses to a Discount Factor Shock



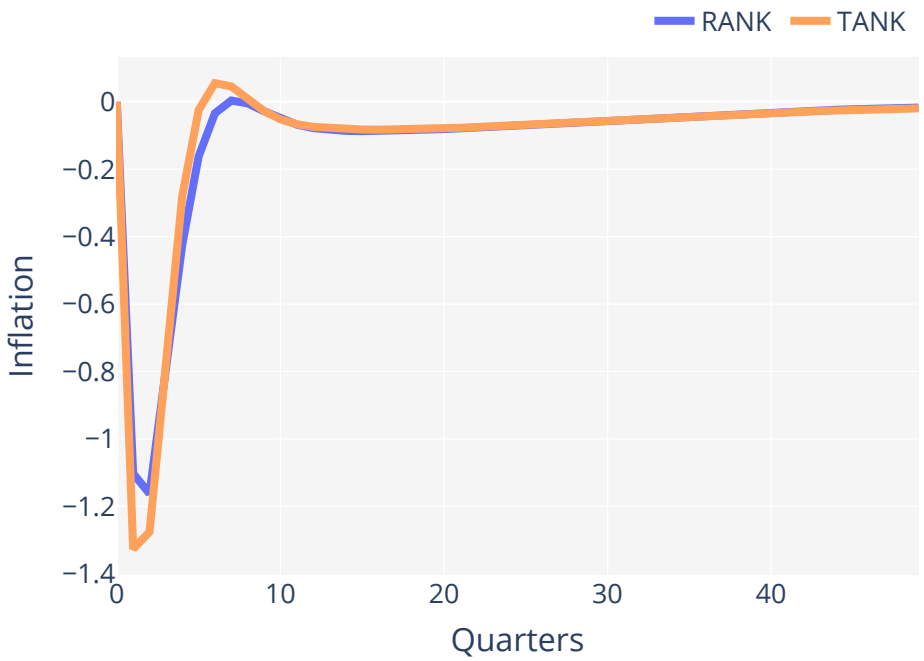
(c) Labour Hours



(d) Wage



(e) Inflation



(f) Nominal Interest Rate

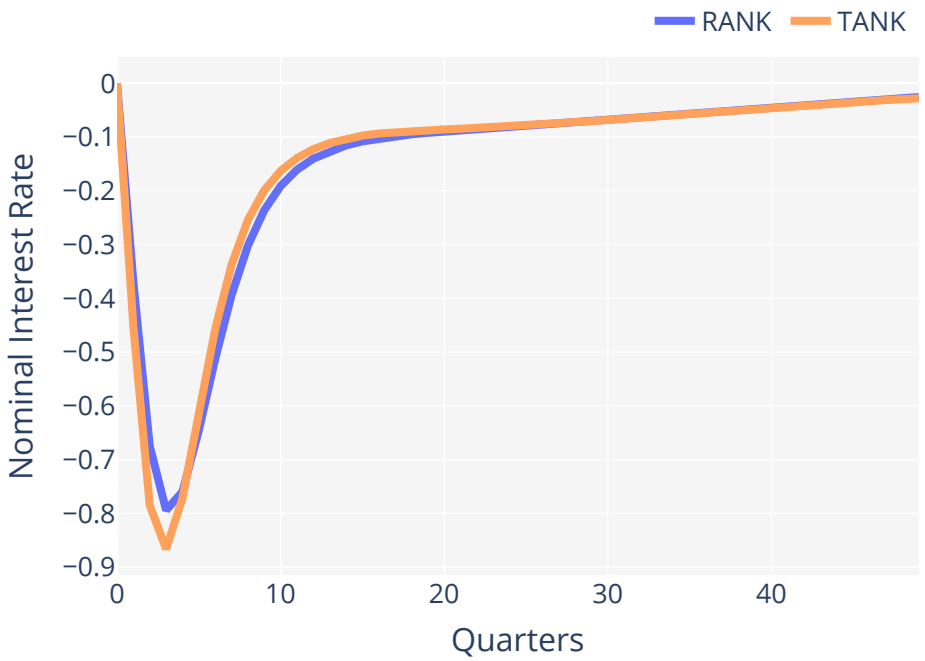
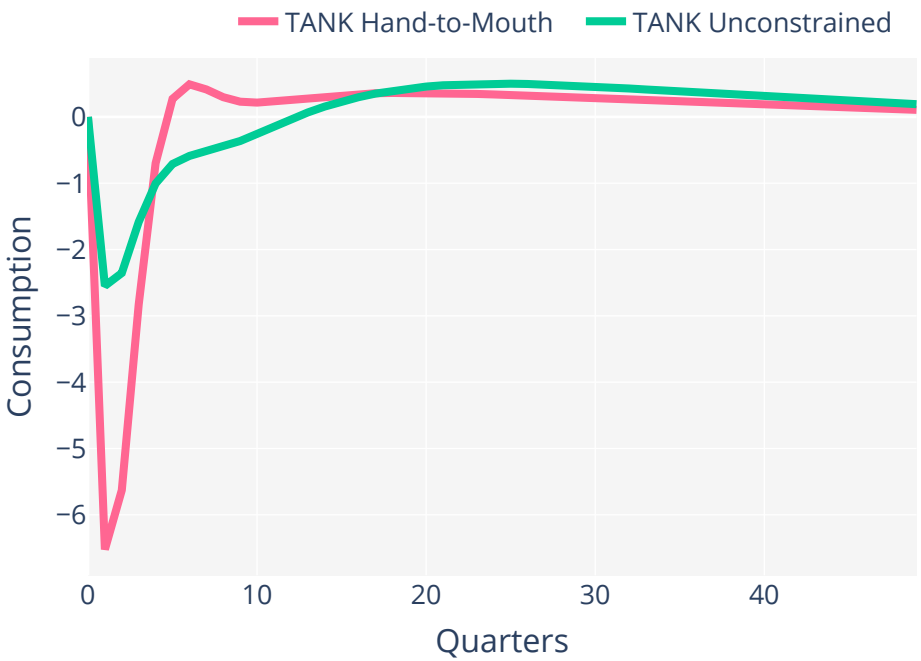
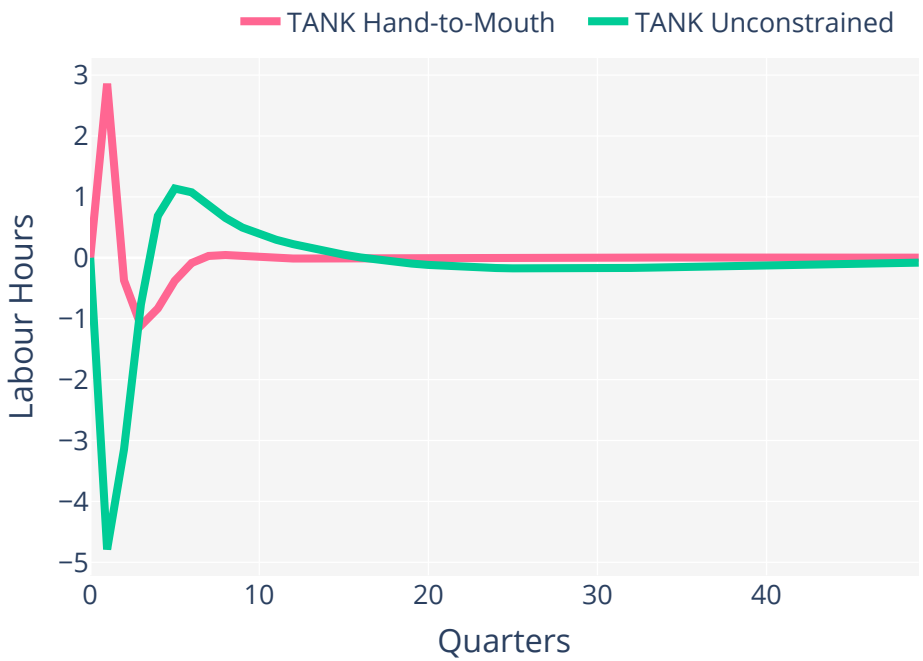


Figure: Individual-Level Responses to a Discount Factor Shock (TANK)

(a) Consumption



(b) Labour Hours

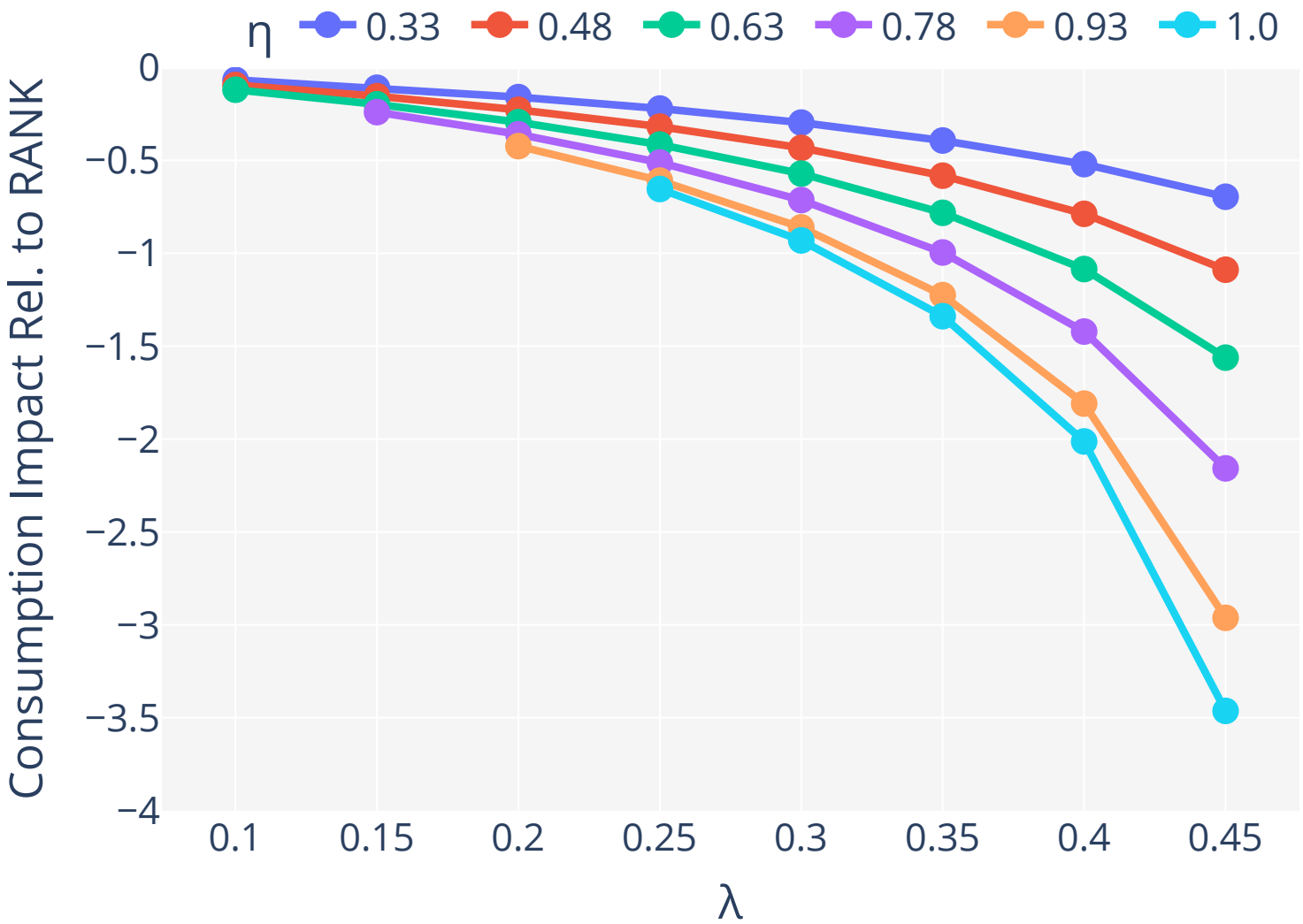


Sensitivity Analysis (I)

- check how the quantitative **relative differences** between RANK and TANK depend on choices of λ and η
- focus on aggregate consumption effects **on impact** after discount factor shock

▸ Go to technology shock

Figure: Aggregate Consumption Response on Impact to a Discount Factor Shock as a Function of λ and η



Sensitivity Analysis (II)

- higher $\lambda \Rightarrow$ stronger impact in TANK relative to RANK for given η
- higher $\eta \Rightarrow$ stronger impact in TANK relative to RANK for given λ

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- **interaction** of high η and λ leads to most pronounced difference
- intuition: together, high λ and high η, imply:

Sensitivity Analysis (II)

- higher $\lambda \Rightarrow$ stronger impact in TANK relative to RANK for given η
- higher $\eta \Rightarrow$ stronger impact in TANK relative to RANK for given λ
- **interaction** of high η and λ leads to most pronounced difference
- intuition: together, high λ and high η, imply:
  - labour market developments matter substantially (many hand-to-mouth)
  - **and** wage changes do not translate as much into changes in hours worked (low elasticity of labour to wages)

Conclusion

– key takeaways of simple RANK vs TANK comparison:

1. responses usually coincide qualitatively
2. for baseline calibration, quantitative differences not too large
3. magnitude of differences depends on λ and η

Conclusion

- key takeaways of simple RANK vs TANK comparison:
  1. responses usually coincide qualitatively
  2. for baseline calibration, quantitative differences not too large
  3. magnitude of differences depends on λ and η
- myriad of possible extensions:
  - include HANK and compare it to RANK & TANK
  - consider fiscal policy and redistribution
  - estimation of key parameters, especially λ and η

Thank you very much for your attention!

Any questions?

References

Boehl, G. (2022). *Econpizza: Solving Nonlinear Heterogeneous Agents Models Using Machine Learning Techniques*. https://econpizza.readthedocs.io/en/latest/index.html

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Galí, J., López-Salido, J. D., & Vallés, J. (2007). Understanding the Effects of Government Spending on Consumption. *Journal of the European Economic Association*, *5*(1), 227–270.

Gust, C., Herbst, E., López-Salido, D., & Smith, M. E. (2012). The Empirical Implications of the Interest-Rate Lower Bound. https://www.federalreserve.gov/econresdata/feds/2012/files/201283r1pap.pdf

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Appendix A: Related Literature ▸ Back

- one of the first papers to do TANK similar to the present model is by Galí et al. (2007)
- seminal paper by Kaplan et al. (2018) on monetary policy transmission in fully-fledged HANK models: direct vs indirect effects of a real interest rate shock
- Debortoli and Galí (2018): prototypical HANK model features three key aspects of heterogeneity; the most important one is the gap in consumption between unconstrained and constrained agents; TANK can replicate this and its aggregate responses are thus close to HANK

Appendix B: Household Budget Constraint

Back

– this is the budget budget constraint of RANK households as well as of unconstrained TANK agents:[1]

$$dd_t + c_t + \tau_t + \frac{\Phi}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2 i_t = w_t n_t + \frac{R_{t-1}}{\pi_t} dd_{t-1} + \ldots \quad (6.1)$$

$$\ldots\left(1 - mc_t - \frac{\psi}{2}\left(\frac{\pi_t}{\tilde{\pi}_{t-1}} - 1\right)^2\right) y_t + \ldots$$

$$\ldots\left(q_t\left(1 - \frac{\Phi}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2 - 1\right) i_t + bprof_t\right.$$

[1] In the latter case, c_t^U and n_t^U replace c_t and n_t, respectively.

Appendix C: The Technology Shock

Back

- technology adheres to:

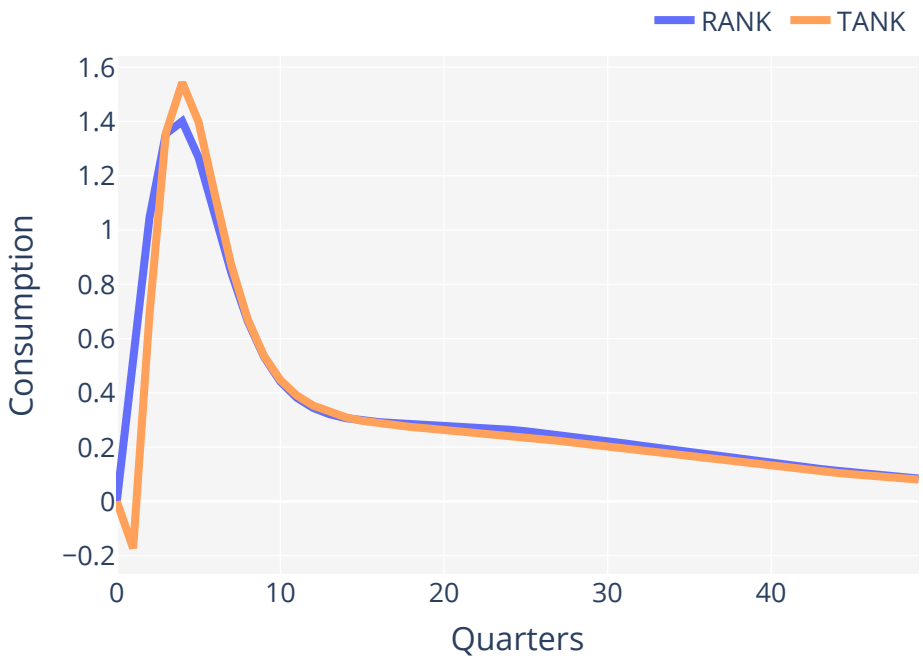
$$z_t = z_{ss}\left(\frac{z_{t-1}}{z_{ss}}\right)^{\rho_z}\exp(\varepsilon_{z,t}) \tag{6.2}$$

where $\varepsilon_{z,t} = 0.02$ in $t = 1$, $z_{ss} = 1$, $\rho_z = 0.8$

- what can one expect to happen?
  - most likely expansion in production, output, consumption as well as drop in labour hours (well-documented fact in NK literature) and inflation (as output does not rise sufficiently due to price adjustment costs), leading to decrease in nominal interest rate
  - in TANK certainly heterogeneous effects as unconstrained households receive higher firm profits and hand-to-mouth suffer from decrease in wages

Figure: Aggregate Responses to a Technology Shock

(a) Consumption



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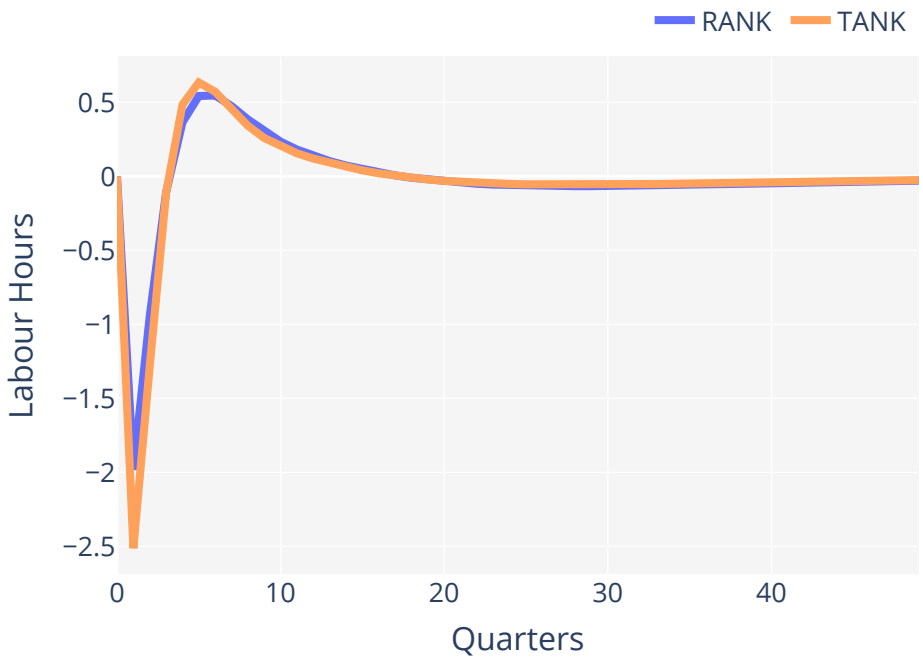

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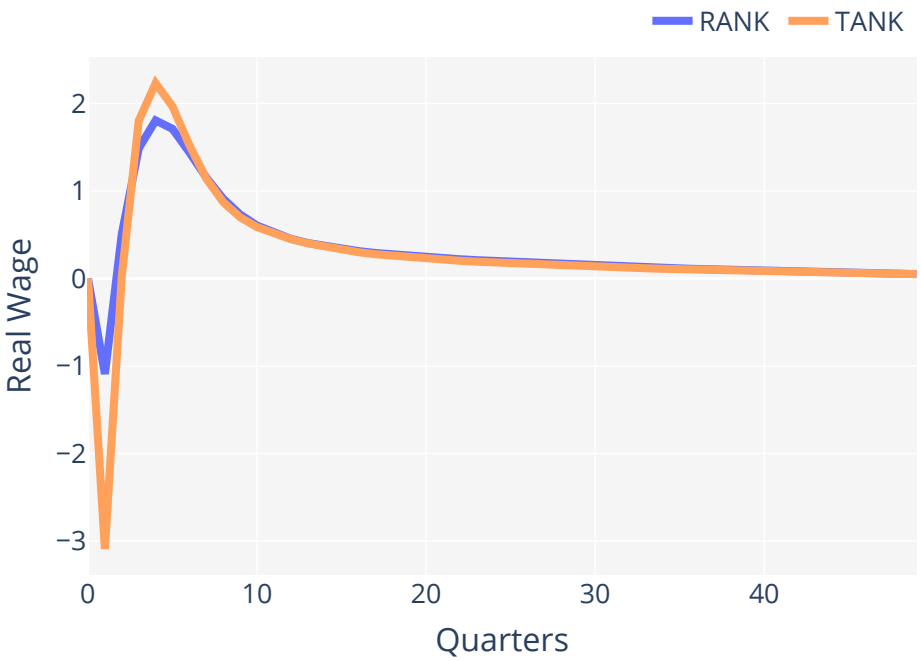

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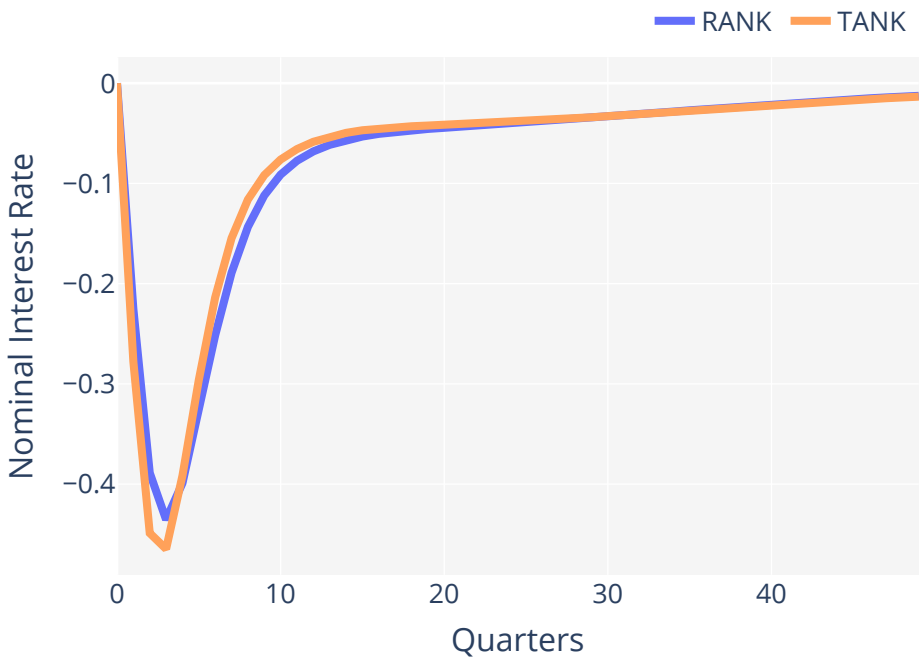

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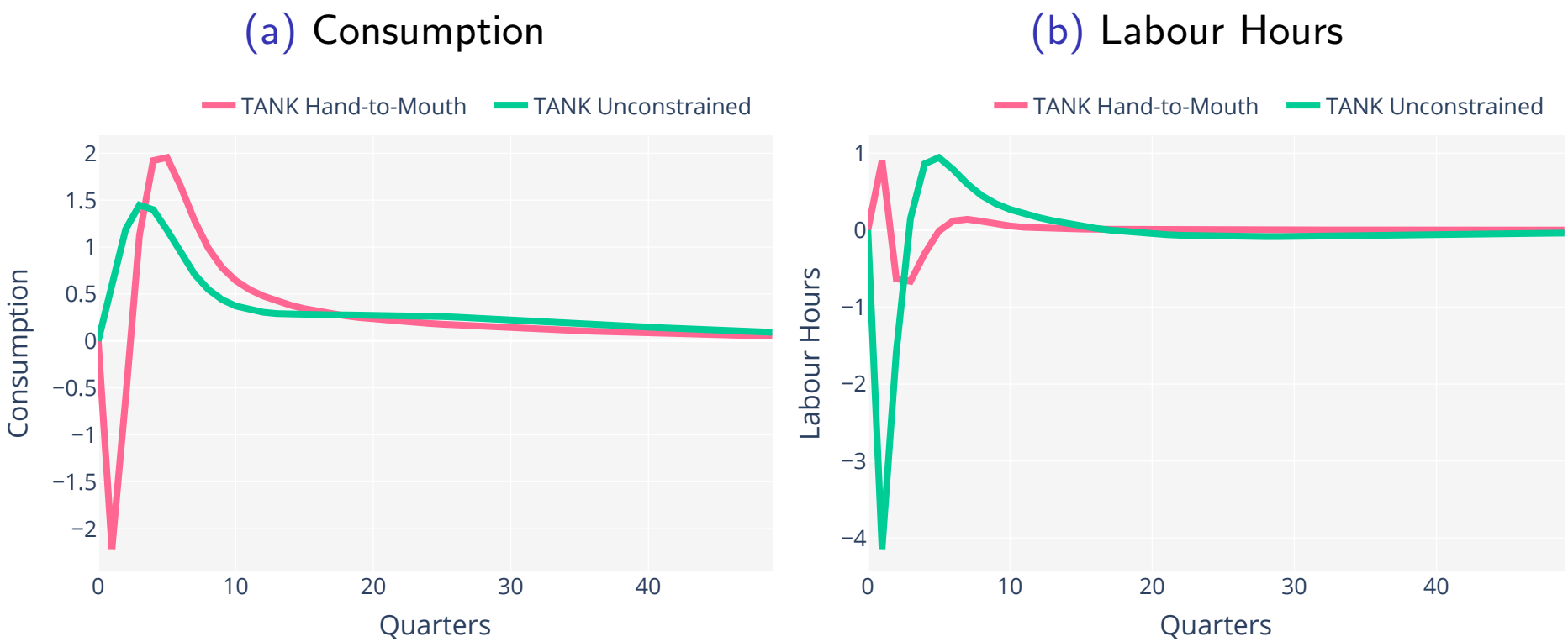

Back

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