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# Fiscal Instruments, Welfare and Inflation: A HANK Approach

# Instrumentos Fiscais, Bem-Estar e Inflação: uma abordagem HANK

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**ABSTRACT**
This study aims at answering two research questions. Firstly, given a change in the VAT rate and a change in targeted transfers, which would impact inflation the most? Secondly, after a negative supply shock, which measure would be more welfare-friendly? We find that VAT changes generate a greater impact on inflation than changes in transfers, both empirically and within the structural model. Additionally, we find that a decrease in the VAT rate, though it generates more inequalities, is more welfare-friendly if it is measured through a utilitarian approach.
Keywords: Fiscal Instruments; HANK; Inflation; Welfare; VAT; Transfers.

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## 1. Introduction

Three years have gone by, and the world is still adapting to all the changes that the COVID-19 pandemic brought. Governments all around the world went through massive fiscal expansions in order to try and sustain aggregate demand, and now, many economies are feeling the impacts of such measures, namely, inflation.

The most orthodox way of dealing with inflation has been to let the monetary authority (Central Bank) control it with the use of open market operations and other instruments. However, governments being such a decisive agent in the economy, may also want to get in on the action. In fact, many countries within the Euro Zone may feel a greater necessity of having the government act accordingly to monetary policies, given that, although all the economies have different characteristics, they are under the same monetary policy ruling.

More recently, three European counties have adopted fiscal policies that have been on the spotlight of economic debates. Portugal, Spain and Italy have all adopted measures regarding temporary decreases on the VAT rate for certain bundles of goods. The purpose of these policies have been to alleviate the inflation rates in the countries and give back some purchasing power to the families. The most recent case, Portugal, has seen a decrease in the VAT rate for essential food items, going from the usual 6% to 0%. This policy was put in place back in April 2023 and is still to this day (December 2023) active. Following this fiscal policy, and analyzing the recent studies of a similar policy put in place earlier in Spain, many economists have debated on the implications of such mea- sure. The first question that is being asked is if such measure even decreases consumer prices, and if so, up to which degree. The purpose of such measures have been to fight inflation so, one would expect to see a decrease in the inflation rates when such measure is applied – a pass-through rate. Secondly, such measure can be very costly for the government, thus hurting its budget. Even if such measure is successful in reducing inflation, how big was the cost of such policy? Economists have been wondering if there are alternative options to ease the decrease in the households purchasing power in a way that is more cost-effective. The most commonly mentioned alternative is to increase transfers to the most vulnerable agents in the economy since it has been showed that these are the ones who suffer the most with inflation.

This paper aims at extending the literature regarding these questions. In Section 2 a literature review on the topic is provided. Section 3 provides an empirical exercise using data from Alesina et al. (2017) so as to analyze which fiscal measure – a change in the VAT rate or a change in targeted transfers – will generate a greater impact on inflation. Section 4 is dedicated to constructing a one-asset Heterogenous Agents New Keynesian (HANK) model where we will calibrate it to resemble the Portuguese economy (Section 5), and will evaluate the welfare impacts coming from both types of fiscal policies - Section 6. Section 7 concludes.

## 2. Literature Review

The use of temporary VAT changes can be considered as a somewhat recent fiscal instrument for governments. By altering the VAT rate, there may be a degree of pass-through to final consumer prices, the measurement of such pass-through rate has been the main focus

of this very much recent literature. The degree to which consumer prices respond to VAT changes is of utmost importance when studying the welfare impacts originating from similar fiscal policy actions, since such elasticity will determine the changes in the households' purchasing power. The main findings of Benzarti et al. (2017) relate to prices asymmetrical responses to VAT changes, concluding that prices respond twice as much to VAT increases than to decreases. More recently, De Amores et al. (2023) conducted a study referring to the Spanish government's decision to temporarily reduce the VAT rate from 4% to 0% for the most necessary goods such as bread, milk, vegetables, fruits, amongst other. The authors compare the price evolution of these goods by analyzing the daily prices available on *Carrefour*'s website – a Spanish supermarket – and comparing them with those on *REWE*'s website – a German supermarket – between the end of December 2022 and the first week of January of 2023. The main findings of this paper point to large pass-through rates for multiple items, with many reaching 100%.

Regarding the impact of transfers on welfare, the literature is more extensive, many authors have studied how transfers may be able to impact the economy's output, while relating such mechanisms to agent's heterogeneity and inequality. Oh and Reis (2012) took notice of the substantial increase in social transfers in OECD countries from 2007 and 2009 and developed a model with idiosyncratic, uninsurable uncertainty regarding income and wealth, as well as nominal rigidities in price setting. The authors concluded that social transfers are expansionary through two main channels: a neo- classical channel which states that the lowering of wealth of marginal workers will induce them to provide more labor; a Keynesian effect suggesting that transferring resources from households with a lower marginal propensity to consume, to those with a higher marginal propensity to consume will boost consumption, aggregate demand and lastly, output. Floden (2001) develops a model with incomplete markets, infinitely-lived households who differ in ability and are hit by idiosyncratic wage shocks. The main question the author wishes to tackle is the effect that variations in public debt and transfers will have on the distribution of resources, efficiency and risk sharing. One of the main findings of the paper is that an increase in transfers can have large welfare gains by providing insurance and redistribution, when using a utilitarian welfare criterion.

With the availability of extensive micro data, modern macroeconomics has been able to depart from a representative agent framework and use instead heterogeneous agents frameworks, which would then change the impacts of shocks on macroeconomic variables (Brinca, 2020). Additionally, Kaplan and Violante (2018) argue that the Great Recession can be considered as a turning point in the literature, by exposing the shortcomings of a representative agent framework to the business cycle analysis. By departing from representative agent framework, the authors argue that results obtained when using heterogeneous agents may be closer to reality, adding that poorer households act more responsive to income effects and less to substitution effects when compared to wealthier households. In this paper, the authors extensively compare the results and mechanisms from a Representative Agent New Keynesian (RANK) and a state of the art Heterogeneous Agents New Keynesian (HANK) model for multiple shocks. Still on the topic, a possible source of heterogeneity across agents is their time preferences. In fact, Carroll et al.(2017) make use of households time preferences to generate more or less impatient agents, which in turn lead to wealth inequality and different marginal propensities to consume amongst them. In their paper, the authors also

mention that aggregate responses to temporary income shocks will be mostly dependent on which agents bear the shock since they will have different marginal propensities to consume.

Much of the literature related to fiscal instruments tries to measure its impacts on the economy's output, denoting it as fiscal multipliers. For this paper, such conclusions will be helpful in order to understand how taxes and transfers may impact the GDP, and through which mechanisms. Using the data and methodology of Ilzetzki et al. (2013) and Brinca et al. (2016) find a strong correlation between the size of fiscal multipliers and wealth inequality. In their paper, Brinca et al.(2016) developed a life-cycle overlapping generations model with heterogeneous agents and uninsurable labor market risk. The authors calibrated the model to multiple OECD countries and found a high degree of sensitivity of the fiscal multiplier to the share of liquidity-constrained agents. More recently, Brinca et al. (2020) concluded that income inequality may originate stronger recessive impacts of fiscal consolidation programs. In their paper, the authors develop a life-cycle, overlapping generations economy with uninsurable labor market risk, and perform three empirical exercises based on the data sets and methodologies from Blanchard and Leigh (2013), Alesina et al. (2017) and Ilzetzki et al. (2013).

From the literature, the framework for the model that is most similar to the one that shall be used in this paper, comes from Brinca et al. (2019). In this paper, it is shown that the fiscal multiplier of government purchases is nonlinear in the size of the spending shock. To prove this, the authors develop a one-asset HANK model where firms are subject to quadratic costs of price adjustment, a Taylor rule is followed by the Central Bank and there is no physical capital, then, the authors calibrate parameters to fit the US economy.

## 3. Empirical Analysis

In this section I study the impact on inflation coming from fiscal consolidations. These fiscal consolidations can come either through transfers or changes in revenues obtained from indirect taxes on goods and services. Such exercise will provide clairvoyance in the usage of different fiscal instruments and their efficiency in tackling inflation.

### 3.1. Data

The data used in this study is from Alesina et al. (2017). This data set of fiscal consolidations contains over 3500 measures for 16 OECD countries[1] from 1978 to 2014. When constructing this data set, the authors used a narrative approach, stating that such fiscal consolidations were solely driven by the need to reduce government deficits. Such approach makes it possible to filter out policy actions driven by the current economic conditions, thus guaranteeing that these fiscal policies are exogenous to the business cycle.

In the data set, fiscal adjustments are decomposed as a multiyear plan in which some fiscal adjustments were implemented unexpectedly, whereas others are known in advance.

[1] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Portugal, Spain, Sweden, United Kingdom, United States.

Such decomposition will be useful for the empirical analysis part of this paper. Additionally, fiscal consolidations are measured as expected revenue coming from changes in taxes, and as alterations of government expenditure relative to the expected level of expenditure if no policy would have taken place. All fiscal plans are scaled to be in percentage of the economy's GDP.

In the initial paper, the authors measure the macroeconomic effects of fiscal consolidations which were divided into tax-based, consumption-based and transfer-based policies, however, the publicly available data set contains detailed information on each fiscal measure, making it possible to split the fiscal consolidations into more specific categories, such as: taxes on goods and services, personal taxes, income taxes, property taxes, corporate taxes, spending on consumption, spending on salaries, spending on investment and spending on transfers.

As previously stated, the purpose of this empirical exercise is to analyze the impact of a fiscal consolidation through transfers on inflation, and compare it with a fiscal consolidation taken place through an increase in VAT revenues. Though Alesina et al. (2017) merely defend exogeneity of the fiscal measures on the business cycle, one can argue that such exogenous attribute may extend to inflation as well. A possible argument could be made regarding the Central Bank's independence in OECD developed countries. Alesina and Summers (1993) studied the independence level of a group of OECD countries from 1955 to 1988, further mentioning that such values have only increased in more recent times. The authors state that, by delegating monetary policy to an agent who is more inflation averse than the remainder of society, should permit a lower rate of inflation. Hence, one can argue that the role to control inflation has been given to Central Banks and not the government, thus extending the exogeneity characteristic of such fiscal consolidations to inflation. Additionally, in order to guarantee that no fiscal policy was created with the intention to combat inflation, all fiscal measures in the data set were studied according to their description, concluding that no mea- sure refers to inflation, or any other related terminology. Having these arguments in mind, for the remainder of the paper, we will assume that these fiscal consolidation measures presented in the original data set are exogenous to the inflation levels of the countries.

### 3.2. Baseline regression and results

The baseline regression of this empirical exercise is as follows:[2]

$$\pi_{i,t} = \alpha + \gamma_1 Trf^{u}_{i,t} + \gamma_2 Trf^{a}_{i,t} + \gamma_3 VAT^{u}_{i,t} + \gamma_4 VAT^{a}_{i,t} + \gamma_5 G^{u}_{i,t} + \gamma_6 G^{a}_{i,t} + \delta_i + \varepsilon_{i,t}$$

where $\pi_{i,t}$ is the inflation rate measured through the CPI (with base 2010) entailed within the original data set, in country $i$ from the year $t-1$ to $t$. $Trf^{u}_{i,t}$ is an unanticipated fiscal consolidation through transfers on country $i$ at year $t$, $Trf^{a}_{i,t}$ is an anticipated fiscal consolidation through transfers on country $i$ at year $t$, $VAT^{u}_{i,t}$ is an unanticipated fiscal consolidation through indirect taxes on goods and services on country $i$ at year $t$ and $VAT^{a}_{i,t}$ is an anticipated fiscal consolidation through indirect taxes on goods and services on country $i$ at

[2] In the baseline regression all variables relate to the original authors categories, i.e., transfers are originated from "Spending – Transfers" and the VAT variables originate from "Indirect Taxes – Goods and Services".

year $t$. As controls, unanticipated fiscal consolidations through other government spending, $G^u_{i,t}$, and through other forms of tax code changes, $T^u_{i,t}$, on country $i$ at year $t$ are used, as well as country fixed effects, $\delta_i$. For the purpose of the empirical exercise, we will look into how inflation behaves to anticipated fiscal consolidations coming from transfers ($Trf^a_{i,t}$) and compare its behavior when fiscal consolidations are formed from unanticipated changes in revenues related to indirect taxes on goods and services ($VAT^u_{i,t}$), as these are the events that one may realistically observe in the world.

The following table presents the main results from the baseline regression:

Table 1: Baseline regression based on data from Alesina et al. (2017)

| Coefficients | Baseline |
|---|---|
| $\gamma_1$ | 0.021*<br>(0.011) |
| $\gamma_2$ | 0.030***<br>(0.01) |
| $\gamma_3$ | 0.043**<br>(0.018) |
| $\gamma_4$ | -0.005<br>(0.016) |
| $\gamma_5$ | -0.015**<br>(0.005) |
| $\gamma_6$ | -0.021*<br>(0.01) |
| Constant | 0.039***<br>(0.0007) |
| Observations | 566 |
| $R^2$ | 0.030 |
| Number of countries | 16 |

Notes: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Robust Standard errors in parentheses.

Out of the previous table, the coefficients that should be looked into more detailed are $\gamma_2$ which relates to an anticipated fiscal consolidation through the transfers channel, and $\gamma_3$ associated with an unanticipated fiscal consolidation through changes in revenues linked to indirect taxes on goods and services. A $\gamma_2$ of –0.03 means that, for a fiscal consolidation in the amount of 1% of GDP, through a decrease in transfers, inflation will decrease in that year, on average, 3 percentage points, *ceteris paribus*, being significant at a 1% level. When it comes to $\gamma_3$, the coefficient is 0.043, meaning that, for a fiscal consolidation in the amount of 1% of GDP, through an increase in revenues coming from indirect taxes on goods and services, inflation will increase in that year, on average, by 4.3 percentage points, *ceteris paribus*, being significant at a 5% level.

The results refer to fiscal consolidations, however, being a linear regression, and, disregarding possible asymmetrical phenomena on the direction of the fiscal measure (as it is not the focus of the paper), in order to understand the impact of a fiscal expansion on inflation, either through an increase in transfers, or a decrease in the revenues coming from indirect taxes on goods and services, one must only invert the sign of the presented coefficients.

These values can be useful when transposing them into the current debates on inflation behavior to fiscal instruments. An important conclusion from the output presented is that, by increasing transfers, inflation in that same year will increase, whereas if agents are aware of announced transfer cuts, inflation will fall, a possible mechanism behind this is the income effect that transfers generate on agents, thus changing aggregate demand, which goes according to macroeconomic theory.

Interestingly, if government revenues generated from indirect taxes on goods and services fall, inflation within the same period will also fall. This result can be seen as a mechanical phenomenon if, for instance, the VAT decreases then, inflation measured through the CPI in that same year is likely to suffer a decrease with a certain degree of pass-through, such topic is now being extensively studied in countries that adopted such fiscal policies, such as Spain and Portugal. Although the interpretation in this empirical exercise does not refer to changes in the VAT rate, the conclusions taken are in accordance with other papers referred in the related literature section.

### 3.3. Robustness

As robustness tests, four additional exercises were performed. A first test was conducted in order to evaluate if the 4 non-European countries (Australia, Canada, Japan and United States) in the data set could be the source of a different behavior to fiscal policies. As a second robustness test, the regression was restricted to only take into account the values starting from 1994. The reason why one should study the relation between fiscal instruments and inflation starting 1994 is that, within the sample, inflation levels were high and on a decreasing trend for most countries, thus possibly generating a bias when conducting the exercise. In the third exercise, instead of using the authors original categories for transfers and indirect taxes on goods and services, a different approach was taken. In this approach – *Proxy Consolidations* – only fiscal measures containing specific names, definitions, abbreviations were taken into account. This way, one can be sure that only changes related to VAT and transfers targeting the most vulnerable are taken into account.

The last robustness test was made with the lagged values of the explanatory variables, in order to evaluate if, by intervening in year $t$, inflation would only react in $t + 1$. The following table presents the results for the baseline and compares it with all the robustness tests performed:

Table 2: Regressions based on data from Alesina et al. (2017)

| Coefficients | Baseline | European Countries | Year > 1993 | Proxy Consolidations | Lagged |
|---|---|---|---|---|---|
| $\gamma_1$ | 0.021* | 0.021 | 0 | 0.021 | 0.01 |
| | (0.011) | (0.012) | (0.006) | (0.02) | (0.007) |
| $\gamma_2$ | -0.030*** | -0.030** | -0.013*** | -0.030 | -0.037*** |
| | (0.01) | (0.01) | (0.003) | (0.019) | (0.01) |
| $\gamma_3$ | 0.043** | 0.043** | 0.001 | 0.046** | 0.016 |
| | (0.018) | (0.019) | (0.008) | (0.023) | (0.011) |
| $\gamma_4$ | -0.005 | -0.009 | 0.016*** | -0.001 | -0.013 |
| | (0.016) | (0.019) | (0.004) | (0.01) | (0.018) |
| $\gamma_5$ | -0.015** | -0.016** | 0 | -0.014** | -0.016*** |
| | (0.005) | (0.005) | (0.003) | (0.006) | (0.004) |
| $\gamma_6$ | -0.021* | -0.021* | -0.005 | -0.017* | -0.008 |
| (0.01) | | (0.011) | (0.005) | (0.009) | (0.005) |
| Constant | 0.039*** | 0.042*** | 0.02*** | 0.039*** | 0.04*** |
| | (0.0007) | (0.0008) | (0.001) | (0.0007) | (0.0008) |
| Observations | 566 | 422 | 336 | 566 | 566 |
| $R^2$ | 0.030 | 0.037 | 0.031 | 0.020 | 0.022 |
| Number of countries | 16 | 12 | 16 | 16 | 16 |

Notes: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Robust Standard errors in parentheses.

As shown above, the values for $\gamma_2$ and $\gamma_3$ are robust to most exercises performed. According to this empirical exercise, if the government conducts an unanticipated expansionary fiscal policy, by reducing their revenues coming from indirect taxes on goods and services, through a decrease in the VAT rate for example, it will generate a greater impact on inflation in that same period when compared to an anticipated fiscal consolidation through a decrease in transfers to households. Once again, although the empirical exercise only refers to fiscal consolidations, one can extend it to fiscal expansions if it assumes symmetric behavior, thus making sure the previously stated conclusions hold.

The empirical exercise exhibited above helps to understand which fiscal instrument, between transfers and indirect taxes on consumption, has the greatest impact on inflation. The coefficients point towards a greater impact from indirect taxes on consumption which is of no surprise given that such taxes are incorporated into the consumer prices up to a certain degree – the pass-through rate. Knowing which fiscal instrument has the greatest impact on inflation is only part of this study. The following sections of the paper are dedicated to developing, solving and calibrating a structural model which will provide conclusions regarding which type of fiscal instrument is more efficient welfare-wise, when governments are faced with a negative supply shock which creates inflationary pressures.

## 4. **Model**

This section is dedicated to the description of the Heterogenous Agents New Keynesian (HANK) model used in this study, a state-of-the-art model that closely resembles the one presented in Brinca et al. (2019), which in turn closely follows the set up in Auclert et al. (2018). Similarly to the previous papers, this is a one asset economy which is represented by infinitely lived households who face persistent idiosyncratic productivity shocks, and the main source of heterogeneity originates in the agents' discount factors. In this version of the model, agents save through government bonds, and, departing from the previous representations, a consumption tax and targeted transfers have been incorporated in this novelty version of the model.

### 4.1. Households

In this version of the model, agents live forever and are ex-ante heterogenous regarding their discount factor which can take three distinct values, $\beta \in \{\beta_1, \beta_2, \beta_3\}$. Additionally, the agents face persistent idiosyncratic productivity shocks, $e$, that follows an AR(1) process:

$$e' = \rho e + \epsilon, \;\; \epsilon \sim N(0, \sigma^2)$$

Every period, agents choose how much to consume, $c$, work, $n$, and save, $b'$, so as to maximize the same period utility function subject to a budget constraint. Households follow a CRRA type utility function where they enjoy consumption and get disutility from working, as follows:

$$U(c,n) = \frac{c^{(1-\sigma)}}{1-\sigma} - \chi \frac{n^{(1+\eta)}}{1+\eta}$$

Considering this, the household problem can be summarized by the following Bellman equation:

$$V(e,b,\beta) = \max_{c,n,b'} \left\{ \frac{c^{(1-\sigma)}}{1-\sigma} - \chi \frac{n^{(1+\eta)}}{1+\eta} + \beta \mathrm{IE}_{e'} V(e',b',\beta) \right\}$$

subject to

$$(1+\tau_c)c + b' = (1+r)b + (1-\tau_l)wne + g + d + tt + ttax$$

where $\tau_c$ is a consumption tax, $\tau_l$ is a labor tax, $w$ is the wage rate, $g$ are transfers from the government, $d$ are dividends and, as an innovation to previous models, $tt$ are included in the budget constraint and are *targeted transfers*, a distinct type of transfer that will be allocated to the 50% poorest agents, whereas $ttax$ is a distinct type of tax that will be allocated to the 50% richest agents.

### 4.2. Firms

Regarding the firms side, a competitive final goods firm aggregates a range of intermediate goods indexed by $j$ with an elasticity of substitution that is constant and given by $\mu/(\mu-1) > 1$. As for intermediate goods, they are produced by monopolistically competitive firms with a linear production function such as:

$$y_i = F(n_j) \equiv n_j$$

Firms will set a price of $p'$ and are subject to quadratic adjustment costs expressed as:

$$\psi(p',p) = \frac{\mu}{(\mu-1)} \frac{1}{2k} \left[ \log\left(\frac{p'}{p}\right) \right]^2 Y$$

The firm's value function is given by:

$$V(p) = \max_{p'} \left\{ \frac{p'}{p} y - wy - \frac{\mu}{(\mu-1)} \frac{1}{2k} \left[ \log\left(\frac{p'}{p}\right) \right]^2 Y + \text{IE}\left[ \frac{V(p')}{1+r'} \right] \right\}$$

subject to

$$y = \left( \frac{p'}{p} \right)^{-\frac{\mu}{(\mu-1)}} Y$$

Assuming that firms adopt symmetric pricing strategies and taking the first-order condition of the firm's problem, we obtain the following New Keynesian Phillips curve:

$$\log(1+\pi) + k\left(\frac{1}{\mu} - w\right) = \text{IE}\left[ \frac{1}{1+r'} \frac{Y'}{Y} \log(1+\pi') \right]$$

Lastly, households receive dividends from owning firms, which equal output net of labor and costs associated with price adjustments: $d = Y - wL - \psi$

### 4.3. Fiscal and monetary policies

The government budget constraint is defined as:

$$\tau_c C + \tau_l wN + B = (1+r)B_{-1} + G + g + tt + ttax$$

where $C$ is total private consumption, $N$ is the aggregate number of hours worked in the economy, $B$ is privately held government debt (denominated in real terms), and $G$ is public consumption. The monetary authority follows a standard Taylor rule given as:

$$i = r^* + \phi_\pi \pi$$

where $r^*$ is the real interest rate target, $\pi$ is the inflation rate and $\phi_\pi$ is the inflation Taylor rule coefficient. For simplicity, it is assumed that the central bank will target the inflation rate to be zero.

### 4.4. Equilibrium

For a given distribution of agents in the economy, $\Phi$, the competitive equilibrium can be defined as follows:

1. Taking factor prices and initial conditions as given, households maximize the value function $V(e, b, \beta)$ with the respective policy functions being given by $c(e, b, \beta)$, $n(e, b, \beta)$, and $b'(e, b, \beta)$.
2. Firms optimize their choices regarding prices, employment, and production.
3. Fiscal and monetary authorities follow their rules.
4. The bonds market clears

$$B = \int b d\Phi$$

5. The labor market clears

$$N = \int n(e,b,\beta)\, e d\Phi$$

6. The goods market clears

$$Y = \int c(e,b,\beta)\, d\Phi + \mathrm{G} + \Psi$$

## 5. Calibration

For the purpose of this study, the model will be calibrated to the Portuguese economy. Some parameters were calibrated based off from their empirical counterparts, whereas the remainder were calibrated using the Sequence-Space Jacobian computational strategy, proposed by Auclert et al. (2021). What follows is a brief explanation on the process behind the choices for the calibrated parameters. Additionally, Table 5 in the Appendix presents a summarized version of the calibrated parameters. Starting off with the Frisch elasticity of labor supply, in this paper it is set to 1 which is considered a standard value in the literature. The net public debt ($B/Y$) is set to be equal to the IMF's Portuguese annual average from 2001 to 2008 – 0.557. Still from IMF's dataset, the average government expenditure is 0.2712, being the average annual value from 2001 to 2008. According to OECD data, the Portuguese average labor tax was of 28.1%, as such, this is the value attributed in the model. Lastly, given that one of the main purposes of this exercise is to understand how the economy behaves to a temporary decrease in the VAT rate, $\tau_c$ is set to 0.06, which is

the rate attributed to goods of first necessity and also the rate which was temporarily changed starting April 2023.

Out of all the parameters, six are calibrated in the model to match data moments – the discount factors, borrowing limit, disutility of labor and the cross-sectional std. of log earnings will match the wealth quartiles, the percentage of Hand-to-Mouth agents, the share of hours worked and the variance of log wages, respectively, thus making the system exactly identified. The computational strategy is set so that it minimizes the following loss function:

$$L\ (\beta 1,\ \beta 2,\ \beta 3,\ b,\ \chi,\ \sigma\epsilon) = ||Mm - Md\ |$$

Table 3 and Table 4 report on the calibration fit for the model.

Table 3: Calibration fit of the benchmark economy, Portugal

| Data Moment | Description | Source | Data Value | Model Value |
|---|---|---|---|---|
| $n^{\sim}$ | Average fraction of hours worked 1990-2011 | OECD | 0.249 | 0.249 |
| Var(ln $w$) | Variance of log wages | LIS | 0.298 | 0.298 |
| % of HtM | Fraction of Hand-to-Mouth households | Wave 3 of HFCS | 0.28 | 0.2879 |
| $Q_{25}$, $Q_{50}$, $Q_{75}$ | Wealth Quartiles | LWS | 0.0058, 0.0821, 0.266 | 0.0027, 0.0545, 0.2654 |

Table 4: Parameters Calibrated Endogenously

| Parameter | Description | Value |
|---|---|---|
| $\beta_1$, $\beta_2$, $\beta_3$ | Discount factors | 0.904, 0.954, 0.983 |
| $\underline{b}$ | Borrowing limit | 0.005 |
| $\chi$ | Disutility of labor | 14.942 |
| $\sigma_\epsilon$ | Cross-sectional std. of log earnings | 0.3345 |

## 6. **Welfare Analysis**

### 6.1. Benchmark scenario – negative unanticipated tfp shock

The following subsection refers to the benchmark case for this exercise. In this scenario, an economy was hit with a one-time, unanticipated, temporary, negative supply sided shock which takes some time to dissipate and generates inflationary pressures – *Negative Unanticipated TFP Shock*. For simplicity, the shock is such that it will generate in the first period an

increase in inflation of 1 percentage point, moving from 0% in the original steady state, to 1% in period one. In this scenario, the government will maintain a balanced budget and will use lump-sum transfers/taxes in order to guarantee so.

### Overall Economy

When analyzing the Impulse Response Functions presented in Figure 5 and Figure 6 we reach the following conclusions for the overall economy:

1. Output ($Y$): due to a negative TFP shock, output in the economy will decrease, slowly converging back to its steady-state level after 50 quarters.
2. Real interest rate ($r$): faced with inflationary pressures, the monetary authority will follow its rule and increase the real interest rate.
3. Wage rate ($w$): the real wage rate will be pro-cyclical and, as firms become less productive due to a negative productivity shock, they will see the need to decrease wages.
4. Dividends ($d$): similar to the wage rate, dividends will also decrease, following the expression provided in the model setup section of the paper.
5. Hours worked: following an increase in the interest rate, there will be an intertemporal substitution effect which will provide an incentive for agents to work more in the current period. Additionally, the fall in the wage rate will create an income effect which will make agents wish to work more, as well as an intra-temporal substitution effect by making leisure a relatively cheaper good and thus making agents want to work less. Combining all the effects we observe that the overall effect in the economy is that total hours worked will increase momentarily.
6. Lump-sum taxes: When looking at the government's budget constraint, and knowing that there must be a balanced budget in this scenario, the natural conclusion is for Lump-sum taxes to increase due to an increase in the real interest (it now becomes more costly to honor the debt level).
7. Consumption: similarly to total hours worked, consumption will suffer changes originating from income and substitution effects. An increase in the real interest rate will make the opportunity cost of consuming today greater, and thus, this intertemporal substitution effect will push consumption down. Consumption will also fall due to the decrease in wages, dividends and an increase in lump-sum taxes, giving origin to three negative income effects.
8. Utility: As observed in the impulse response functions, we notice how utility falls and takes a while to recover. This is naturally explained since consumption has fallen and the total hours worked has increased.

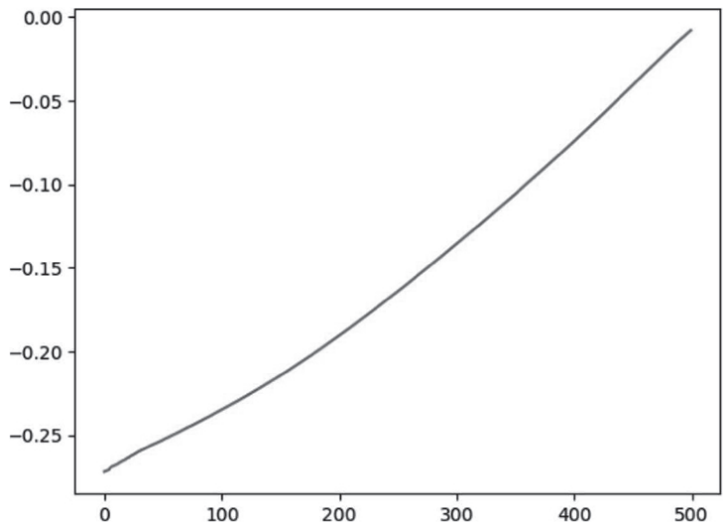
## Measuring Welfare

In order to understand the impact of such shock on welfare, we must first compute the welfare state. For the purpose of this paper, the economy's welfare will be measured through a utilitarian approach by summing all the agent's lifetime welfare. Each agent's lifetime welfare is obtained through the net present value of the agent's utility throughout the horizon being studied, discounted by their respective discount factors, as follows:

$$w = \Sigma(\beta^{t-1} u_t)$$

Lastly, we apply the module of this value and calculate the percentage change from the steady-state as if nothing happened, in order to obtain a more conventional analysis regarding how much welfare changed in the economy when hit with the shock. What follows is the change in welfare across the wealth distribution in the economy, ranging from *0 assets* to *500 assets*. Figure 1 shows what is highly portrayed in much of the literature regarding asymmetrical inflation effects. As observed, the poorest in the economy are the ones who have suffered the biggest losses in their welfare. The graphs tell us that, although everyone in the economy has become worst off with such event, the poorest agents have suffered the biggest losses in welfare, registering decreases up to 0,25% when compared to a scenario if there was not *Negative Unanticipated TFP Shock*. A possible explanation is that the poorest agents usually react more to income effects and not so much to substitution effects when compared to the wealthiest, and, as such will suffer bigger decreases on consumption while being required to work more, as stated previously. In fact, that is precisely what is observed when considering Figure 7 and Figure 8 of the Appendix.

Figure 1: % Change in welfare across the wealth distribution



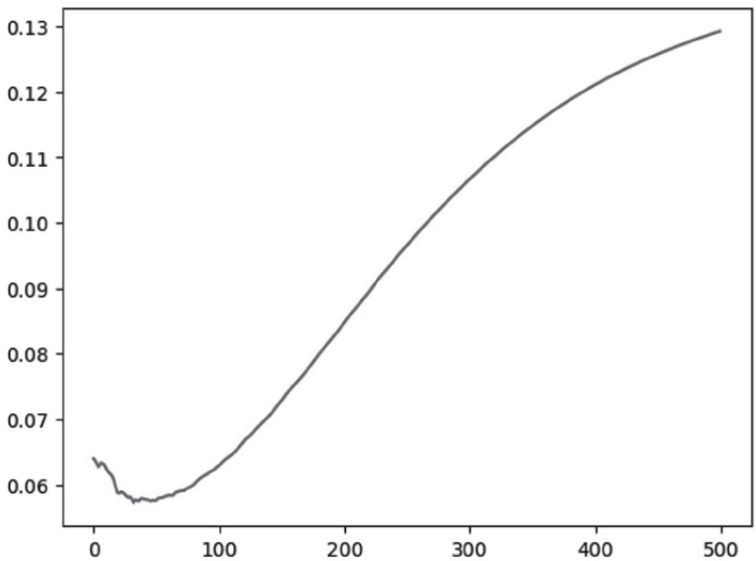
### 6.2. Vat reduction scenario

In this exercise, when faced with the same previous *Negative Unanticipated TFP Shock*, the government will perform a deficit-financed fiscal expansion policy where it will reduce the current consumption tax in the economy and slowly increase it throughout time in order to be able to repay the newly created debt, in order to clear the government's budget constraint, lump-sum transfers/taxes will be used for all agents in the economy. Looking at Figure 9 and Figure 10 we take the following conclusions:

1. Consumption Tax ($\tau c$): As part of the fiscal policy, the government will intervene and reduce the consumption tax, while slowly increase it back to its steady-state level as time goes by.
2. Bonds ($B$): Being a deficit-financed policy, the government bonds level will increase momentarily, following a defined path of repayment using a combination of both the consumption tax path and lump-sum taxes.
3. Consumption: Facing a lower consumption tax, households will be able to consume more in the economy, effectively feeling a positive income effect. This expansion in consumption will only be temporary but it will serve to expand the aggregate demand of the economy.
4. Output ($Y$): Though there is still present a Negative Unanticipated TFP Shock, the increase in consumption, and thus aggregate demand, more than compensates for the decrease in productivity, and so, we observe a New Keynesian channel which makes output increase momentarily via an expansion in the demand side of the economy.
5. Inflation: The inflation rate will observe a big decrease in the first period due to the decrease in the consumption tax. This decrease is explained by the pass-through rate which in the model has a value of 100%. As $\tau_c$ shifts back to its original value, and the aggregate demand pulls the economy's output upwards, so too will the inflation levels jump. In fact, the increase in the inflation level is such that, up until it converges to the steady-state level (0%), it will always be above the inflation levels if there was no government intervention.
6. Lump-sum Taxes: Taking a look at the lump-sum taxes in the economy, one can observe that these are negative in the first periods, thus becoming effectively lump-sum transfers to households and providing an additional income effect to consumption. Not long after, this variable becomes positive and thus the government starts to repay its debt through lump-sum taxation.
7. Real interest rate ($r$): faced with inflationary pressures, the monetary authority will follow its rule and increase the real interest rate, given that the inflation tendencies were greater than in the benchmark scenario with no government action, so too will the increase in the real interest rate be greater.
8. Utility: Finally, although there was a *Negative Unanticipated TFP Shock*, government intervention did in fact provide a way to improve the economy's utility, this is driven by the increase in consumption.

We now proceed to analyze the welfare percentage changes in this scenario, as opposed to if nothing in the economy were to happen. As seen in Figure 2, everyone's welfare across the wealth distribution improves with such measure, however, the richest in the economy clearly benefit more. Such measure may create inequalities since VAT by itself is already progressive, and so, by temporarily decreasing it, one could argue it is actually a regressive action. Having in mind that the welfare is measured through the net present value of all utility, and this in turn is dependent on consumption and hours worked, one must look into these variables in order to understand what is going on. Figure 11 and Figure 12 go according to what has been said. There seems to be an inequality generated with such measure where, although everyone is benefiting from such fiscal policy, the poorest have the lowest consumption increase (around 0.35%) whereas the richest consume 0.65% more. The agents at the left side of the wealth distribution are also the ones who seem to be working more hours, having an increase of around 0.70%, this is especially significant when taking into consideration that the richest agents have only increased hours worked by around 0.30%. One mechanism that explains such phenomena is that, due to a great increase in the real interest rate, the agents who hold higher quantities of wealth will feel a big income effect and thus not feeling the need to work as much when compared with the agents that hold little or no amount of assets.

Figure 2: % Change in welfare across the wealth distribution – VAT decrease scenario




All in all, such measure seems to be a success in dealing with overall welfare measured through a utilitarian way. Though it may lead to inequalities, the economy's overall welfare improved by 0.334% if the government did not intervene with such action.

### 6.3. Robin Hood scenario

This last exercise refers to an alternative scenario where there is still the same *Negative Unanticipated TFP Shock*, but now the government decides to do a deficit-financed fiscal expansion policy increasing targeted transfers which will go to the poorest 50% agents in the wealth distribution. This scenario will have the same debt repayment path as the one in the previous scenario, in order to make the two cases comparable in size. To pay for the debt, the government will increase taxes but only to the richest 50% in the wealth distribution – effectively taking from the richest to give to the poor. To take conclusions regarding this scenario, we will look into Figure 13 and Figure 14 of the Appendix.

1. Targeted Transfers to the poorest ($tt$): As part of the fiscal policy, the government will intervene and increase targeted transfers to the poorest 50% in the wealth distribution. This policy will dissipate as time goes by, eventually returning to their steady-state levels, zero.
2. Bonds ($B$): To be comparable with the VAT scenario, the government bonds impulse response function, and therefore its payment path, must be the same.
3. Targeted Taxes to the richest ($ttax$): This variable will be the one which will clear the government budget constraint, and so, it will be whatever it needs to be to account for the increase in spending. As seen in its IRF, this tax is actually negative in the first periods, so, the richest are effectively getting more money, however, this is soon undone and there is a huge spike in order to start repaying the newly created debt.
4. Consumption: Consumption will see a great increase in the early stages due to an increase in transfers to both the poorest and richest, thus creating an income effect for all households in the economy, eventually boosting consumption and aggregate demand.
5. Output ($Y$): Similarly to the VAT decrease scenario, though there is still present a Negative Unanticipated TFP Shock, the increase in consumption, and thus aggregate demand, more than compensates for the decrease in productivity.
6. Inflation: The original Negative Unanticipated TFP Shock was done in order to produce a inflation rate of 1% in the first period, but now, since we have an increase in aggregate demand through an expansionary fiscal policy (and, contrary to the VAT decrease scenario, no pass-through rate), inflation will actually be higher than 1% in the first period, but fastly converging back to 0. Interestingly, we see that inflation will not be as high in the following periods when compared to the VAT decrease scenario, this goes according to the conclusions on the empirical exercise regarding the magnitude of fiscal instruments on inflation, where we saw that fiscal policy through indirect taxes have a greater impact on inflation.
7. Real interest rate ($r$): The behavior of this variable is similar to the VAT decrease scenario. However, the increase in the real interest rate is greater due to the higher inflation rate levels in the first periods.
8. Utility: Finally, although there was a Negative Unanticipated TFP Shock, government intervention did in fact provide a way to improve the economy's utility, this is driven by the increase in consumption.

As in the previous scenarios, Figure 3 depicts the change in welfare across the wealth distribution. Contrary to the previous scenarios though, if the government decides to tax the richest 50% to give to the poorest 50%, the ones who will observe greater increases in welfare are the poorest in the economy. However, within the middle of the asset distribution, the middle class will actually suffer welfare losses. Looking at Figure 15 and Figure 16 we can see that the ones who will decrease consumption and suffer the highest increases in hours worked are in the middle of the asset distribution. A possible explanation is that, around the values where we observe this behavior, we are already in the top 50% richest agents of the economy, so they will suffer the greatest burden with such policy, and, at the same time, will not own enough assets for the income effect coming from an increase in the interest rate to compensate. Although the change in overall welfare of this policy is not as big as with the VAT decrease scenario (in this case, the economy's overall welfare only increased by 0.28% as opposed to 0.33% in the previous scenario), Figure 4 demonstrates that this policy provides greater welfare changes up until the poorest 33% agents in the economy, fully including the Hand-to-Mouth agents too. Knowing this, one could argue which measure of welfare should be used for the whole economy. In this paper, a utilitarian approach was used, however, this transfers policy could have brought greater welfare changes to the overall economy if one used a Rawlsian approach, for example.

Figure 3: % Change in welfare across the wealth distribution – Robin Hood scenario

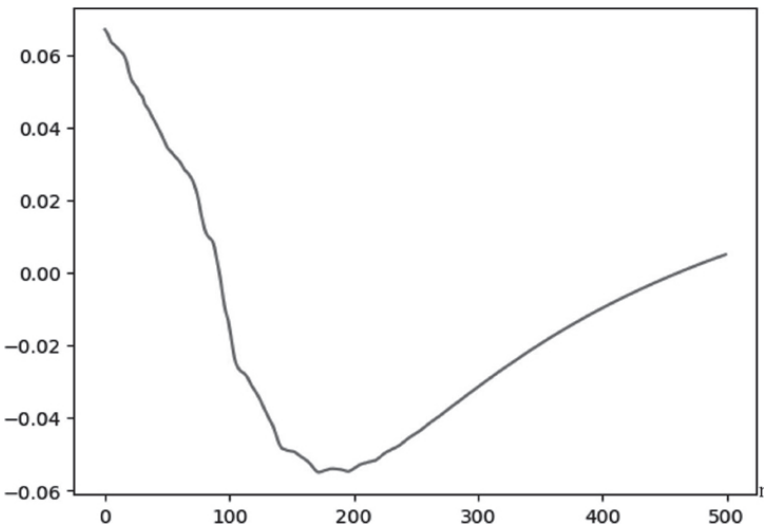
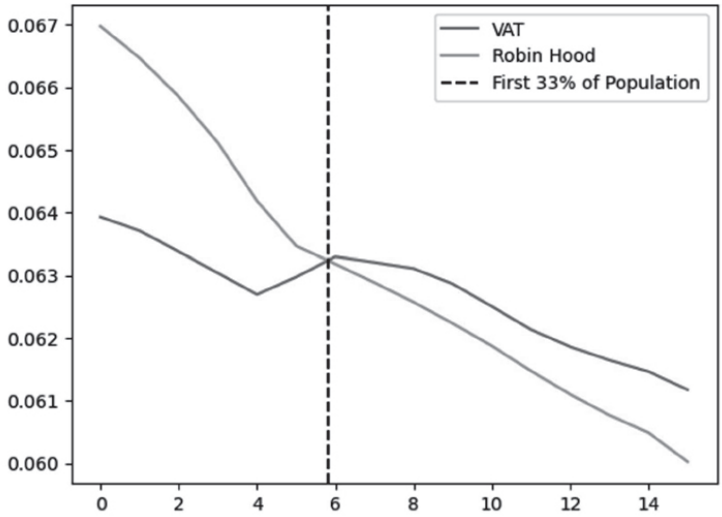


Figure 4: % Change in welfare across the wealth distribution – Scenario Comparison




## 7. Conclusion

This paper aimed at extending the literature of the effects originated from the recently adopted temporary VAT rate changes across multiple countries, while comparing it with the much debated counterpart policy – an increase in transfers to the most vulnerable. To do so, an empirical exercise was conducted to understand which fiscal policy would generate greater impacts on inflation. Later, a one-asset HANK model was constructed in order to evaluate the welfare impacts on the economy coming from such fiscal actions, while also confirming the conclusions previously taken in the empirical exercise.

This study finds that unanticipated fiscal expansions due to decreases in revenues from indirect taxes on goods and services lead to lower inflation levels, which goes according to current literature regarding the pass-through rate to consumer final prices when there is a change in the VAT rate. Additionally, we find that an anticipated fiscal expansion through an increase in government transfers also increases inflation, but to a lesser degree than when there is a change in revenues coming from indirect taxes on goods and services.

As for the welfare impacts, we find that a *Negative Unanticipated TFP Shock* will negatively impact everyone in the society, and that the poorest are the ones who will suffer the most, thus generating inequality. We show that both a fiscal expansion through a consumption tax decrease or an increase in targeted transfers lead to a higher welfare level if the government did not intervene. Additionally, the results conclude that a fiscal expansion through a VAT decrease will lead to a higher welfare of the economy, measured in a utilitarian way, and will lead to greater inequalities, whereas, although an increase in transfers to the poorest, paid

by the richest, will lead to lower levels of welfare, it will decrease inequality, since the bottom 33% in the wealth distribution will be the ones benefiting the most.

To conclude, though both fiscal policies lead to a welfare improvement, a VAT decrease will generate greater levels of inequality since the richest will benefit the most from such policy. In a richer model, where firms' profits are distributed to asset holders and markups are not constant, a VAT decrease will, in general, not generate a pass-through of 100% (unlike our model), meaning that welfare gains would be more unequally distributed and concentrated on the rich, thus decreasing the welfare gains we document here. It is ultimately up to the society to decide how welfare should be measured and how much should we consider inequality across the wealth distribution. One must also take into account that the inflationary tendencies might have been greater than modeled and that it can be a challenge to compare the two type of policies empirically, since they may not be comparable in size regarding deficit levels.

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## Appendix

Table 5: Calibration of one-asset HANK economy, Portugal

| Parameter | Description | Value | Source |
|---|---|---|---|
| Households<br>$\sigma$ | Inverse IES | 1.2 | Trabandt and Uhlig (2011) |
| $\eta$ | Inverse Frisch | 1 | Consistent w. literature |
| $\rho$ | Autocorrelation of earnings | 0.761 | PSID 1968-1997 |
| Firms<br>$\mu$ | Steady-state markup | 1.1 | Consistent w. literature |
| $\kappa$ | Slope of Phillips Curve | 0.1 | Consistent w. literature |
| Fiscal and Monetary Authorities | | | |
| $B/Y$ | Average net public debt | 0.557 | IMF 2001-2008 |
| $G$ | Average government expenditure | 0.2712 | IMF 2001-2008 |
| $\tau_c$ | Consumption Tax | 0.06 | Portuguese lowest VAT rate |
| $\tau_l$ | Average Labor Tax | 0.281 | OECD |
| $\phi_\pi$ | Taylor-Rule coefficient on inflation | 1.25 | Consistent w. literature |

Figure 5: IRF for Output, Consumption, Lump-sum Taxes and Dividends when hit with a Negative Unanticipated TFP Shock – Benchmark scenario

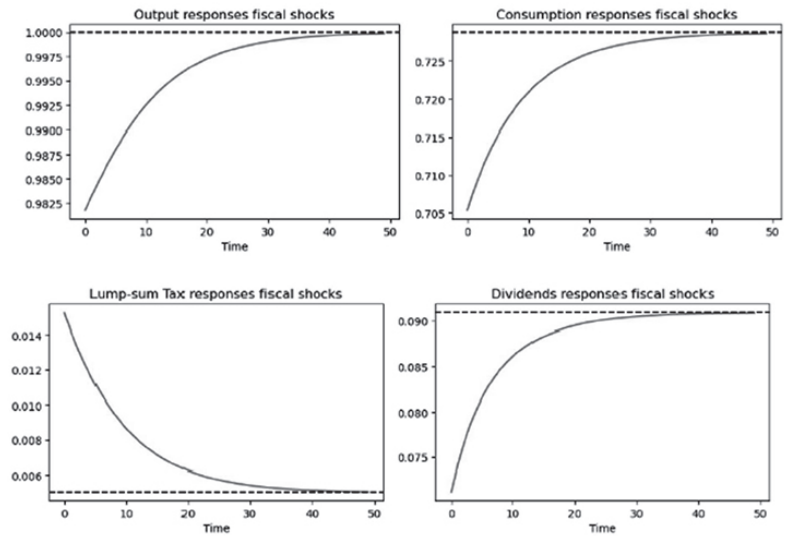

Figure 6: IRF for *r*, Inflation, *i*, Utility, Wage rate and Hours Worked when hit with a Negative Unanticipated TFP Shock – Benchmark scenario

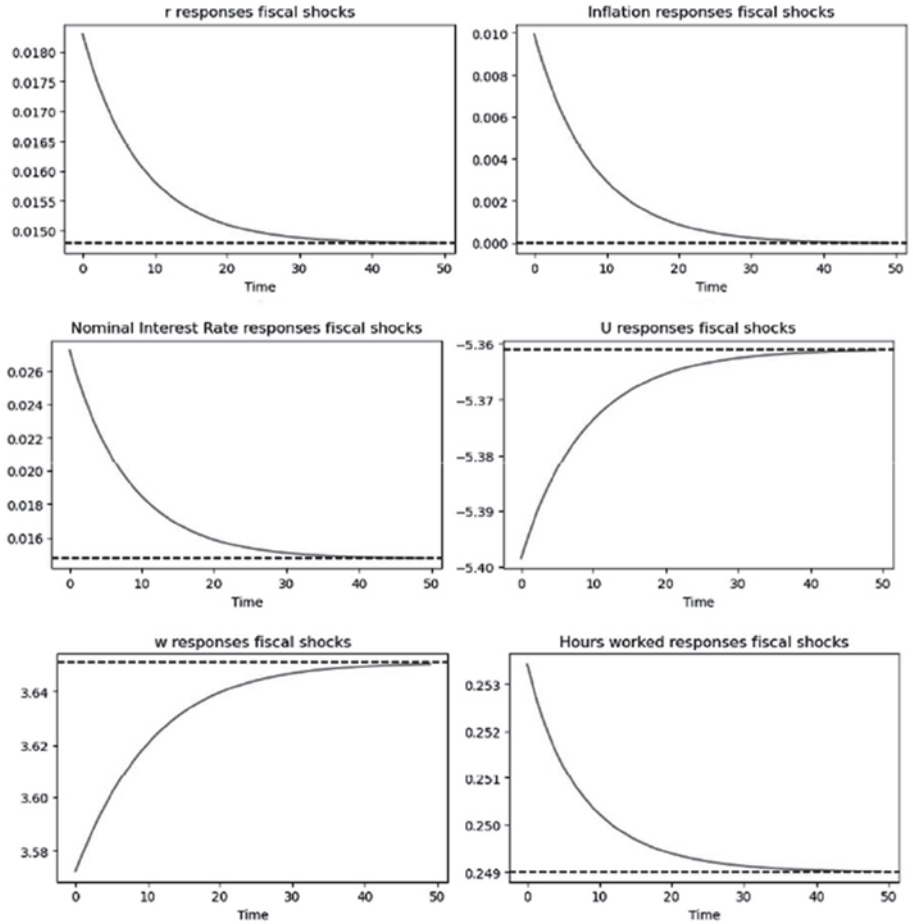

Figure 7: % change in consumption from steady-state when hit with a Negative Unanticipated TFP Shock, across wealth distribution – Benchmark scenario

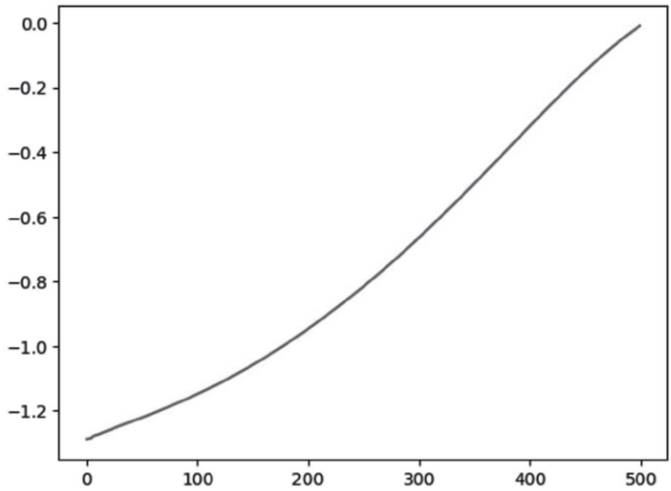


Figure 8: % change in hours worked from steady-state when hit with a Negative Unanticipated TFP Shock, across wealth distribution – Benchmark scenario

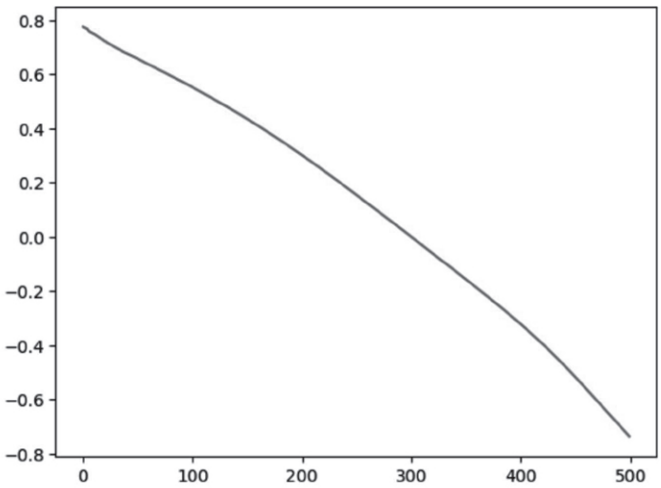

Figure 9: IRF for Output, Consumption, Consumption Tax and Bonds when hit with a Negative Unanticipated TFP Shock and a reduction of the consumption tax – VAT decrease scenario

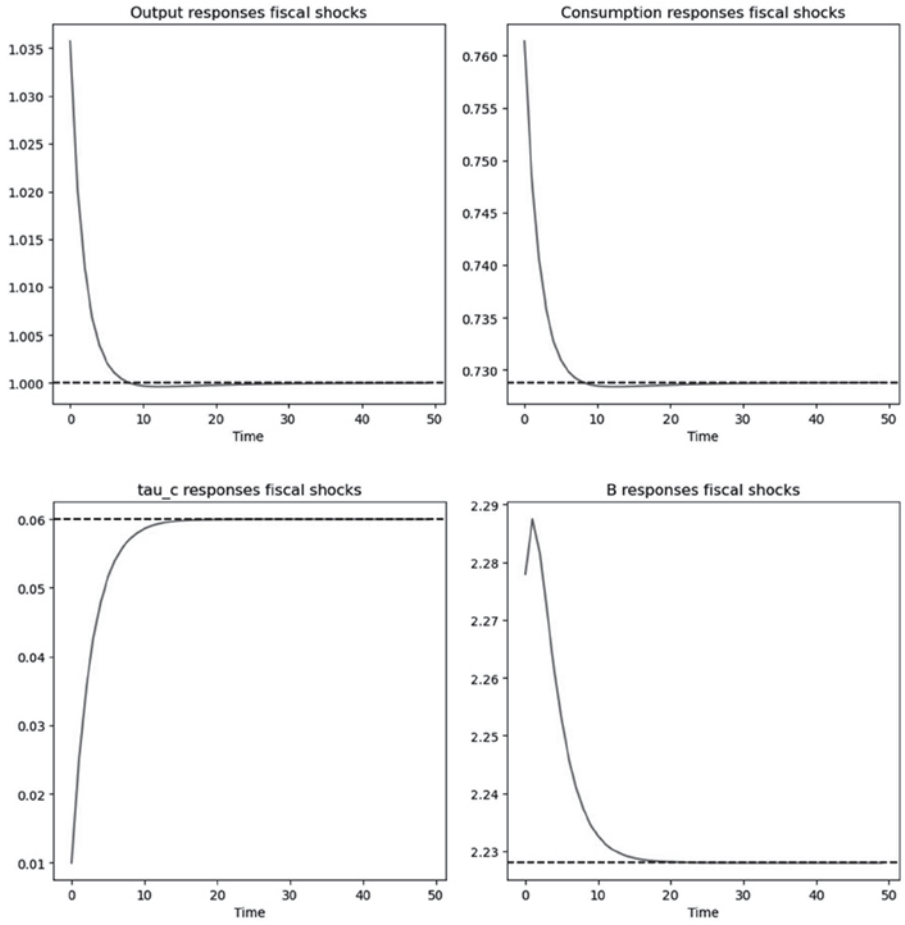

Figure 10: IRF for *r*, Lump-Sum Tax/Transfer, Inflation and Utility when hit with a Negative Unanticipated TFP Shock and a reduction of the consumption tax – VAT decrease scenario

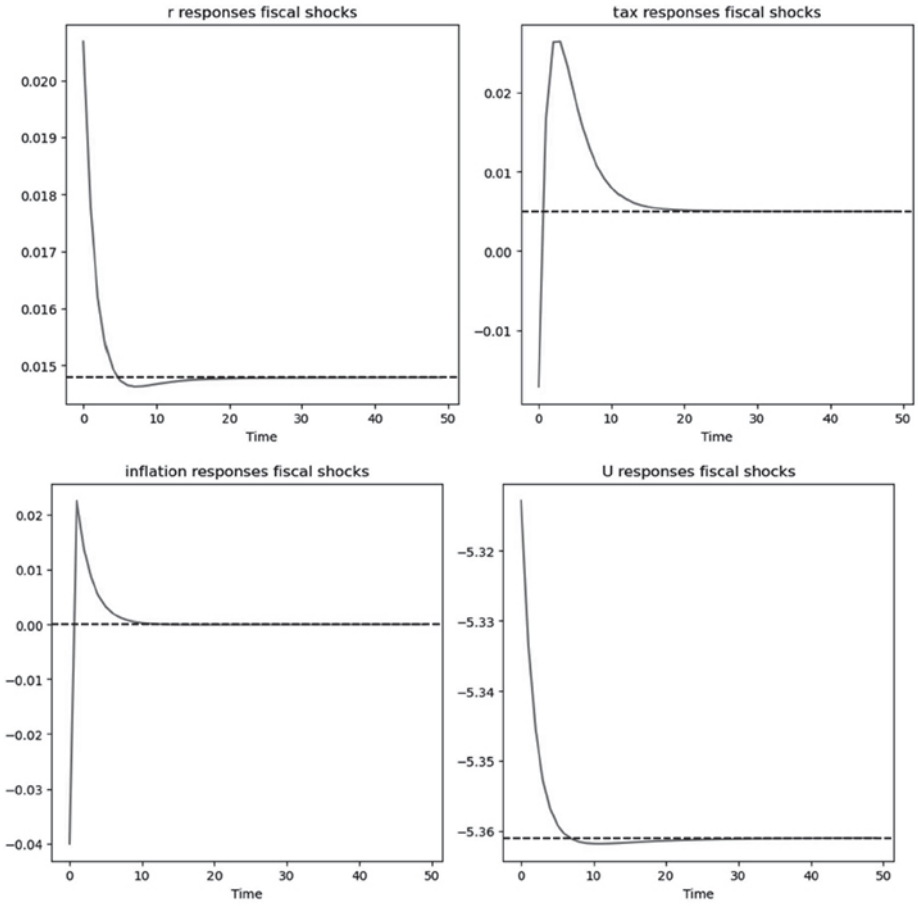

Figure 11: % change in consumption from steady-state when hit with a Negative Unanticipated TFP Shock, across wealth distribution – VAT decrease scenario

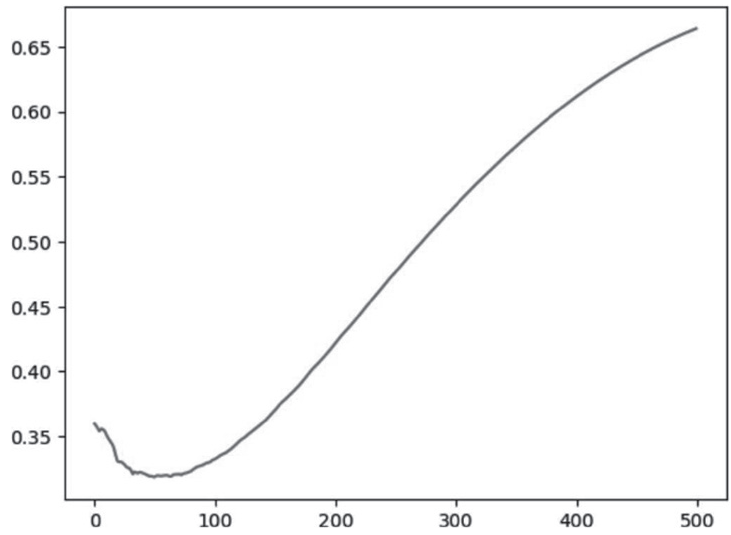


Figure 12: % change in hours worked from steady-state when hit with a Negative Unanticipated TFP Shock, across wealth distribution – VAT decrease scenario

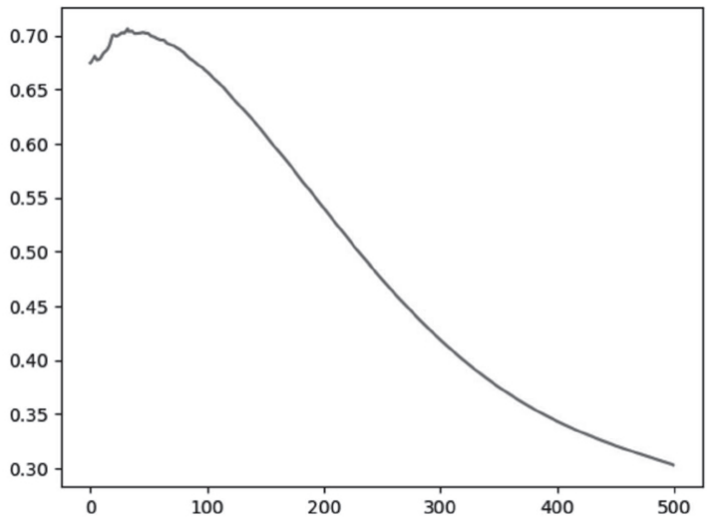

Figure 13: IRF for Output, Consumption, Taxes to the Richest and Bonds when hit with a Negative Unanticipated TFP Shock and an increase in targeted transfers to the poor – Robin Hood scenario

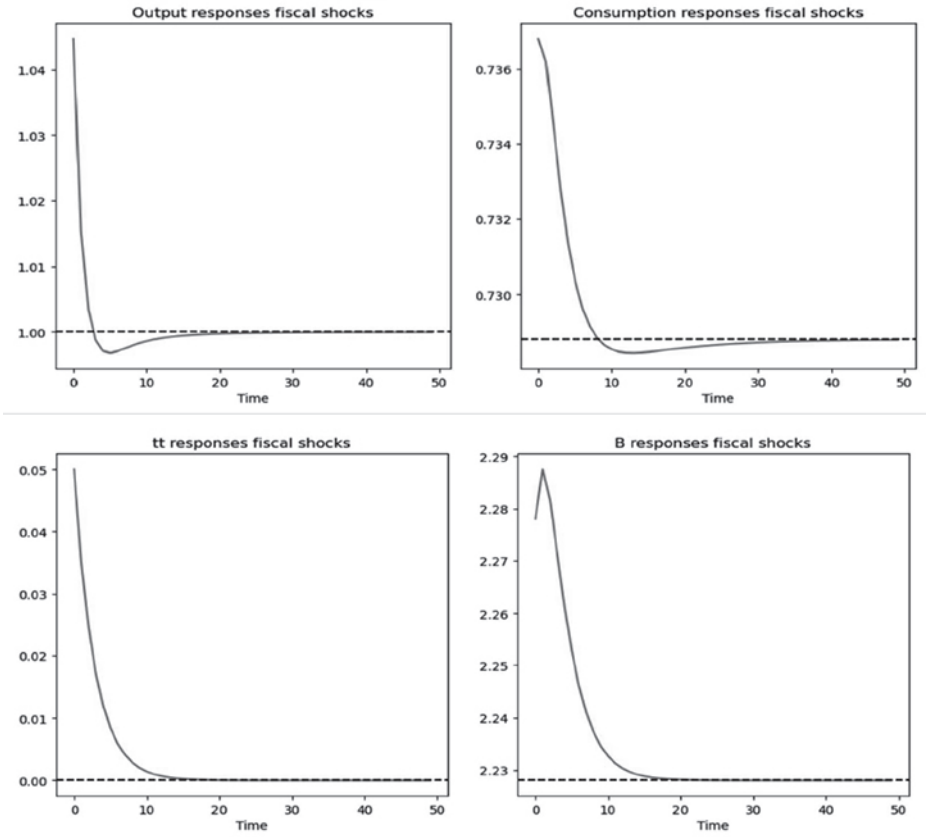

Figure 14: IRF for *r*, Transfers to the Poorest, Inflation and Utility when hit with a Negative Unanticipated TFP Shock and an increase in targeted transfers to the poor – Robin Hood scenario

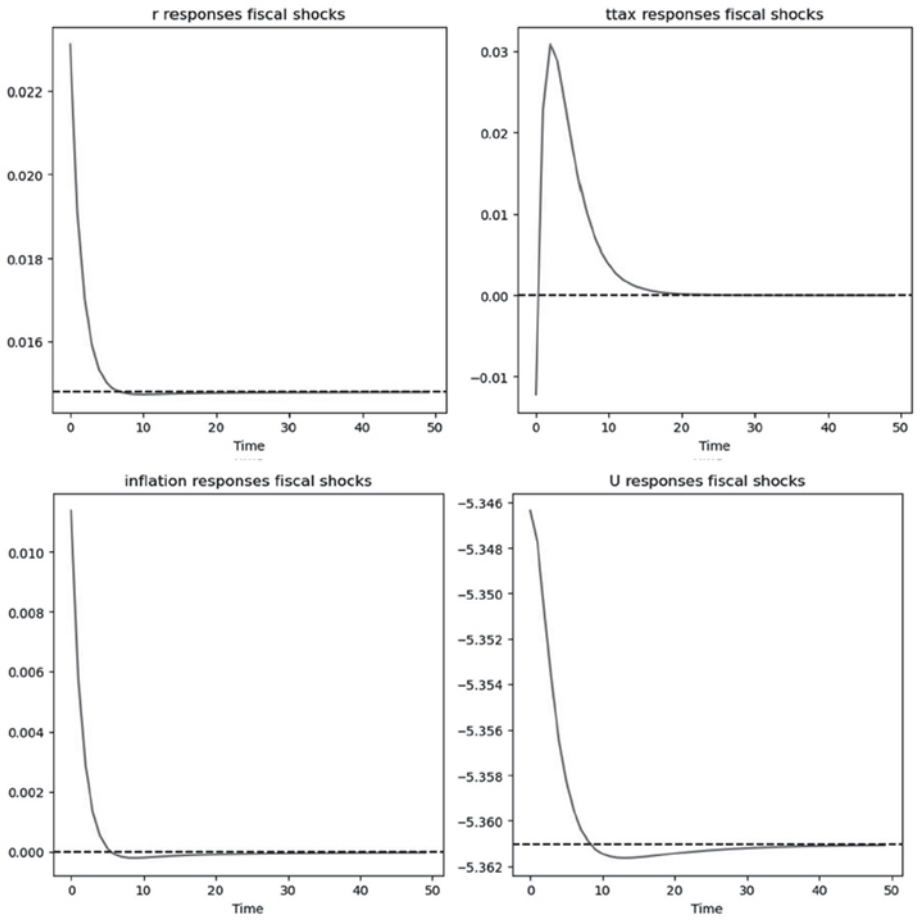

Figure 15: % change in consumption from steady-state when hit with a Negative Unanticipated TFP Shock, across wealth distribution – Robin Hood scenario

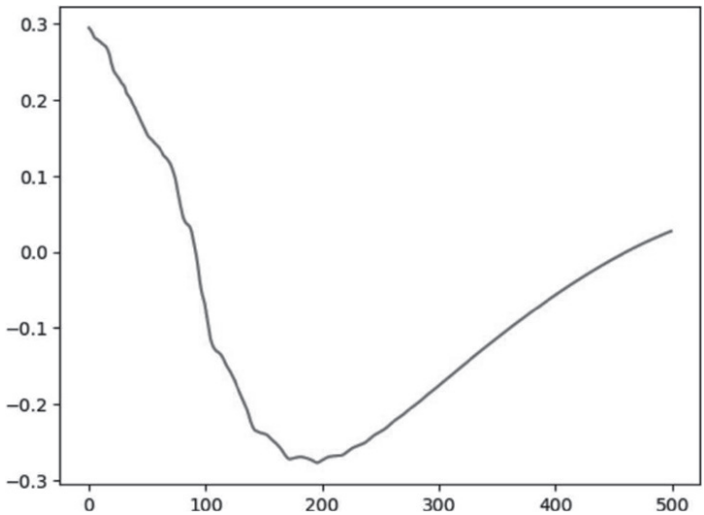


Figure 16: % change in hours worked from steady-state when hit with a Negative Unanticipated TFP Shock, across wealth distribution – Robin Hood scenario