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Comparative Analysis of Households and Digital Currencies for the US, China and Russia

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In a two-period decision model, a central bank chooses a CBDC (central bank digital currency) interest rate and a representative household allocates resources into production, consumption, CBDC holding, and non-CBDC holding. The model's analytical results and a plausible benchmark are compared with the empirics for the US, China and Russia. Interesting novelties of the article are that the model predicts that the US in 2021/2022 should choose 7.56% *rather than 0.125% CBDC interest to combat its high October 2021 empirical inflation of 6.2%. That would induce households to hold more CBDC, hold less non-CBDC, and produce and consume less. In contrast, the model predicts that China should choose a low* 2.99% *rather than* 3.85% *CBDC interest rate. That would decrease each household's CBDC holding and increase the low inflation. The model predicts that Russia should choose* 6.82% *rather than* 6.75% *CBDC interest rate. Russia's strategy is remarkably consistent with the model's predictions. The model predicts that the central bank should choose negative CBDC interest rate when the inflation and real interest rate are low, and the inflation target is high. The article shows how extremely high inflation, which increases the CBDC interest rate, makes production and consumption nearly impossible, unless the real interest rate is extremely negative.*

Introduction

Central banks investigate CBDCs (central bank digital currencies) (Boar & Wehrli, 2021; Urbinati et al., 2021), and cryptocurrencies continue to be adopted (Bhimani, Hausken, & Arif, 2022; G. Wang, Zhang, Yu, & Ning, 2021). This article is the second in a series of two articles. The first article, G. Wang and Hausken (2022), builds a decision model with a central bank applying the Taylor (1993) rule and a representative household choosing strategically, and compares with a plausible benchmark solution. This second article compares with the empirics for the US, China and Russia.

This article briefly summarizes the model and results of G. Wang and Hausken (2022). Compared with the benchmark solution in G. Wang and Hausken (2022), the article explores the empirical data of the US, China and Russia. The model recommends that the US in 2021/2022 should choose a CBDC interest rate far above its 0.125% empirical interest rate. The CBDC can be interpreted as money suppy M2 issued by the central bank. China should choose a lower CBDC interest rate than its 3.85% empirical interest rate. Russia should choose a CBDC interest rate slightly above its 6.75% empirical interest rate. The article shows how the central bank should choose negative CBDC interest rate when the inflation and real interest rate are low, and the inflation target is high. The article explores the implications of increased inflation rates. Extremely high inflation, which increases the CBDC interest rate, makes production and consumption nearly impossible, unless the real interest rate is extremely negative.

Negative interest rates have already occurred in Switzerland, Denmark, and Japan (Blanke & Krogstrup, 2016), and may become easier to implement with CBDCs which may potentially enable universal accessibility, flexible policy, confidentiality and privacy and higher transaction efficiencies. Whereas Grasselli and Lipton (2019) find that negative interest rates impact consumption less than investment, this article shows high and positive impact of negative interests on both production and consumption. While Jia (2020) finds that negative interest rates induce agents to consume more and save less, this article finds that agents produce more and

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save more non-CBDC. Both Mooij (2021) and this article find that negative CBDC interest rates may cause the agents to hold more CBDCs.

Just as this article considers the decisions of central banks and households, G. Wang and Hausken (2021) consider a household choosing between a cryptocurrency or a national currency. Welburn and Hausken (2015, 2017) extend beyond these two players, to countries, firms, banks, and financial inter-governmental organizations.

Regarding CBDC design, see Agur, Ari, and Dell'Ariccia (2021). Kiff et al. (2020), Auer and Böhme (2020) and Choi, Henry, Lehar, Reardon, and Safavi-Naini (2021) evaluate retail CBDCs and structured frameworks for CBDC issuance, and Allen et al. (2020) assess capabilities and challenges for CBDCs. H. Wang and Gao (2021) focus more on the types of CBDCs and how they impact regulation and global financial networks, while Lee, Yan, and Wang (2021) assess benefits and risks of CBDCs.

Böser and Gersbach (2020) assess how an interest-bearing CBDC impact bank activities and policy, and Davoodalhosseini (2021) investigates the suitable policy when choosing between cash and a CBDC. Beniak (2019) evaluates how CBDCs may impact policy. Bindseil (2020) and Bindseil and Fabio (2020) assesses benefits and risks of CBDCs. They recommend a two-tier remuneration which enables payment, universal accessibility, possible avoidance of bank disintermediation, and the possibility of negative interest rates.

Article organization

Section 2 presents the model. Section 3 analyzes the model. Section 4 compares the empirical data of the US, China and Russia. Section 5 assesses the impact of high inflation and hyperinflation. Section 6 discusses the results and concludes.

Methodology: The model

In period 1 the central bank uses the Taylor (1993) rule to determine its interest rate

$$I_m = \max\left\{\pi + I_r + a_\pi(\pi - \pi^*) + a_p Log\left(\frac{p^h}{\bar{p}^h}\right), z\right\} \tag{1}$$

where I_r is the equilibrium real interest rate; π is the inflation rate; π^* is the desired inflation rate; p^h is the representative household's production; h is a production parameter; $\bar{p}^h$, is the household's potential production; Log is the logarithm with base ten; a_π is the weight assigned to inflation; $a_p = 1 - a_\pi$ is the weight assigned to production; and z is the negative lower bound on the interest rate I_m.

In period 2 the representative household chooses its production p, consumption c, and CBDC holding m, causing the non-CBDC holding $q = r - ap - c - m$, where r is the household's resources and a is the household's unit production cost. The household's utility is

$$U = p^{h(\alpha - MI_m - QI_q)} c^{\beta - MI_m - QI_q} \big(m(1+I_m)\big)^{\gamma + 2MI_m} \times \big((r - ap - c - m)(1+I_q)\big)^{1-\alpha-\beta-\gamma+2QI_q} \frac{m^\mu (r - ap - c - m)^\eta}{\theta c^\lambda} \tag{2}$$

where α is the household's output elasticity for production p, $0 \le \alpha \le 1$, β is the household's output elasticity for consumption c, $0 \le \lambda \le \beta \le 1$, γ is the household's output elasticity for CBDC m, $0 \le \gamma \le 1$, M is the household's weight of the CBDC interest rate I_m in its output elasticities, Q is the household's weight of the non-CBDC interest rate I_q in its output elasticities, $1 - \alpha - \beta - \gamma + 2QI_q$ is the household's output elasticity for non-CBDC q, $0 \le 1 - \alpha - \beta - \gamma + 2QI_q \le 1$, I_q is the non-CBDC interest rate, μ is the household's transaction efficiency for CBDC m, η is the household's transaction efficiency for non-CBDC q, $\lambda$is the household's transaction efficiency for consumption c, and θ is the scaling or degree or level of the household's transaction cost, $\theta \ge 0$.

Analyzing the model

When $p \ge 0, c \ge 0, m \ge 0, q \ge 0, U \ge 0$, the household's production p, consumption c, CBDC holding m, non-CBDC holding q, and utility U, are

$$\begin{aligned}
p &= \frac{rh(\alpha - MI_m - QI_q)}{a\big(1 - (1-h)(\alpha - MI_m - QI_q) + \eta - \lambda + \mu\big)}, \\
c &= \frac{r(\beta - \lambda - MI_m - QI_q)}{1 - (1-h)(\alpha - MI_m - QI_q) + \eta - \lambda + \mu}, \\
m &= \frac{r(\gamma + 2MI_m + \mu)}{1 - (1-h)(\alpha - MI_m - QI_q) + \eta - \lambda + \mu}, \\
q &= \frac{r(1 - \alpha - \beta - \gamma + \eta + 2QI_q)}{1 - (1-h)(\alpha - MI_m - QI_q) + \eta - \lambda + \mu}, \\
U &= \frac{(1 - \alpha - \beta - \gamma + \eta + 2QI_q)}{\theta(\beta - \lambda - MI_m - QI_q)}(1+I_m)^{\gamma + 2MI_m}(1+I_q)^{1-\alpha-\beta-\gamma+2QI_q}
\end{aligned} \tag{3}$$

$$\times\left(\frac{-rh\left(\alpha-MI_m-QI_q\right)}{a\left(\left(1-h\right)\left(\alpha-MI_m-QI_q\right)-\eta+\lambda-\mu-1\right)}\right)^{h\left(\alpha-MI_m-QI_q\right)}$$
$$\times\left(\frac{-r\left(1-\alpha-\beta-\gamma+\eta+2QI_q\right)}{\left(1-h\right)\left(\alpha-MI_m-QI_q\right)-\eta+\lambda-\mu-1}\right)^{-\alpha-\beta-\gamma+\eta+2QI_q}$$
$$\times\left(\frac{-r\left(\beta-\lambda-MI_m-QI_q\right)}{\left(1-h\right)\left(\alpha-MI_m-QI_q\right)-\eta+\lambda-\mu-1}\right)^{1+\beta-\lambda-MI_m-QI_q}$$
$$\times\left(\frac{-r\left(\gamma+2MI_m+\mu\right)}{\left(1-h\right)\left(\alpha-MI_m-QI_q\right)-\eta+\lambda-\mu-1}\right)^{\gamma+2MI_m+\mu}$$

which are inserted into (1) to give the central bank's CBDC interest rate I_m, i.e.

$$I_m=\max\left\{\pi+I_r+a_\pi(\pi-\pi^*)+a_p hLog\left(\frac{rh\left(\alpha-MI_m-QI_q\right)}{a\left(1-\left(1-h\right)\left(\alpha-MI_m-QI_q\right)+\eta-\lambda+\mu\right)\bar{p}}\right),z\right\} \tag{4}$$

Proof. See G. Wang and Hausken (2022). ■

Figure 1 is plotted in G. Wang and Hausken (2022).

Figure 1. See G. Wang and Hausken (2022).
Figure 2 is plotted in G. Wang and Hausken (2022).

Figure 2. See G. Wang and Hausken (2022).

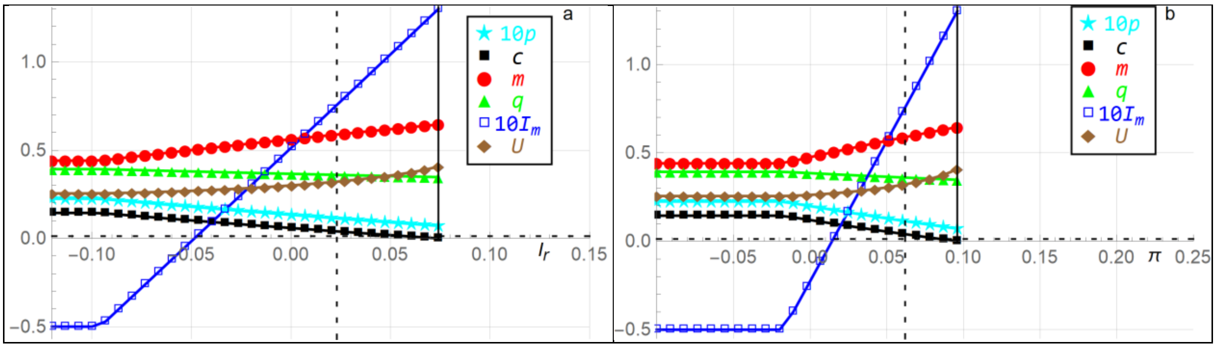
Comparing the US, China and Russia

The US

The Federal Open Market Committee (2021) maintained the target range for the federal funds rate (refers to CBDC interest rate I_m) at $0\% - 0.25\%$ on September 22, 2021. We choose the midpoint of this range, that is $I_m = 0.125\%$. The US real interest rate was $I_r = 2.305\%$ in 2020 (The World Bank, 2021c). The US annual inflation rate was $\pi = 6.2\%$ for the 12 months ending October 31, 2021 (The US Labor Department, 2021). The Federal Open Market Committee (2021) seeks to achieve an average target inflation rate at $\pi^* = 2\%$ in the long-run. Table 1 summarizes these numbers.

Table 1: Empirical CBDC interest rate I_m, model CBDC interest rate I_m, empirical equilibrium real interest rate I_r, empirical inflation rate π, and empirical desired or target inflation rate π^*, for the US, China and Russia.

Parameters	The US	China	Russia
Empirical CBDC interest rate I_m	0.125%	3.85%	6.75%
Model CBDC interest rate I_m	7.56%	2.99%	6.82%
Empirical real interest rate I_r	2.305%	3.6535 %	5.83%
Empirical inflation rate π	6.2%	2.419%	3.382%
Empirical target inflation rate π^*	2%	3%	4%



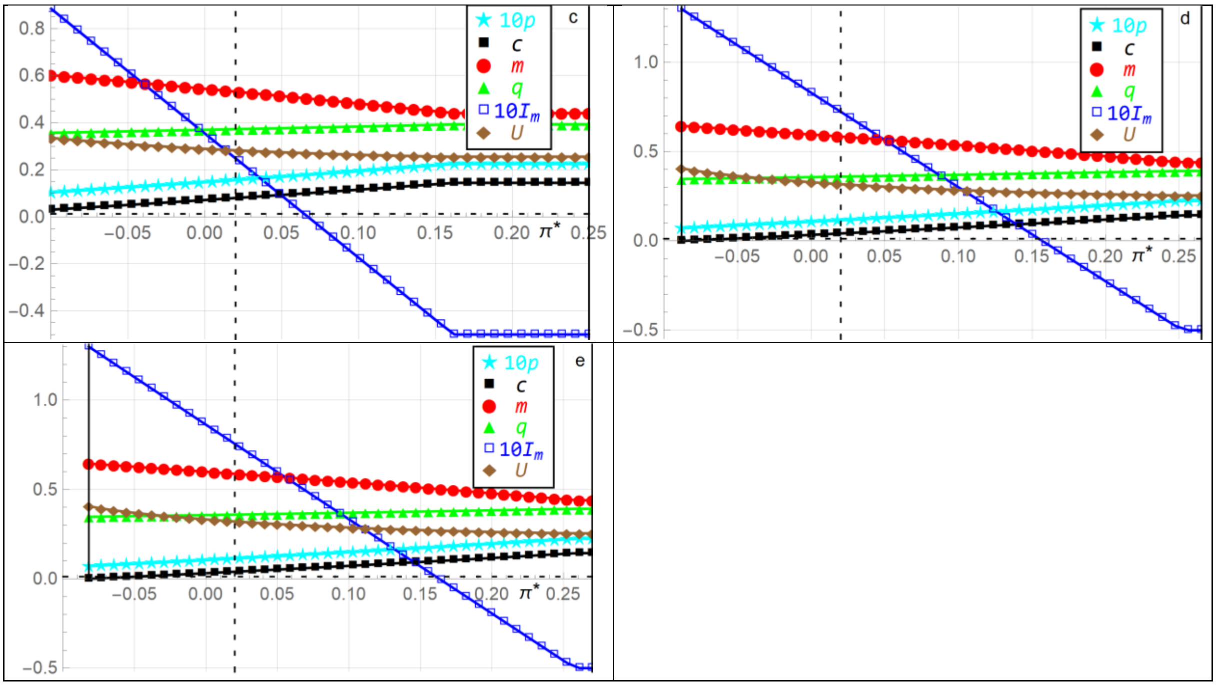


Figure 3: The household's production p, consumption c, CBDC holding m, non-CBDC holding q, utility U, and the CBDC interest rate I_m for the US, as functions of the real interest rate I_r, inflation rate π, and target inflation rate π^*, respectively, relative to the benchmark parameter values $\alpha = \beta = \gamma = \frac{1}{4}, r = a = M = Q = 1, I_q = 2\%, I_r = 2.305\%, \eta = \frac{1}{5}, \mu = \frac{2}{5}, \lambda = \frac{1}{10}, \pi = 6.2\%, \pi^* = 2\%, h = \frac{1}{10}, \bar{p} = \frac{1}{2}, a_\pi = a_p = \frac{1}{2}, z = -5\%$. Multiplication of p and I_m with 10 is for scaling purposes.

Figure 3a plots p, c, m, q, U, I_m as functions of the real interest rate I_r when the inflation rate $\pi = 6.2\%$, which is higher than $\pi = 3\%$ in Figure 1. All the other parameter values are as the benchmarks in Figure 1. The household's consumption c decreases to $c = 0$ when $I_r > 7.4\%$, which is lower than $I_r > 12.21\%$ in Figure 1n. The higher inflation rate $\pi = 6.2\% > 3\%$ decreases consumption c in Figure 3a. Compared to Figure 1n, in Figure 3a the household chooses lower consumption c, lower production p, and holds less non-CBDC q. The household holds more CBDC m and earns higher utility U. The CBDC interest rate I_m becomes negative when $I_r < -4.85\%$, which is lower than $I_r < 0.00\%$ in Figure 1n. The model thus predicts a higher CBDC interest rate I_m when the inflation rate is $\pi = 6.2\%$ in Figure 3a compared to $\pi = 3\%$ in Figure 1n. That follows from the logic of the Taylor (1993) rule in (4). The central bank combats high inflation rate $\pi = 6.2\%$ by increasing its CBDC interest rate I_m, to make saving in the form of holding CBDC m more attractive than consumption c, which is lower in Figure 3a than in Figure 1n. Mathematically, high inflation $\pi = 6.2\%$ on the right hand side in (4) causes high CBDC interest rate I_m on the left hand side in (4). For example, the CBDC interest rate is $I_m = 7.56\%$ at the benchmark $I_r = 2.305\%$ in Figure 3a, which is higher than $I_m = 2.48\%$ when $I_r = 2.305\%$ in Figure 1n, and much higher than the empirical $I_m = 0.125\%$ in Table 1. That seems remarkable. The model and the Taylor (1993) rule predict that the US CBDC interest rate I_m should be substantially higher, $I_m = 7.56\%$, than the empirical $I_m = 0.125\%$, in order to induce holding more CBDC m, and suppress the high inflation $\pi = 6.2\%$.

Figure 3b plots p, c, m, q, U, I_m as functions of the inflation rate π, when the real interest rate $I_r = 2.305\%$, which is higher than $I_r = 2\%$ in Figure 1. All the other parameter values are as the benchmarks in Figure 1. The household's consumption c decreases to $c = 0$ when $I_r > 9.60\%$, which is slightly lower than $I_r > 9.80\%$ in Figure 1o. The CBDC interest rate I_m becomes negative when $\pi < 1.43\%$, which is lower than $\pi < 1.63\%$ in Figure 1o. Hence the higher real interest rate $I_r = 2.305\%$ decreases the consumption c and increases the CBDC interest rate I_m. The CBDC interest rate is $I_m = 7.56\%$ at the benchmark $\pi = 6.2\%$, which is higher than $I_m = 7.24\%$ when $\pi = 6.2\%$ in Figure 1o. Both these I_m are substantially higher than I_m =0.125% in Table 1.

Figure 3c plots p, c, m, q, U, I_m as functions of the target inflation rate π^* for the same real interest rate $I_r = 2.305\%$, which is higher than $I_r = 2\%$ in Figure 1. All the other parameter values are as the benchmarks in Figure 1. The CBDC interest rate I_m becomes negative when $\pi^* > 6.71\%$, which is higher than $\pi^* > 6.10\%$ in Figure 1p. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 16.19\%$, which is higher than $\pi^* > 15.58\%$ in Figure 1p. Hence the higher real interest rate $I_r = 2.305\%$ increases the target inflation rate π^* and the CBDC interest rate I_m. The CBDC interest rate is $I_m = 2.48\%$ at the benchmark $\pi^* = 2\%$, which is higher than $I_m = 0.125\%$ in Table 1, and also higher than $I_m = 2.00\%$ in Figure 1p when $\pi^* = 2\%$.

Figure 3d plots p, c, m, q, U, I_m as functions of the target inflation rate π^*, when the inflation rate is $\pi = 6.2\%$, which is higher than $\pi = 3\%$ in Figure 1. All the other parameter values are as the benchmarks in Figure 1. The CBDC interest rate I_m becomes negative when $\pi^* > 15.70\%$, which is much higher than $\pi^* > 6.10\%$ in Figure 1p. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 25.18\%$, which is much higher than $\pi^* > 15.58\%$ in Figure 1p. Hence the higher inflation rate $\pi = 6.2\%$ greatly increases the target inflation rate π^* and the CBDC interest rate I_m. The CBDC interest rate is $I_m = 7.24\%$ at the benchmark $\pi^* = 2\%$, which is much higher than $I_m = 0.125\%$ in Table 1, and also higher than $I_m = 2.00\%$ in Figure 1p when $\pi^* = 2\%$.

Figure 3e plots p, c, m, q, U, I_m as functions of the target inflation rate π^*, when the real interest rate is $I_r = 2.305\%$ and the inflation rate is $\pi = 6.2\%$. All the other parameter values are as the benchmarks in Figure 1. It is the combination of Figure 3c and Figure 3d. The CBDC interest rate I_m becomes negative when $\pi^* > 16.31\%$, which is much higher than $\pi^* > 6.10\%$ in Figure 1p. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 25.79\%$, which is much higher than $\pi^* > 15.58\%$ in Figure 1p. Hence the higher inflation rate is $\pi = 6.2\%$ and the higher real interest rate $I_r = 2.305\%$ greatly increases the target inflation rate π^* and the CBDC interest rate I_m. The CBDC interest rate is $I_m = 7.56\%$ at the benchmark $\pi^* = 2\%$, which is much higher than $I_m = 0.125\%$ in Table 1, and also higher than $I_m = 2.00\%$ in Figure 1p when $\pi^* = 2\%$.

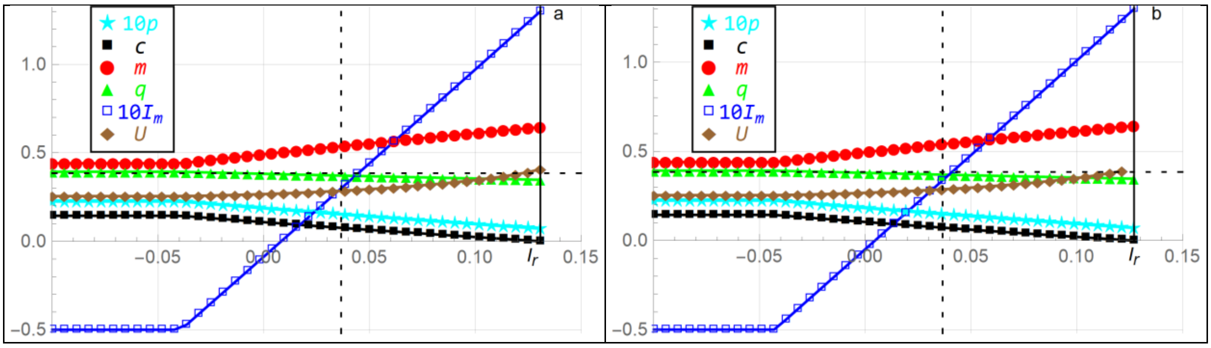
The empirical US inflation rate $\pi = 6.2\%$ is much higher than the empirical CBDC interest rate $I_m = 0.125\%$. Thus, the gap between the predicted CBDC interest rate I_m and the US empirical CBDC interest rate I_m is large, at the real interest rate benchmark I_r and the target inflation benchmark π^*. The model predicts that the US CBDC interest rate I_m should be substantially higher than $I_m = 0.125\%$. The higher real interest rate I_r decreases the consumption c, increases the CBDC interest rate I_m, and increases the target inflation rate π^*. The higher inflation rate increases the target inflation rate π^* and increases the CBDC interest rate I_m.

Table 2: Interpretation of Figure 3 for the US compared to Figure 1.

The US	Changed parameter values from the benchmark in Figure 1	c decreases to zero when	c, p, m, q reach constant values when	I_m becomes negative when	I_m at the benchmark
Figure 3a	$\pi = 6.2\%$	$I_r > 7.4\%$	$I_r < -9.59\%$	$I_r < -4.85\%$	$I_m = 7.56\%$ at $I_r = 2.305\%$
Figure 3b	$I_r = 2.305\%$	$\pi > 9.60\%$	$\pi < -1.73\%$	$\pi < 1.43\%$	$I_m = 7.56\%$ at $\pi = 6.2\%$
Figure 3c	$I_r = 2.305\%$	$\pi^* < -17.80\%$	$\pi^* > 16.19\%$	$\pi^* > 6.71\%$	$I_m = 2.48\%$ at $\pi^* = 2\%$
Figure 3d	$\pi = 6.2\%$	$\pi^* < -8.81\%$	$\pi^* > 25.18\%$	$\pi^* > 15.70\%$	$I_m = 7.24\%$ at $\pi^* = 2\%$
Figure 3e	$I_r = 2.305\%$ $\pi = 6.2\%$	$\pi^* < -8.20\%$	$\pi^* > 25.79\%$	$\pi^* > 16.31\%$	$I_m = 7.56\%$ at $\pi^* = 2\%$
Figure 1n	$I_r = 2\%$	$I_r > 12.21\%$	$I_r < -4.79\%$	$I_r < 0.00\%$	$I_m = 2.48\%$ at $I_r = 2.305\%$
Figure 1o	$\pi = 3\%$	$I_r > 9.80\%$	$I_r < -1.53\%$	$\pi < 1.63\%$	$I_m = 7.24\%$ at $\pi = 6.2\%$
Figure 1p	$\pi^* = 2\%$	$\pi^* < -18.41\%$	$\pi^* > 15.58\%$	$\pi^* > 6.10\%$	$I_m = 2.00\%$ at $\pi^* = 2\%$

China

The People's Bank of China kept its interest rate unchanged since October 2015. The China interest rate has on average been I_m =3.85% over the last year (Gang, 2021). The China real interest rate is $I_r = 3.6535$ % in 2020, the China annual inflation rate is $\pi = 2.419\%$, according to the World Bank (The World Bank, 2021a). The State Council of China (2020) set the inflation target $\pi^* = 3\%$ for the year 2021, just as in 2020.



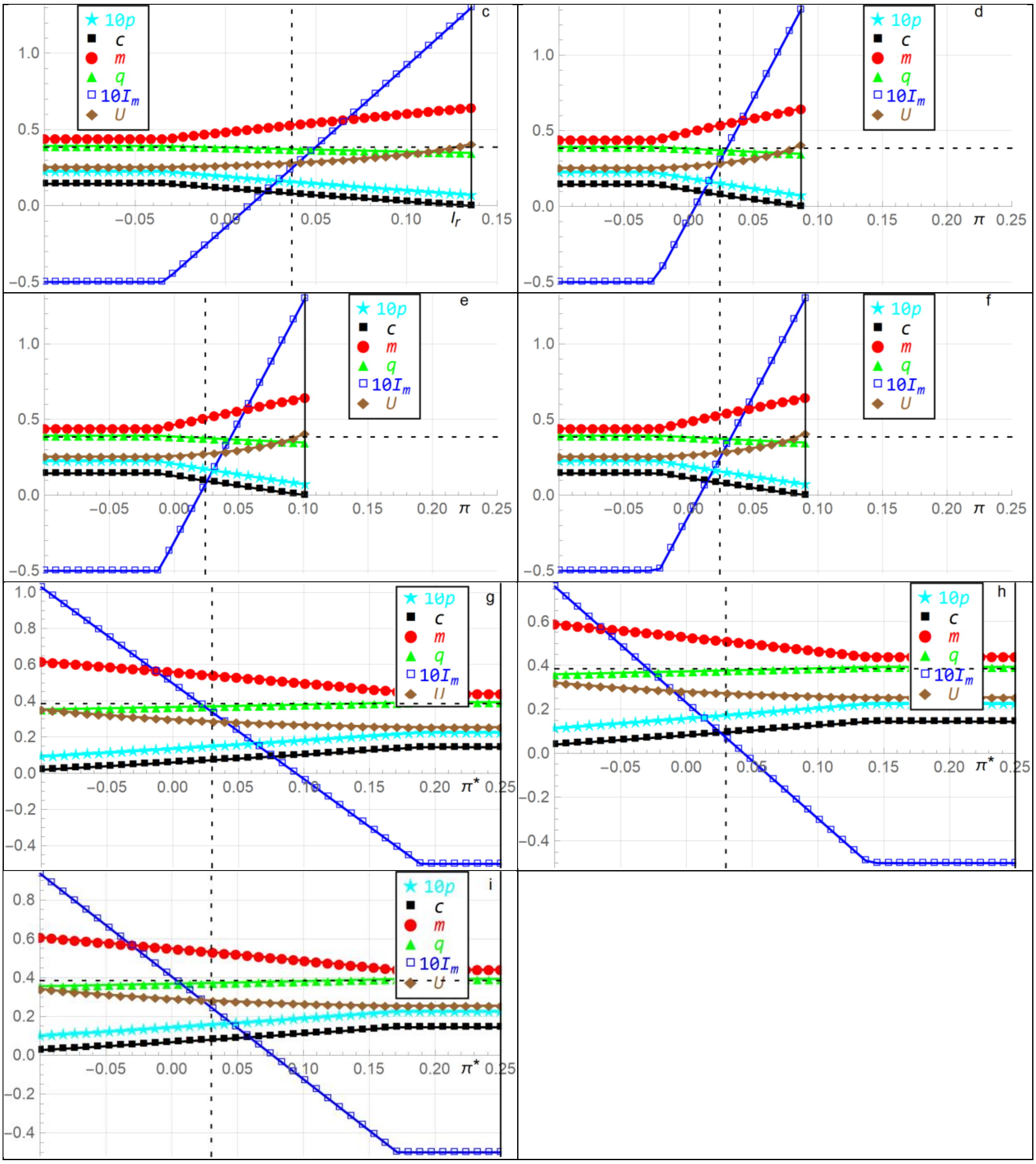


Figure 4: The household's production p, consumption c, CBDC holding m, non-CBDC holding q, utility U, and the CBDC interest rate I_m for China, as functions of the real interest rate I_r, inflation rate π, and target inflation rate π^*, respectively, relative to the benchmark parameter values $\alpha = \beta = \gamma = \frac{1}{4}, r = a = M = Q = 1, I_q = 2\%, I_r = 3.6535\%, \eta = \frac{1}{5}, \mu = \frac{2}{5}, \lambda = \frac{1}{10}, \pi = 2.419\%, \pi^* = 3\%, h = \frac{1}{10}, \bar{p} = \frac{1}{2}, a_\pi = a_p = \frac{1}{2}, z = -5\%$. Multiplication of p and I_m with 10 is for scaling purposes.

Figure 4a plots p, c, m, q, U, I_m as functions of the real interest rate I_r, when the inflation rate $\pi = 2.419\%$, which is lower than $\pi = 3\%$ in Figure 1. All the other parameter values are as the benchmark in Figure 1. The household's consumption c decreases to $c = 0$ when $I_r > 13.08\%$, which is slightly higher than $I_r > 12.21\%$ in Figure 1n. The lower inflation rate $\pi = 2.419\% < 3\%$ increases slightly the consumption c in Figure 4a compared to Figure 1n, in contrast to the decreased consumption c in Figure 3a for the US. Compared to Figure 1n in Figure 4a, the household chooses higher consumption c, higher production p, and holds more non-CBDC q, in contrast to Figure 3a for the US. The household holds less CBDC m and earns lower utility U, also in contrast to Figure 3 for the US. The CBDC interest rate I_m becomes negative when $I_r < 0.82\%$ which is higher than $I_r < 0.00\%$ in Figure 1n, and much higher than $I_r < -4.85\%$ in Figure 3a for the US. The model thus predicts a lower CBDC interest rate I_m when the inflation rate is $\pi = 2.419\%$ in Figure 4a compared to $\pi = 3\%$ in Figure 1n. That follows from the logic of the Taylor (1993) rule in (4). The central bank responds to low inflation rate $\pi = 2.419\%$ by decreasing its CBDC interest rate I_m, to make saving in the form of holding CBDC m less attractive than consumption c, which is higher in Figure 4a than in Figure 1n. Mathematically, low inflation $\pi = 2.419\%$ on the right hand side in (4) causes low CBDC interest rate I_m on the left hand side in (4). For example, the CBDC interest rate is $I_m = 2.99\%$ at the benchmark $I_r = 3.6535\%$ in Figure 4a, which is lower than $I_m = 3.91\%$ when $I_r = 3.6535\%$ in Figure 1n, and also lower than the empirical $I_m = 3.85\%$ in Table 1. The model predicts partly in accordance with the empirics. The model and the Taylor (1993) rule predict that China's CBDC interest rate I_m should be lower, $I_m = 2.99\%$, than the empirical $I_m = 3.85\%$, in order to induce holding less CBDC m, and increase the low inflation rate $\pi = 2.419\%$ towards its target $\pi^* = 3\%$.

Figure 4b plots p, c, m, q, U, I_m as functions of the real interest rate I_r, when the target inflation rate $\pi^* = 3\%$, which is higher than $\pi^* = 2\%$ in Figure 1. All the other parameter values are as the benchmark in Figure 1. The household's consumption c decreases to $c = 0$ when $I_r > 12.71\%$, which is higher than $I_r > 12.21\%$ in Figure 1n. The CBDC interest rate I_m becomes negative when $I_r < 0.45\%$, which is higher than $I_r < 0.00\%$ in Figure 1n. Hence the higher target inflation rate $\pi^* = 3\%$ increases the consumption c and correspondingly decreases the CBDC interest rate I_m. Both of these are in contrast to the US in Figure 3b. Accordingly, the CBDC interest rate is $I_m = 3.38\%$ at the benchmark $I_r = 3.6535\%$, which is lower than $I_m = 3.91\%$ when $I_r = 3.6535\%$ in Figure 1n, and lower than $I_m = 3.85\%$ in Table 1.

Figure 4c plots p, c, m, q, U, I_m as functions of the real interest rate I_r,when the inflation rate $\pi = 2.419\%$ and the target inflation rate $\pi^* = 3\%$, thus combining the assumptions for Figure 4a and Figure 4b. All the other parameter values are as the benchmark in Figure 1. The consumption c decreases and the CBDC interest rate I_m increases. More specifically, the household's consumption c decreases to $c = 0$ when $I_r > 13.58\%$, which is higher than $I_r > 12.21\%$ in Figure 1n. The CBDC interest rate I_m becomes negative when $I_r < 1.32\%$, which is higher than $I_r < 0.00\%$ in Figure 1n. The CBDC interest rate is $I_m = 2.46\%$ at the benchmark $I_r = 3.6535\%$, which is lower than $I_m = 3.91\%$ when $I_r = 3.6535\%$ in Figure 1n, and also lower than 3.85% in Table 1.

Figure 4d plots p, c, m, q, U, I_m as functions of the inflation rate π, when the real interest rate $I_r = 3.6535\%$, which is higher than $I_r = 2\%$ in Figure 1. All the other parameter values are as the benchmark in Figure 1. The household's consumption c decreases to $c = 0$ when $\pi > 8.70\%$, which is lower than $\pi > 9.80\%$ in Figure 1o. The CBDC interest rate I_m becomes negative when $\pi < 0.53\%$, which is lower than $\pi < 1.63\%$ in Figure 1o. Hence the higher real interest rate $I_r = 3.6535\%$ decreases the consumption c and correspondingly increases the CBDC interest rate I_m. The CBDC interest rate is $I_m = 2.99\%$ at the benchmark $\pi = 2.419\%$, which is higher than $I_m = 1.24\%$ when $\pi = 2.419\%$ in Figure 1o, but lower than $I_m = 3.85\%$ in Table 1. Hence China empirically chooses a higher CBDC interest rate $I_m = 3.85\%$ than $I_m = 2.99\%$ predicted by the model, which is the opposite of what the US does.

Figure 4e plots p, c, m, q, U, I_m, as functions of the inflation rate π, when the target inflation rate $\pi^* = 3\%$, which is higher than $\pi^* = 2\%$ in Figure 1. All the other parameter values are as the benchmark in Figure 1. The household's consumption c decreases to $c = 0$ when $\pi > 10.14\%$, which is higher than $\pi > 9.80\%$ in Figure 1o. The CBDC interest rate I_m becomes negative when $\pi < 1.97\%$, which is higher than $\pi < 1.63\%$ in Figure 1o. Hence the higher target inflation rate $\pi^* = 3\%$ increases the consumption c and correspondingly decreases the CBDC interest rate I_m. The CBDC interest rate is $I_m = 0.71\%$ at the benchmark $\pi = 2.419\%$, which is lower than $I_m = 1.24\%$ when $\pi = 2.419\%$ in Figure 1o, and also lower than 3.85% in Table 1. Again, China empirically chooses a higher CBDC interest rate $I_m = 3.85\%$ than $I_m = 0.71\%$ predicted by the model, which is the opposite of what the US does.

Figure 4f plots p, c, m, q, U, I_m, as functions of the inflation rate π, when the real interest rate $I_r = 3.6535\%$ and the target inflation rate $\pi^* = 3\%$, thus combining the assumptions for Figure 4d and Figure 4e. All the other parameter values are as the benchmark in Figure 1. The household's consumption c decreases to $c = 0$ when $\pi > 9.03\%$, which is lower than $\pi > 9.80\%$ in Figure 1o. The CBDC interest rate I_m becomes negative when $\pi < 0.87\%$, which is lower than $\pi < 1.63\%$ in Figure 1o. Hence $I_r = 3.6535\%$ and $\pi^* = 3\%$ increase the consumption c and correspondingly decreases the CBDC interest rate I_m. The results are intermediate between those of Figure 4d and Figure 4e which pull in opposite directions. More specifically, the CBDC interest rate is $I_m = 2.46\%$ at the benchmark $\pi = 2.419\%$, which is higher than $I_m = 1.24\%$ when $\pi = 2.419\%$ in Figure 1o, and lower than 3.85% in Table 1.

Figure 4g plots p, c, m, q, U, I_m, as functions of the target inflation rate π^*, when the real interest rate $I_r = 3.6535\%$, which is higher than $I_r = 2\%$ in Figure 1. All the other parameter values are as the benchmark in Figure 1. The CBDC interest rate I_m becomes negative when $\pi^* > 9.40\%$, which is higher than $\pi^* > 6.10\%$ in Figure 1p. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 18.89\%$, which is higher than $\pi^* > 15.58\%$ in Figure 1p. The CBDC interest rate is $I_m = 3.38\%$ at the benchmark $\pi^* = 3\%$, which is higher than $I_m = 1.63\%$ when $\pi^* = 3\%$ in Figure 1p, but lower than 3.85% in Table 1. Thus, the higher real interest rate $I_r = 3.6535\%$ increases the target inflation rate π^*, but decreases the CBDC interest rate I_m, which is contrary to the US.

Figure 4h plots p, c, m, q, U, I_m, as functions of the target inflation rate π^*, when the inflation rate $\pi = 2.419\%$, which is lower than $\pi = 3\%$ in Figure 1. All the other parameter values are as the benchmark in Figure 1. The CBDC interest rate I_m becomes negative when $\pi^* > 4.35\%$, which is lower than $\pi^* > 6.10\%$ in Figure 1p. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 13.84\%$, which is lower than $\pi^* > 15.58\%$ in Figure 1p. The CBDC interest rate is $I_m = 0.71\%$ at the benchmark $\pi^* = 3\%$, which is lower than $I_m = 1.63\%$ when $\pi^* = 3\%$ in Figure 1p, and much lower than 3.85% in Table 1. The lower inflation rate $\pi = 2.419\%$ decreases the CBDC interest rate I_m, and decreases the target inflation rate π^*.

Figure 4i plots p, c, m, q, U, I_m, as functions of the target inflation rate π^*, when the real interest rate $I_r = 3.6535\%$ and the inflation rate $\pi = 2.419\%$, thus combining the assumptions for Figure 4g and Figure 4h. All the other parameter values are as the benchmark in Figure 1. The CBDC interest rate I_m becomes negative when $\pi^* > 7.66\%$, which is higher than $\pi^* > 6.10\%$ in Figure 1p. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 17.15\%$, which is higher than $\pi^* > 15.58\%$ in Figure 1p. The CBDC interest rate is $I_m = 2.46\%$ at the benchmark $\pi^* = 3\%$, which is higher than $I_m = 1.63\%$ when $\pi^* = 3\%$ in Figure 1p, but lower than 3.85% in Table 1. Thus, the real interest rate $I_r = 3.6535\%$ combined with the lower inflation rate $\pi = 2.419\%$, increase target inflation rate π^* and decrease the CBDC interest rate I_m.

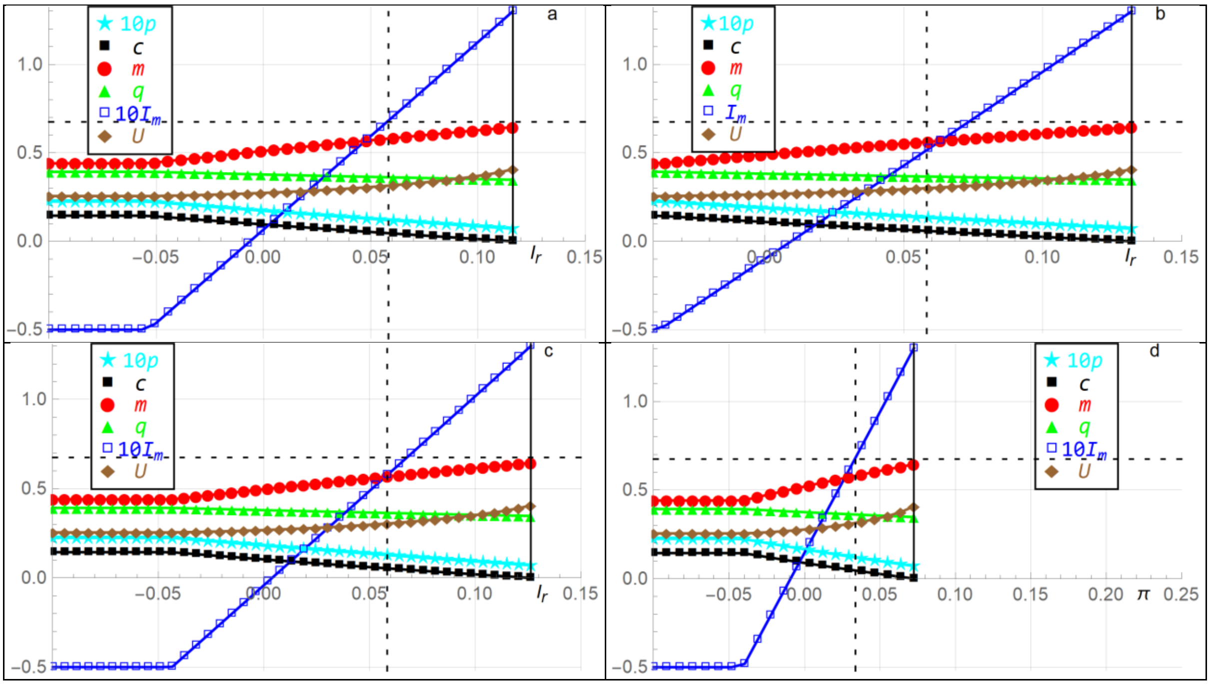
The gap between the empirical inflation rate $\pi = 2.419\%$ and the empirical CBDC interest rate $I_m = 3.6535\%$ is much lower for China than for the US. The model predicts that China's CBDC interest rate I_m should be slightly lower. China empirically chooses a higher CBDC interest rate I_m predicted by the model, which is contrary to the US. The higher real interest rate increases the target inflation rate π^*, but decreases the CBDC interest rate I_m. The higher target inflation rate π^* increases the consumption c and decreases the CBDC interest rate I_m. The lower inflation rate π decreases the CBDC interest rate I_m, and decreases the target inflation rate π^*.

Table 3: Interpretation of Figure 4 for China compared to Figure 1.

China	Changed parameter values from the benchmark in Figure 1	c decreases to zero when	c, p, m, q reach constant values when	I_m becomes negative when	I_m at the benchmark
Figure 4a	$\pi = 2.419\%$	$I_r > 13.08\%$	$I_r < -3.92\%$	$I_r < 0.82\%$	$I_m = 2.99\%$ at $I_r = 3.6535\%$
Figure 4b	$\pi^* = 3\%$	$I_r > 12.71\%$	$I_r < -4.29\%$	$I_r < 0.45\%$	$I_m = 3.38\%$ at $I_r = 3.6535\%$
Figure 4c	$\pi = 2.419\%$ $\pi^* = 3\%$	$I_r > 13.58\%$	$I_r < -3.42\%$	$I_r < 1.32\%$	$I_m = 2.46\%$ at $I_r = 3.6535\%$
Figure 4d	$I_r = 3.6535\%$	$\pi > 8.70\%$	$\pi < -2.63\%$	$\pi < 0.53\%$	$I_m = 2.99\%$ at $\pi = 2.419\%$
Figure 4e	$\pi^* = 3\%$	$\pi > 10.14\%$	$\pi < -1.19\%$	$\pi < 1.97\%$	$I_m = 0.71\%$ at $\pi = 2.419\%$
Figure 4f	$I_r = 3.6535\%$ $\pi^* = 3\%$	$\pi > 9.03\%$	$\pi < -2.3\%$	$\pi < 0.87\%$	$I_m = 2.46\%$ at $\pi = 2.419\%$
Figure 4g	$I_r = 3.6535\%$	$\pi^* < -15.1\%$	$\pi^* > 18.89\%$	$\pi^* > 9.40\%$	$I_m = 3.38\%$ at $\pi^* = 3\%$
Figure 4h	$\pi = 2.419\%$	$\pi^* < -20.15\%$	$\pi^* > 13.84\%$	$\pi^* > 4.35\%$	$I_m = 0.71\%$ at $\pi^* = 3\%$
Figure 4 i	$I_r = 3.6535\%$ $\pi = 2.419\%$	$\pi^* < -16.85\%$	$\pi^* > 17.15\%$	$\pi^* > 7.66\%$	$I_m = 2.46\%$ at $\pi^* = 3\%$
Figure 1n	$I_r = 2\%$	$I_r > 12.21\%$	$I_r < -4.79\%$	$I_r < 0.00\%$	$I_m = 3.91\%$ at $I_r = 3.6535\%$
Figure 1o	$\pi = 3\%$	$I_r > 9.80\%$	$I_r < -1.53\%$	$\pi < 1.63\%$	$I_m = 1.24\%$ at $\pi = 2.419\%$
Figure 1p	$\pi^* = 2\%$	$\pi^* < -18.41\%$	$\pi^* > 15.58\%$	$\pi^* > 6.10\%$	$I_m = 1.63\%$ at $\pi^* = 3\%$

Russia

The Bank of Russia (2021) set its interest rate to $I_m = 6.75\%$ September 10, 2021. Russia's real interest rate is $I_r = 5.83\%$ in 2020 and its annual inflation rate is $\pi = 3.382\%$ (The World Bank, 2021b). The Bank of Russia (2021) set its inflation target rate $\pi^* = 4\%$.



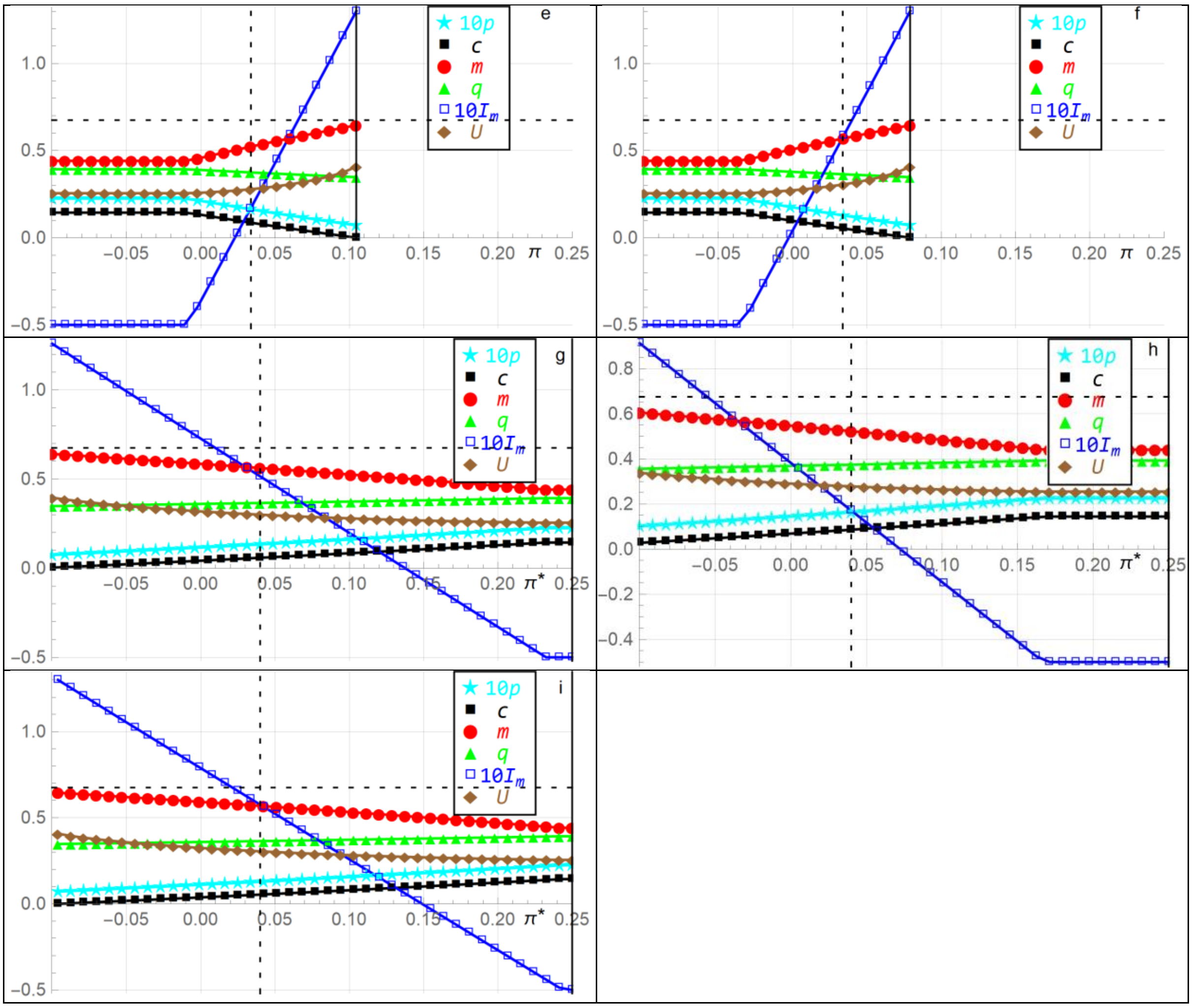


Figure 5: The household's production p, consumption c, CBDC holding m, non-CBDC holding q, utility U, and the CBDC interest rate I_m for Russia, as functions of the real interest rate I_r, inflation rate π, and target inflation rate π^*, respectively, relative to the benchmark parameter values $\alpha = \beta = \gamma = \frac{1}{4}, r = a = M = Q = 1, I_q = 2\%, I_r = 5.83\%, \eta = \frac{1}{5}, \mu = \frac{2}{5}, \lambda = \frac{1}{10}, \pi = 3.382\%, \pi^* = 4\%, h = \frac{1}{10}, \bar{p} = \frac{1}{2}, a_\pi = a_p = \frac{1}{2}, z = -5\%$. Multiplication of p and I_m with 10 is for scaling purposes.

Figure 5a plots p, c, m, q, U, I_m as functions of the real interest rate I_r, when the inflation rate $\pi = 3.382\%$, which is higher than $\pi = 3\%$ in Figure 1. All the other parameter values are as the benchmark in Figure 1. The household's consumption c decreases to $c = 0$ when $I_r > 11.63\%$, which is slightly lower than $I_r > 12.21\%$ in Figure 1n. The higher inflation rate $\pi = 3.382\% > 3\%$ decreases consumption c in Figure 5a. Compared to Figure 1n, in Figure 5a the household chooses lower consumption c, lower production p, and holds less non-CBDC q. The household holds more CBDC m and earns higher utility U. The CBDC interest rate I_m becomes negative when $I_r < -0.62\%$, which is lower than $I_r < 0.00\%$ in Figure 1n. The model thus predicts a higher CBDC interest rate I_m when the inflation rate is $\pi = 3.382\%$ in Figure 5a compared to $\pi = 3\%$ in Figure 1n. Analogously to Figure 3a for the US, that follows from the logic of the Taylor (1993) rule in (4). The central bank combats high inflation rate $\pi = 3.382\%$ by increasing its CBDC interest rate I_m, to make saving in the form of holding CBDC m more attractive than consumption c, which is lower in Figure 5a than in Figure 1n. Mathematically, high inflation $\pi = 3.382\%$ on the right hand side in (4) causes high CBDC interest rate I_m on the left hand side in (4). For example, the CBDC interest rate is $I_m = 6.82\%$ at the benchmark $I_r = 5.83\%$ in Figure 5a, which is higher than $I_m = 6.21\%$ when $I_r = 5.83\%$ in Figure 1n, and slightly higher than the empirical $I_m = 6.75\%$ in Table 1. We interpret this to mean that the model and the Taylor (1993) rule predict appropriately and in accordance with the current empirics for Russia. Interestingly, the model shows that Russia chooses a slightly higher CBDC interest rate I_m to suppress the inflation rate π. But its empirical inflation rate $\pi = 3.382$ is lower than its target inflation rate $\pi^* = 4\%$. The model suggests that Russia should choose a slightly lower CBDC interest rate I_m, which decreases the household's CBDC holding m, and encourages the household to consume and produce more.

Figure 5b plots p, c, m, q, U, I_m, as functions of the real interest rate I_r, when the target inflation rate $\pi^* = 4\%$. All the other parameter values are as the benchmark in Figure 1. The household's consumption c decreases to $c = 0$ when $I_r > 13.20\%$, which is higher than $I_r > 12.21\%$ in Figure 1n. The CBDC interest rate I_m becomes negative when $I_r < 0.95\%$, which is higher than $I_r < 0.00\%$ in Figure 1n. Hence the higher target inflation rate $\pi^* = 4\%$ increases the consumption c and correspondingly decreases the CBDC interest rate I_m. The impact of the higher target inflation rate is in contrast to the US in Figure 3b, but the same as for China in Figure

4b. The CBDC interest rate is $I_m = 5.15\%$ at the benchmark $I_r = 5.83\%$, which is lower than $I_m = 6.21\%$ when $I_r = 5.83\%$ in Figure 1n, and also lower than $I_m = 6.75\%$ in Table 1.

Figure 5c plots p, c, m, q, U, I_m, as functions of the real interest rate I_r, when the inflation rate $\pi = 3.382\%$ and the target inflation rate $\pi^* = 4\%$, thus combining the assumptions for Figure 4d and Figure 5e. All the other parameter values are as the benchmark in Figure 1. The household's consumption c decreases to $c = 0$ when $I_r > 12.63\%$, which is slighter higher than $I_r > 12.21\%$ in Figure 1n. The CBDC interest rate I_m becomes negative when $I_r < 0.38\%$, which is higher than $I_r < 0.00\%$ in Figure 1n. Thus, the higher inflation rate $\pi = 3.382\%$ combined with the target inflation rate $\pi^* = 4\%$ increase the consumption c slightly, and decrease the CBDC interest rate I_m slightly. The CBDC interest rate is $I_m = 5.76\%$ at the benchmark $I_r = 5.83\%$, which is lower than $I_m = 6.21\%$ when $I_r = 5.83\%$ in Figure 1n, and also lower than 6.75% in Table 1.

Figure 5d plots p, c, m, q, U, I_m, as functions of the inflation rate π, when the real interest rate $I_r = 5.83\%$, which is higher than $I_r = 2\%$ in Figure 1. All the other parameter values are as the benchmark in Figure 1. The household's consumption c decreases to $c = 0$ when $\pi > 7.25\%$, which is lower than $\pi > 9.80\%$ in Figure 1o. The CBDC interest rate I_m becomes negative when $\pi < -0.92\%$, which is lower than $\pi < 1.63\%$ in Figure 1o. The CBDC interest rate is $I_m = 6.82\%$ at the benchmark $\pi = 3.382\%$, which is higher than $I_m = 3.46\%$ when $\pi = 3.382\%$ in Figure 1o, and slightly higher than $\pi = 6.75\%$ in Table 1. Thus, the higher real interest rate $I_r = 5.83\%$ decreases the consumption c and increases the CBDC interest rate I_m.

Figure 5e plots p, c, m, q, U, I_m, as functions of the inflation rate π, when the target inflation rate $\pi^* = 4\%$. All the other parameter values are as the benchmark in Figure 1. The household's consumption c decreases to $c = 0$ when $\pi > 10.47\%$, which is higher than $\pi > 9.80\%$ in Figure 1o. The CBDC interest rate I_m becomes negative when $\pi < 2.3\%$, which is higher than $\pi < 1.63\%$ in Figure 1o. The CBDC interest rate is $I_m = 1.71\%$ at the benchmark $\pi = 3.382\%$, which is lower than $I_m = 3.46\%$ when $\pi = 3.382\%$ in Figure 1o, and much lower than $\pi = 6.75\%$ in Table 1. Notably, the higher target inflation rate $\pi^* = 4\%$ decreases CBDC interest rate I_m. Again, the model predicts that Russia should choose a lower CBDC interest rate I_m.

Figure 5f plots p, c, m, q, U, I_m, as functions of the inflation rate π, when the real interest rate $I_r = 5.83\%$ and the target inflation rate $\pi^* = 4\%$. Both parameter values are higher than in Figure 1. Figure 5f thus combines the assumptions for Figure 5d and Figure 5e. All the other parameter values are as the benchmark in Figure 1. The household's consumption c decreases to $c = 0$ when $\pi > 7.92\%$, which is lower than $\pi > 9.80\%$ in Figure 1o. The CBDC interest rate I_m becomes negative when $\pi < -0.25\%$, which is lower than $\pi < 1.63\%$ in Figure 1o. The CBDC interest rate is $I_m = 5.76\%$ at the benchmark $\pi = 3.382\%$, which is higher than $I_m = 3.46\%$ when $\pi = 3.382\%$ in Figure 1o, but lower than $\pi = 6.75\%$ in Table 1. The impact of the higher real interest rate $I_r = 5.83\%$ is greater than the higher target inflation rate $\pi^* = 4\%$. Thus, the household's consumption c decreases compared to Figure 1o.

Figure 5g plots p, c, m, q, U, I_m, as functions of the target inflation rate π^*, when the real interest rate $I_r = 5.83\%$, which is higher than $I_r = 2\%$ in Figure 1. All the other parameter values are as the benchmark in Figure 1. The CBDC interest rate I_m becomes negative when $\pi^* > 13.76\%$, which is higher than $\pi^* > 6.10\%$ in Figure 1p. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 23.24\%$, which is higher than $\pi^* > 15.58\%$ in Figure 1p. The CBDC interest rate is $I_m = 5.15\%$ at the benchmark $\pi^* = 4\%$, which is much higher than $I_m = 1.11\%$ when $\pi^* = 4\%$ in Figure 1p, but lower than 6.75% in Table 1. Hence, the higher real interest rate $I_r = 5.83\%$ increases the target inflation rate π^*, but decreases the CBDC interest rate I_m. The impact of the higher interest rate I_r is the same as for China in Figure 4g for the target inflation rate π^* and the CBDC interest rate I_m, but in contrast to the US for the CBDC interest rate I_m.

Figure 5h plots p, c, m, q, U, I_m, as functions of the target inflation rate π^*, when the inflation rate $\pi = 3.382\%$, which is higher than $\pi = 3\%$ in Figure 1. All the other parameter values are as the benchmark in Figure 1. The CBDC interest rate I_m becomes negative when $\pi^* > 7.24\%$, which is higher than $\pi^* > 6.10\%$ in Figure 1p. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 16.73\%$, which is higher than $\pi^* > 15.58\%$ in Figure 1p. The CBDC interest rate is $I_m = 1.71\%$ at benchmark $\pi^* = 4\%$, which is much lower than $I_m = 1.11\%$ when $\pi^* = 4\%$ in Figure 1p, and much lower than $\pi^* = 6.5\%$ in Table 1. The higher inflation rate $\pi = 3.382\%$ increases the target inflation rate π^*, but decreases the CBDC interest rate I_m.

Figure 5i plots p, c, m, q, U, I_m, as functions of the target inflation rate π^*, when the real interest rate $I_r = 5.83\%$ and the inflation rate $\pi = 3.382\%$. Both parameter values are higher than in Figure 1. All the other parameter values are as the benchmark in Figure 1. The CBDC interest rate I_m becomes negative when $\pi^* > 14.90\%$, which is much higher than $\pi^* > 6.10\%$ in Figure 1p. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 24.39\%$, which is higher than $\pi^* > 15.58\%$ in Figure 1p. The CBDC interest rate is $I_m = 5.76\%$ at the benchmark $\pi^* = 4\%$, which is much higher than $I_m = 1.11\%$ when $\pi^* = 4\%$ in Figure 1p, but slightly lower than $\pi^* = 6.5\%$ in Table 1. Hence, the higher real interest rate $I_r = 5.83\%$ and the higher inflation rate $\pi = 3.382\%$ CBDC interest rate I_m, and increase the target inflation rate π^*.

The Russia inflation rate $\pi = 3.382\%$ is lower than the CBDC interest rate $I_m = 6.75\%$. The gap between the predicted CBDC interest rate I_m and the Russia empirical CBDC interest rate I_m is intermediate between The US and China. The model predicts that Russia chooses a slightly higher CBDC interest rate I_m to suppress the inflation rate π. Notably, the change of real interest rate I_r has a higher impact on the CBDC interest rate I_m, the change of the inflation rate π has a lower impact on the CBDC interest rate I_m. This holds for the three countries' empirical data. Table 1 shows the empirical data of the four variables I_m, I_r, π, π^* for the US, China and Russia.

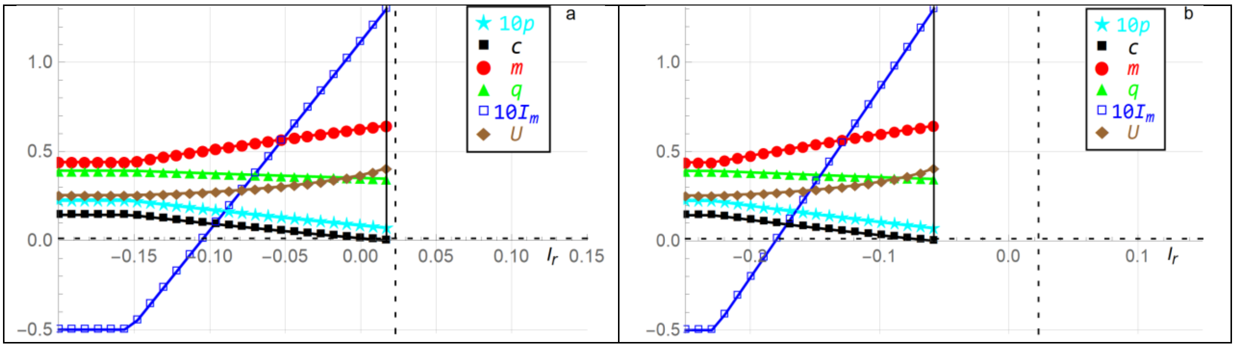
Table 4: Interpretation of Figure 5 for Russia compared to Figure 1.

Russia	Changed parameter values from the benchmark in Figure 1	c decreases to zero when	c, p, m, q reach constant values when	I_m becomes negative when	I_m at the benchmark
Figure 5a	$\pi = 3.382\%$	$I_r > 11.63\%$	$I_r < -5.36\%$	$I_r < -0.62\%$	$I_m = 6.82\%$ at $I_r = 5.83\%$
Figure 5b	$\pi^* = 4\%$	$I_r > 13.20\%$	$I_r < -3.79\%$	$I_r < 0.95\%$	$I_m = 5.15\%$ at $I_r = 5.83\%$
Figure 5c	$\pi = 3.382\%$ $\pi^* = 4\%$	$I_r > 12.63\%$	$I_r < -4.36\%$	$I_r < 0.38\%$	$I_m = 5.76\%$ at $I_r = 5.83\%$
Figure 5d	$I_r = 5.83\%$	$\pi > 7.25\%$	$\pi < -4.08\%$	$\pi < -0.92\%$	$I_m = 6.82\%$ at $\pi = 3.382\%$
Figure 5e	$\pi^* = 4\%$	$\pi > 10.47\%$	$\pi < -0.86\%$	$\pi < 2.3\%$	$I_m = 1.71\%$ at $\pi = 3.382\%$
Figure 5f	$I_r = 5.83\%$ $\pi^* = 4\%$	$\pi > 7.92\%$	$\pi < -3.41\%$	$\pi < -0.25\%$	$I_m = 5.76\%$ at $\pi = 3.382\%$
Figure 5g	$I_r = 5.83\%$	$\pi^* < -10.75\%$	$\pi^* > 23.24\%$	$\pi^* > 13.76\%$	$I_m = 5.15\%$ at $\pi^* = 4\%$
Figure 5h	$\pi = 3.382\%$	$\pi^* < -17.26\%$	$\pi^* > 16.73\%$	$\pi^* > 7.24\%$	$I_m = 1.71\%$ at $\pi^* = 4\%$
Figure 5i	$I_r = 5.83\%$ $\pi = 3.382\%$	$\pi^* < -9.6\%$	$\pi^* > 24.39\%$	$\pi^* > 14.90\%$	$I_m = 5.76\%$ at $\pi^* = 4\%$
Figure 1n	$I_r = 2\%$	$I_r > 12.21\%$	$I_r < -4.79\%$	$I_r < 0.00\%$	$I_m = 6.21\%$ at $I_r = 5.83\%$ i
Figure 1o	$\pi = 3\%$	$I_r > 9.80\%$	$I_r < -1.53\%$	$\pi < 1.63\%$	$I_m = 3.46\%$ at $\pi = 3.382\%$
Figure 1p	$\pi^* = 2\%$	$\pi^* < -18.41\%$	$\pi^* > 15.58\%$	$\pi^* > 6.10\%$	$I_m = 1.11\%$ at $\pi^* = 4\%$

Assessing higher inflation rates π for the US, China and Russia

This section analyzes the implications of hypothetically higher inflation rates $\pi = 10\%$ and $\pi = 15\%$ for the US, China and Russia. The relevance of such an analysis is underscored by Turkey's annual inflation increasing to a three-year high of 21.31% in November 2021.[1] Hanke and Krus (2013) summarize 56 worldwide hyperinflation examples. The highest is $\pi = 2.93 \times 10^{177}\%$ per year ($\pi = 4.19 \times 10^{16}\%$ per month) in Hungary in July 1946. We consider $\pi = 2{,}688{,}670\%$ Venezuela, January 2019 (Descifrado, 2019) for analysis.

The US



[1] https://www.reuters.com/world/middle-east/turkish-inflation-jumps-3-year-high-amid-lira-plunge-2021-12-03/, retrieved April 22, 2022.

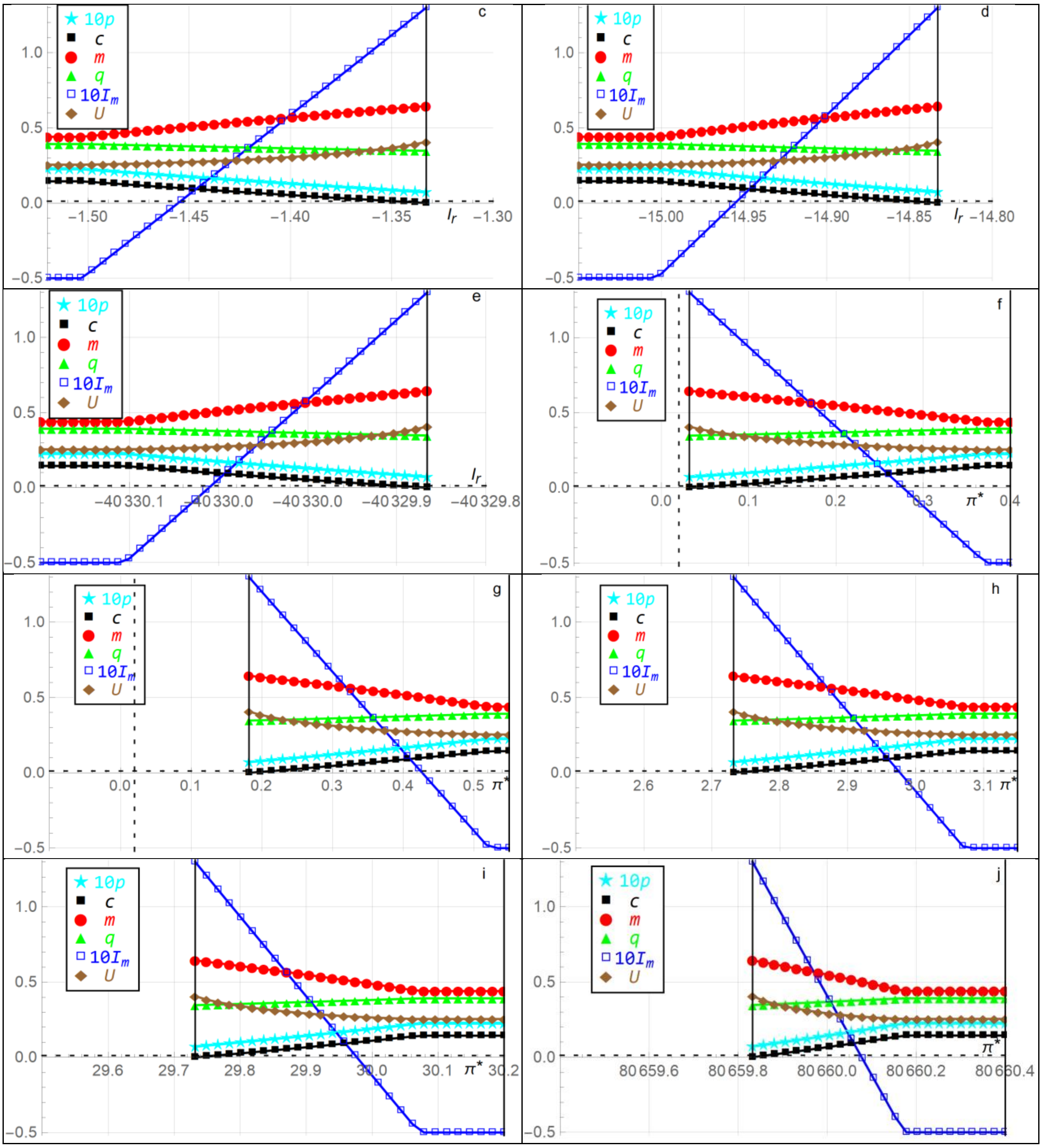


Figure 6: The household's production p, consumption c, CBDC holding m, non-CBDC holding q, utility U, and the CBDC interest rate I_m, as functions of the real interest rate I_r, inflation rate π, and target inflation rate π^*, respectively, relative to the benchmark parameter values $\alpha = \beta = \gamma = \frac{1}{4}, r = a = M = Q = 1, I_q = 2\%, I_r = 2.305\%, \eta = \frac{1}{5}, \mu = \frac{2}{5}, \lambda = \frac{1}{10}, \pi^* = 2\%, h = \frac{1}{10}, \bar{p} = \frac{1}{2}, a_\pi = a_p = \frac{1}{2}, z = -5\%$. Panels a and f: $\pi = 10\%$. Panels b and g: $\pi = 15\%$. Panels c and h: $\pi = 100\%$. Panels d and i: $\pi = 1000\%$. Panels e and j: $\pi = 2{,}688{,}670\%$. Multiplication of p and I_m with 10 is for scaling purposes.

Figure 6a plots p, c, m, q, U, I_m as functions of the real interest rate I_r when the inflation rate $\pi = 10\%$, which is higher than $\pi = 3\%$ in Figure 1. All the other parameter values are as the benchmarks in Figure 1. The household's consumption c decreases to $c = 0$ when $I_r > 1.71\%$, which is lower than $I_r > 12.21\%$ in Figure 1n and lower than $I_r > 7.4\%$ in Figure 3a. The higher inflation rate $\pi = 10\% > 3\%$ decreases consumption c in Figure 6a. The CBDC interest rate I_m becomes negative when $I_r < -10.55\%$, which is lower than $I_r < 0.00\%$ in Figure 1n and lower than $I_r < -4.85\%$ in Figure 3a. Thus, the curves move to the left compared to Figure 1n and Figure 3a. When consumption c decreases to $c = 0$, the CBDC interest rate is $I_m = 13.0\%$. Again, the central bank combats high inflation rate $\pi = 6.2\%$ by increasing its CBDC interest rate I_m, to make saving in the form of holding CBDC m more attractive than consumption c. But it is costly since the CBDC interest rate I_m goes up a lot.

Figure 6b plots p, c, m, q, U, I_m as functions of the real interest rate I_r when the inflation rate $\pi = 15\%$. All the other parameter values are as the benchmarks in Figure 1. The household's consumption c decreases to $c = 0$ when $I_r > -5.8\%$, which is lower than

$I_r > 1.71\%$ in Figure 6a. Thus, the higher inflation rate $\pi = 15\%$ decreases consumption c in Figure 6b. The CBDC interest rate I_m becomes negative when $I_r < -18.05\%$, which is lower than $I_r < -10.55\%$ in Figure 6a. Again, the curves move to the left compared to Figure 1n, Figure 3a and Figure 6a.

Figure 6c plots p, c, m, q, U, I_m as functions of the real interest rate I_r when the inflation rate $\pi = 100\%$. All the other parameter values are as the benchmarks in Figure 1. The household's consumption c decreases to $c = 0$ when $I_r > -133.3\%$, which is lower than $I_r > -5.8\%$ in Figure 6b. The CBDC interest rate I_m becomes negative when $I_r < -145.55\%$, which is lower than $I_r < -18.05\%$ in Figure 6b. The curves move to the left compared to Figure 1n, Figure 3a, Figure 6a, Figure 6b.

Figure 6d plots p, c, m, q, U, I_m as functions of the real interest rate I_r when the inflation rate $\pi = 1000\%$. All the other parameter values are as the benchmarks in Figure 1. The household's consumption c decreases to $c = 0$ when $I_r > -1483.3\%$, which is lower than $I_r > -133.3\%$ in Figure 6c. The CBDC interest rate I_m becomes negative when $I_r < -1495.55\%$.

Figure 6e plots p, c, m, q, U, I_m as functions of the real interest rate I_r when the inflation rate $\pi = 2{,}688{,}670\%$, as in Venezuela, January 2019. All the other parameter values are as the benchmarks in Figure 1. The household's consumption c decreases to $c = 0$ when $I_r > -4{,}032{,}988.3\%$. The CBDC interest rate I_m becomes negative when $I_r < -4{,}033{,}000.55\%$. The high Venezuela inflation rate $\pi = 2{,}688{,}670\%$ makes consumption c almost impossible, unless the real interest rate I_r is extremely and unrealistically negative.

Figure 6f plots p, c, m, q, U, I_m as functions of the target inflation rate π^*, when the real interest rate is $I_r = 2.305\%$ and the inflation rate is $\pi = 10\%$. Both the real interest rate and the inflation rate are higher than in Figure 1. All the other parameter values are as the benchmarks in Figure 1. The CBDC interest rate I_m becomes negative when $\pi^* > 27.71\%$, which is much higher than $\pi^* > 6.10\%$ in Figure 1p and higher than $\pi^* > 16.31\%$ in Figure 3e. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 37.19\%$, which is much higher than $\pi^* > 15.58\%$ in Figure 1p and higher than $\pi^* > 25.79\%$ in Figure 3e. Thus, the curves move to the right compared to Figure 1p and Figure 3e. The higher inflation rate $\pi = 10\%$ and the higher real interest rate $I_r = 2.305\%$ greatly increase the target inflation rate π^* and decrease the CBDC interest rate I_m. The household consumption c decreases to $c = 0$ when $\pi^* < 3.2\%$, where the CBDC interest rate is $I_m = 13.00\%$.

Figure 6g plots p, c, m, q, U, I_m as functions of the target inflation rate π^*, when the real interest rate is $I_r = 2.305\%$ and the inflation rate is $\pi = 15\%$. Both the real interest rate and the inflation rate are higher than in Figure 1. All the other parameter values are as the benchmarks in Figure 1. The CBDC interest rate I_m becomes negative when $\pi^* > 42.71\%$. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 52.20\%$. The higher inflation rate $\pi = 15\%$ and the higher real interest rate $I_r = 2.305\%$ greatly increases the target inflation rate π^* and increase the CBDC interest rate I_m. The household consumption c decreases to $c = 0$ when $\pi^* < 18.20\%$, where the CBDC interest rate is $I_m = 13.00\%$.

Figure 6h plots p, c, m, q, U, I_m as functions of the target inflation rate π^*, when the real interest rate is $I_r = 2.305\%$ and the inflation rate is $\pi = 100\%$. Both the real interest rate and the inflation rate are higher than in Figure 1. All the other parameter values are as the benchmarks in Figure 1. The CBDC interest rate I_m becomes negative when $\pi^* > 297.71\%$. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 307.20\%$. The higher inflation rate $\pi = 100\%$ and the higher real interest rate $I_r = 2.305\%$ greatly increases the target inflation rate π^* and increase the CBDC interest rate I_m. The household consumption c decreases to $c = 0$ when $\pi^* < 18.20\%$, where the CBDC interest rate is $I_m = 13.00\%$.

Figure 6i plots p, c, m, q, U, I_m as functions of the target inflation rate π^*, when the real interest rate is $I_r = 2.305\%$ and the inflation rate is $\pi = 1000\%$. Both the real interest rate and the inflation rate are higher than in Figure 1. All the other parameter values are as the benchmarks in Figure 1. The CBDC interest rate I_m becomes negative when $\pi^* > 2997.8\%$. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 3072.0\%$. The higher inflation rate $\pi = 1000\%$ and the higher real interest rate $I_r = 2.305\%$ greatly increases the target inflation rate π^* and increase the CBDC interest rate I_m. The household consumption c decreases to $c = 0$ when $\pi^* < 2937.20\%$, where the CBDC interest rate is $I_m = 13.00\%$.

Figure 6j plots p, c, m, q, U, I_m as functions of the target inflation rate π^*, when the real interest rate is $I_r = 2.305\%$ and the inflation rate is $\pi = 2{,}688{,}670\%$. Both the real interest rate and the inflation rate are higher than in Figure 1. All the other parameter values are as the benchmarks in Figure 1. The CBDC interest rate I_m becomes negative when $\pi^* > 8{,}066{,}007.71\%$. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 8{,}066{,}017.19\%$. The extremely high inflation rate $\pi = 2{,}688{,}670\%$ and the higher real interest rate $I_r = 2.305\%$ greatly increase the target inflation rate π^* and increase the CBDC interest rate I_m.

Table 5: Implication summary of higher inflation rates for the US.

The US	Changed parameter values from the benchmark in Figure 1	c decreases to zero when	I_m becomes negative when	p, c, m, q reach constant values when	I_m at the benchmark	How curves change compared to Figure 3
Figure 6a	$\pi = 10\%$	$I_r > 1.71\%$	$I_r < -10.55\%$	$I_r < 15.29\%$	$I_m = 13.64\%$	Left
Figure 6b	$\pi = 15\%$	$I_r > -5.8\%$	$I_r < -18.05\%$	$I_r < 22.79\%$	$I_m = 22.09\%$	Left
Figure 6c	$\pi = 100\%$	$I_r > -133.3\%$	$I_r < -145.55\%$	$I_r < -150.29\%$	$I_m = 1495.41\%$	Left

Figure 6d	$\pi = 1000\%$	$I_r > -1483.3\%$	$I_r < -1495.55\%$	$I_r < -1500.29\%$	$I_m = 14998.17$	Left
Figure 6e	$\pi =$ 2,688,670%.	$I_r > -4{,}032{,}988.3\%$	$I_r < -4{,}033{,}000.55\%$	$I_r < 4033005.29\%$	$I_m = 40{,}330{,}048.78\%$	Left
Figure 6f	$\pi = 10\%$ $I_r = 2.305\%$	$\pi^* < 3.2\%$	$\pi^* > 27.71\%$	$\pi^* > 37.19\%$	$I_m = 13.64\%$	Right
Figure 6g	$\pi = 15\%$ $I_r = 2.305\%$	$\pi^* < 18.2\%$	$\pi^* > 42.71\%$	$\pi^* > 52.20\%$	$I_m = 22.09\%$	Right
Figure 6h	$\pi = 100\%$ $I_r = 2.305\%$	$\pi^* < 273.2\%$	$\pi^* > 297.71\%$	$\pi^* > 307.20\%$	$I_m = 1495.41\%$	Right
Figure 6i	$\pi = 1000\%$ $I_r = 2.305\%$	$\pi^* < 2973.2\%$	$\pi^* > 2997.8\%$	$\pi^* > 3072.0\%$	$I_m = 14998.2\%$	Right
Figure 6j	$\pi = 2{,}688{,}670\%$ $I_r = 2.305\%$	$\pi^* < 8{,}065{,}983.2\%$	$\pi^* > 8{,}066{,}007.71\%$	$\pi^* > 8{,}066{,}017.19\%$	$I_m = 40{,}330{,}048.78\%$	Right
Figure 1n	$\pi = 3\%$	$I_r > 12.21\%$	$I_r < 0.00\%$	$I_r < -4.79\%$	$I_m = 3.91\%$	Right
Figure 1p	$I_r = 2\%$	$\pi^* < -18.41\%$	$\pi^* > 6.10\%$	$\pi^* > 15.58\%$	$I_m = 1.63\%$	Left

China

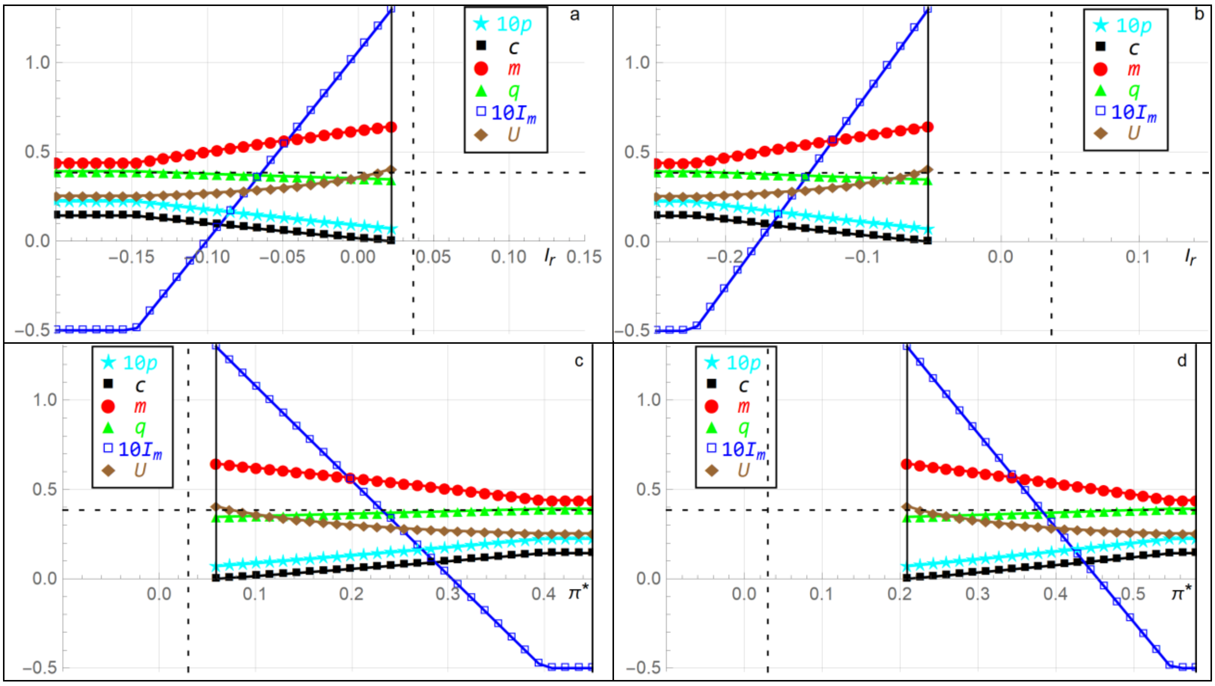


Figure 7: The household's production p, consumption c, CBDC holding m, non-CBDC holding q, utility U, and the CBDC interest rate I_m, as functions of the real interest rate I_r, inflation rate π, and target inflation rate π^*, respectively, relative to the benchmark parameter values $\alpha = \beta = \gamma = \frac{1}{4}, r = a = M = Q = 1, I_q = 2\%, I_r = 3.6535\%, \eta = \frac{1}{5}, \mu = \frac{2}{5}, \lambda = \frac{1}{10}, \pi^* = 3\%, h = \frac{1}{10}, \bar{p} = \frac{1}{2}, a_\pi = a_p = \frac{1}{2}, z = -5\%$. Panels a and c: $\pi = 10\%$. Panels b and d: $\pi = 15\%$. Multiplication of p and I_m with 10 is for scaling purposes.

Figure 7a plots p, c, m, q, U, I_m as functions of the real interest rate I_r, when the inflation rate $\pi = 10\%$ and the target inflation rate $\pi^* = 3\%$. All the other parameter values are as the benchmark in Figure 1. The consumption c decreases and the CBDC interest rate I_m increases. More specifically, the household's consumption c decreases to $c = 0$ when $I_r > 2.2\%$, which is much lower than $I_r > 12.21\%$ in Figure 1n, and also much lower than $I_r > 13.58\%$ in Figure 4c. The CBDC interest rate I_m becomes negative when $I_r < -10.05\%$, which is lower than $I_r < 0.00\%$ in Figure 1n, and lower than $I_r < 1.32\%$ in Figure 4c. Thus, the curves move to the left compared to Figure 1n and Figure 4c. The high inflation rate $\pi = 10\%$ decreases the consumption c and decreases the real interest rate I_r. The central bank increases its interest to combat inflation.

Figure 7b plots p, c, m, q, U, I_m as functions of the real interest rate I_r, when the inflation rate $\pi = 15\%$ and the target inflation rate $\pi^* = 3\%$. All the other parameter values are as the benchmark in Figure 1. The household's consumption c decreases to $c = 0$ when $I_r > -5.3\%$, which is much lower than $I_r > 12.21\%$ in Figure 1n, much lower than $I_r > 13.58\%$ in Figure 4c, and lower than $I_r > 2.2\%$ in Figure 7a. The CBDC interest rate I_m becomes negative when $I_r < -17.55\%$, which is lower than $I_r < 0.00\%$ in Figure 1n, lower than $I_r < 1.32\%$ in Figure 4c, and lower than $I_r < -10.05\%$ in Figure 7a. Again, the curves move to the right even further compared to Figure 1n, Figure 4c and Figure 7a. The high inflation rate $\pi = 15\%$ decreases the consumption c and decreases the real interest rate I_r.

Figure 7c plots p, c, m, q, U, I_m as functions of the target inflation rate π^*, when the real interest rate $I_r = 3.6535\%$ and the inflation rate $\pi = 10\%$. All the other parameter values are as the benchmark in Figure 1. The CBDC interest rate I_m becomes negative when $\pi^* > 30.40\%$, which is much higher than $\pi^* > 6.10\%$ in Figure 1p and higher than $\pi^* > 7.66\%$ in Figure 4i. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 39.89\%$, which is much higher than $\pi^* > 15.58\%$ in Figure 1p and higher than $\pi^* > 17.15\%$ in Figure 4i. Thus, the curves move to the right compared to Figure 1p and Figure 4i. The higher inflation rate $\pi = 10\%$ and the higher real interest rate $I_r = 3.6535\%$ greatly increase the target inflation rate π^*. The household consumption c decreases to $c = 0$ when $\pi^* < 5.9\%$, the CBDC interest rate is $I_m = 13.00\%$ at this point.

Figure 7d plots p, c, m, q, U, I_m as functions of the target inflation rate π^*, when the real interest rate $I_r = 3.6535\%$ and the inflation rate $\pi = 15\%$. All the other parameter values are as the benchmark in Figure 1. The CBDC interest rate I_m becomes negative when $\pi^* > 45.4\%$, which is much higher than $\pi^* > 6.10\%$ in Figure 1p, much higher than $\pi^* > 7.66\%$ in Figure 4I, and higher than $\pi^* > 30.40\%$ in Figure 7c. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 45.41\%$, which is higher than $\pi^* > 15.58\%$ in Figure 1p, higher than $\pi^* > 17.15\%$ in Figure 4i, and higher than $\pi^* > 39.89\%$ in Figure 7c. Again, the curves move to the right even further compared to Figure 1p, Figure 4i and Figure 7c. The higher inflation rate $\pi = 15\%$ and the higher real interest rate $I_r = 3.6535\%$ greatly increase the target inflation rate π^*. The household consumption c decreases to $c = 0$ when $\pi^* < 5.9\%$, the CBDC interest rate is $I_m = 13.00\%$ at this point.

Table 6: Implication summary of higher inflation rates for China.

China	Changed parameter values from the benchmark in Figure 1	c decreases to zero when	I_m becomes negative when	p, c, m, q reach constant values when	I_m at the benchmark	How curves change compared to Figure 4
Figure 7a	$\pi = 10\%$ $\pi^* = 3\%$	$I_r > 2.2\%$	$I_r < -10.05\%$	$I_r < -14.79\%$	$I_m = 14.56\%$	Left
Figure 7b	$\pi = 15\%$ $\pi^* = 3\%$.	$I_r > -5.3\%$	$I_r < -17.55\%$	$I_r < -22.29\%$	$I_m = 23.21\%$	Left
Figure 7c	$\pi = 10\%$ $I_r = 3.6535\%$	$\pi^* < 5.9\%$	$\pi^* > 30.40\%$	$\pi^* > 39.89\%$	$I_m = 14.56\%$	Right
Figure 7d	$\pi = 15\%$ $I_r = 3.6535\%$	$\pi^* < 20.9\%$	$\pi^* > 45.4\%$	$\pi^* > 45.41\%$	$I_m = 23.21\%$	Right
Figure 1n	$\pi = 3\%$	$I_r > 12.21\%$	$I_r < 0.00\%$	$I_r < -4.79\%$	$I_m = 3.91\%$	Right
Figure 1p	$I_r = 2\%$	$\pi^* < -18.41\%$	$\pi^* > 6.10\%$	$\pi^* > 15.58\%$	$I_m = 1.63\%$	Left

Russia

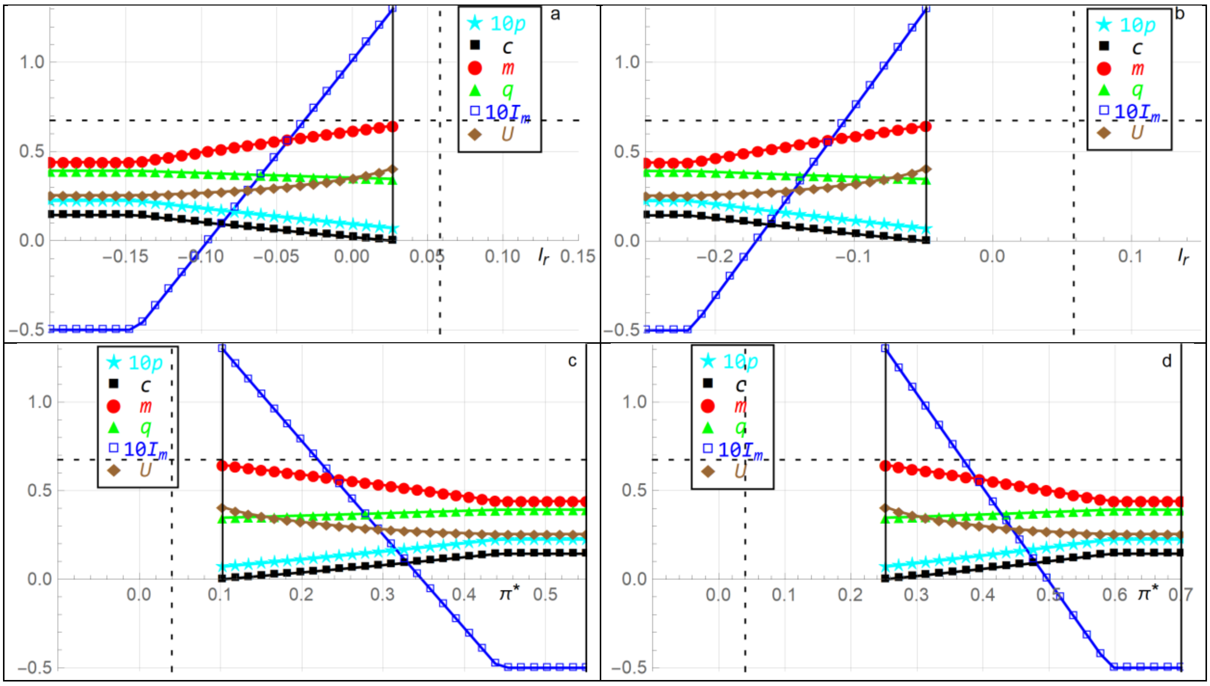


Figure 8: The household's production p, consumption c, CBDC holding m, non-CBDC holding q, utility U, and the CBDC interest rate I_m, as functions of the real interest rate I_r, inflation rate π, and target inflation rate π^*, respectively, relative to the benchmark

parameter values $\alpha = \beta = \gamma = \frac{1}{4}, r = a = M = Q = 1, I_q = 2\%, I_r = 5.83\%, \eta = \frac{1}{5}, \mu = \frac{2}{5}, \lambda = \frac{1}{10}, \pi^* = 4\%, h = \frac{1}{10}, \bar{p} = \frac{1}{2}, a_\pi = a_p = \frac{1}{2}, z = -5\%$. Panels a and c: $\pi = 10\%$. Panels b and d: $\pi = 15\%$. Multiplication of p and I_m with 10 is for scaling purposes.

Figure 8a plots p, c, m, q, U, I_m as functions of the real interest rate I_r, when the inflation rate $\pi = 10\%$ and the target inflation rate $\pi^* = 4\%$. All the other parameter values are as the benchmark in Figure 1. The consumption c decreases and the CBDC interest rate I_m increases. More specifically, the household's consumption c decreases to $c = 0$ when $I_r > 2.7\%$, which is much lower than $I_r > 12.21\%$ in Figure 1n, and lower than $I_r > 12.63\%$ in Figure 5c. The CBDC interest rate I_m becomes negative when $I_r < -9.5\%$, which is lower than $I_r < 0.00\%$ in Figure 1n, and lower than $I_r < 0.38\%$ in Figure 5c. Thus, the curves move to the left compared to Figure 1n and Figure 5c. The high inflation rate $\pi = 10\%$ decreases the consumption c and decreases the real interest rate I_r.

Figure 8b plots p, c, m, q, U, I_m as functions of the real interest rate I_r, when the inflation rate $\pi = 15\%$ and the target inflation rate $\pi^* = 4\%$. All the other parameter values are as the benchmark in Figure 1. The household's consumption c decreases to $c = 0$ when $I_r > -4.8\%$, which is much lower than $I_r > 12.21\%$ in Figure 1n, lower than $I_r > 12.63\%$ in Figure 5c, and lower than $I_r > 2.7\%$ in Figure 8a. The CBDC interest rate I_m becomes negative when $I_r < -17.0\%$, which is lower than $I_r < 0.00\%$ in Figure 1n, lower than $I_r < 0.38\%$ in Figure 5c, and lower than $I_r < -9.5\%$ in Figure 8a. Again, the curves move to the left even further compared to Figure 1n, Figure 5c, and Figure 8a. The higher inflation rate $\pi = 15\%$ further decreases the consumption c and decreases the real interest rate I_r.

Figure 8c plots p, c, m, q, U, I_m as functions of the target inflation rate π^*, when the real interest rate $I_r = 5.83\%$ and the inflation rate $\pi = 10\%$. All the other parameter values are as the benchmark in Figure 1. The CBDC interest rate I_m becomes negative when $\pi^* > 34.76\%$, which is much higher than $\pi^* > 6.10\%$ in Figure 1p and higher than $\pi^* > 14.90\%$ in Figure 5i. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 44.24\%$, which is much higher than $\pi^* > 15.58\%$ in Figure 1p and higher than $\pi^* > 24.39\%$ in Figure 5i. The household consumption c decreases to $c = 0$ when $\pi^* < 10.25\%$. Thus, the curves move to the right compared to Figure 1p and Figure 5i. The higher inflation rate $\pi = 10\%$ and the higher real interest rate $I_r = 5.83\%\%$ greatly increase the target inflation rate π^*.

Figure 8d plots p, c, m, q, U, I_m as functions of the target inflation rate π^*, when the real interest rate $I_r = 5.83\%$ and the inflation rate $\pi = 15\%$. All the other parameter values are as the benchmark in Figure 1. The CBDC interest rate I_m becomes negative when $\pi^* > 49.76\%$, which is much higher than $\pi^* > 6.10\%$ in Figure 1p, higher than $\pi^* > 14.90\%$ in Figure 5i, and higher than $\pi^* > 34.76\%$ Figure 8c. The household consumption c, production p, CBDC holding m and non-CBDC holding q reach constant values when $\pi^* > 59.24\%$, which is much higher than $\pi^* > 15.58\%$ in Figure 1p, higher than $\pi^* > 24.39\%$ in Figure 5i, and higher than $\pi^* > 44.24\%$ in Figure 8c. The household consumption c decreases to $c = 0$ when $\pi^* < 25.25\%$. Again, the curves move to the right even further compared to Figure 1p, Figure 5i, and Figure 8c.

Table 7: Implication summary of higher inflation rates for Russia.

Russia	Changed parameter values from the benchmark in Figure 1	c decreases to zero when	I_m becomes negative when	p, c, m, q reach constant values when	I_m at the benchmark	How curves change compared to Figure 5
Figure 8a	$\pi = 10\%$ $\pi^* = 4\%$	$I_r > 2.7\%$	$I_r < -9.5\%$	$I_r < -14.29\%$	$I_m = 16.37\%$	Left
Figure 8b	$\pi = 15\%$ $\pi^* = 4\%$	$I_r > -4.8\%$	$I_r < -17.0\%$	$I_r < -21.79\%$	$I_m = 24.74\%$	Left
Figure 8c	$\pi = 10\%$ $I_r = 5.83\%$	$\pi^* < 10.25\%$	$\pi^* > 34.76\%$	$\pi^* > 44.24\%$	$I_m = 16.37\%$	Right
Figure 8d	$\pi = 15\%$ $I_r = 5.83\%$	$\pi^* < 25.25\%$	$\pi^* > 49.76\%$	$\pi^* > 59.24\%$	$I_m = 24.74\%$	Right
Figure 1n	$\pi = 3\%$	$I_r > 12.21\%$	$I_r < 0.00\%$	$I_r < -4.79\%$	$I_m = 3.91\%$	Right
Figure 1p	$I_r = 2\%$	$\pi^* < -18.41\%$	$\pi^* > 6.10\%$	$\pi^* > 15.58\%$	$I_m = 1.63\%$	Left

Conclusion

The article extends G. Wang and Hausken (2022) in a series of two articles by comparing a decision model with the empirics for the US, China and Russia. In period 1 the central bank chooses positive or negative interest rate. In period 2 the household allocates its resources into production, consumption, CBDC (central bank digital currency) holding, and non-CBDC holding.

Whereas the benchmark in G. Wang and Hausken (2022) assumed the inflation rate 3% and the target inflation rate 2%, the US's October 2021 empirical inflation rate is 6.2%, with a target 2% inflation rate. The model predicts and quantifies how the US should choose a substantially higher CBDC interest rate 7.56% than its empirical interest rate 0.125%, in order to suppress the high inflation rate. That would encourage the household to hold more CBDC, hold less non-CBDC, and produce and consume less. The central bank should choose negative CBDC interest rate when the inflation and real interest rate are low, and the inflation target is high.

China, in contrast, has a low empirical inflation rate 2.419% below its target inflation rate 3%. The model predicts that China should choose the low CBDC interest rate 2.99%, below its empirical interest rate 3.85%. That would decrease the household's CBDC holding and increase the low inflation rate to the target inflation rate. It would also induce the household to hold more non-CBDC, and produce and consume more.

Russia chooses a strategy in between that of the US and China. Russia's inflation rate is 3.382%, which is below its target inflation rate 4%. The model predicts that Russia should choose the CBDC interest rate 6.82%, which is slightly above its empirical interest rate 6.75%. Compared to the benchmark in G. Wang and Hausken (2022), Russia's high CBDC interest rate 6.82% induces the household to hold slightly more CBDC and earn slightly higher utility, and hold slightly less non-CBDC and produce and consume slightly less.

The article also assesses higher inflation rates for the US, Russia, and China. The highest recent inflation rate 2,688,670% occurred in Venezuela in January 2019. As inflation increases, all curves move to the left compared to the benchmark for the real interest rate. That is, extremely high inflation makes production and consumption almost impossible, unless the real interest rate is extremely negative. The extremely high inflation greatly increases the CBDC interest rate. In contrast, all curves move to the right compared to the benchmark for the target inflation rate. That is, an extremely high target inflation rate makes production and consumption almost impossible, unless the target inflation rate is extremely positive.

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Institutional Review Board Statement: Ethical review and approval were waived for this study, due to that the research does not deal with vulnerable groups or sensitive issues.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy.

Conflicts of Interest: The authors declare no conflict of interest.

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