Minimum Wage Policy and Macroeconomic Adjustment: Insights from a Small Open Economy Model with Formal and Informal Labor*

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Abstract

We examine the adjustment of a small and open emerging market economy (SOEME) to an unexpected increase in the minimum wage using an extended New-Keynesian SOE model. Our model incorporates heterogeneity among households, a flexible production structure, and a minimum wage rule based on labor productivity, past inflation, and unexpected shocks. Calibrating the model for Colombia, we find that an unexpected increase in the minimum wage has significant effects on real variables (output and employment), while the impacts on inflation and the policy interest rate are relatively weaker. The rise in the minimum wage prompts the substitution of formal low-skilled labor with informal jobs and capital, resulting in reduced output, increased inflation, and higher policy interest rates. We also observe that the minimum wage influences the transmission of productivity, demand, and monetary shocks, leading to a more persistent impact on macroeconomic variables. Our findings suggest that the minimum wage is an important policy instrument that has significant macroeconomic implications. The results of our study are relevant for policymakers in emerging SOEs that consider increasing their minimum wage.

JEL classification: E13, E50, J31, J46.

***Keywords*—** DSGE model, minimum wage, informal labor markets, monetary policy, heterogeneous agents.

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1 Introduction

What are the macroeconomic effects at business cycle frequencies of changes in the minimum wage? How do the minimum wage and its setting rules change the transmission of shocks to the economy? Recent studies on the general equilibrium macroeconomic effects of the minimum wage have focused on developed economies. Two notable studies are Šauer (2018) and Glover (2019), which analyzed the macroeconomic effects of changes in the minimum wage for the United States and how they would depend on monetary policy, specifically, the strength of its determination to fight inflation, or how "hawkish" or "dovish" monetary policy is (Šauer (2018)), and the impact of having monetary policy constrained by the zero-lower bound (Glover (2019)). However, the results of these papers may not be directly applicable to developing economies, where the minimum wage has far greater relevance within the economic structure, the economy is better characterized as small and open, monetary policy is less likely to hit the zero-lower bound and other characteristics such as informality in labor markets are key features of the environment. In this paper we answer those questions for emerging, small open economies, filling a gap in the literature.

By many measures, some of which are reported in Table 1, the relevance of the minimum wage in emerging market economies (EMEs) is much higher than in developed economies and thus, potentially, its aggregate implications. In particular, the share of workers earning the minimum wage in emerging market economies is over twice that of developed economies (DEs). Moreover, in the former, the minimum wage serves to a greater degree as a reference for the determination of wages that are not subject to the minimum wage, a phenomenon known as the lighthouse/beacon effect.

Table 1: Minimum wage, EMEs and DEs.

	EMEs	DEs	Colombia
% of workers receiving the minimum wage	19.8%	9.0%	15.7%
% of workers receiving less than the minimum wage (total informality)	69.5%	7.8%	58.1%
% of workers receiving less than the minimum wage (urban informality)	59.8%	7.3%	51.0%
% of workers receiving less than the minimum wage (rural informality)	78.8%	9.7%	84.5%
Average frequency of change in minimum wage (years)	4.0	2.0	1.0
Minimum wage as % of median wage	67%	55%	90%
Minimum wage as % of mean wage	45%	41%	54%

Notes: Informal jobs are those that are not subject to labor laws, income taxes, or social protection. They may be non-declared, casual, low-wage, or performed by unincorporated enterprises or in households. The frequency of change in the minimum wage is measured as the average number of years of how often it changes.
Sources: ILO (2020), ILO STAT Database, OECD. Own calculations.

Furthermore, EMEs typically have lower and more dispersed levels of labor productivity, which implies that employers face more difficulties absorbing the additional labor costs associated with changes in the minimum wage. Also, EMEs are characterized by higher degrees of labor informality, which implies the existence of a market wage below the legal minimum wage. Also, labor informality may, in part, be the result of the minimum wage. As shown in Table 1, the percentage of informal workers, measured as those workers who do not have a labor contract and who are therefore more likely to earn a wage lower than the legal minimum, is considerably higher in EMEs than in DEs. When facing changes in the minimum wage or shocks, this situation generates a possible mechanism of substitution of low-productivity formal workers, who earn the minimum wage, with informal labor, who earn a lower wage, or even with machines through automation.

Also, in EMEs and countries with low levels of per capita income, minimum wages are relatively higher compared to DEs and are earned by a higher percentange of the formal workers. As shown in Table 1, minimum wages are set at approximately 55% of the median wage in DEs and around 67% of the median wage in EMEs and developing countries. In addition, the frequency of minimum wage adjustments differs significantly between EMEs and DEs. On average, EMEs adjust their minimum wage every four years, while DEs tend to do so every two years (Table 1). In EMEs, these adjustments typically (or often?) follow a predetermined rule that is known to all economic agents (see section 2).

In this paper, we study the macroeconomic and general equilibrium effects of the minimum wage in emerging or developing economies. To do this, we propose a TANK-SOE model that explicitly considers the aforementioned characteristics of emerging economies and that contrasts with those of developed economies studied in the literature.

The economy is populated by two types of households: highly skilled and low-skilled. Highly skilled households participate in the formal labor market and have access to domestic and international financial markets. They own both types of capital and firms, and receive a wage determined by the interaction of supply and demand of labor. Low-skilled households, on the other hand, only have wage income, as they lack access to savings and investment opportunities. These households offer their labor both in the formal and informal labor markets. Low-skilled formal workers earn the minimum wage, while low-skilled informal workers earn less than the minimum wage required by law. One factor that can influence the employment of low-skilled formal workers after an increase in the minimum wage is the type of capital used by firms. To consider the possible direct effect on the employment of low-skilled formal workers after an increase in the minimum wage, there are two types of capital: machinery capital and buildings capital. Machinery capital is a substitute for low-skilled labor, which means that, in the face of an increase in the minimum wage, firms can lay off low-skilled workers and buy machines to replace them. Buildings capital, on the other hand, is complementary to labor. The minimum wage is adjusted according to a rule that takes into account observed inflation and productivity growth but leaves some room for additional adjustments (unexpected increases). The minimum wage also has a lighthouse/beacon effect, which increases its impact on the economy by acting as a signal for the calculation of other formal wages.

We calibrate the model for Colombia, a small open emerging country with macroeconomic and labor market characteristics of a typical EME (Table 1) and whose minimum wage institution has some accentuated features. In particular, the minimum wage is earned by an important share of formal workers (17%), it is relatively high (around 90% of the median wage), it is adjusted routinely once a year through a bargaining process and with certain rules that make it rigid in nominal and real terms, and the labor market is characterized by a relatively high informality rate (52%). With this characteristics, this country provides an appropriate setting to calibrate the model and study the macroeconomic affects of the minimum wage.

Our results show that after an unexpected increase of the minimum wage we observe larger effects on the labor market and the main macroeconomic variables, and moderate effects on inflation and monetary policy. Low-skilled formal labor reduces by roughly 0.9% on impact, and is partially substituted by informal labor (0.2%) and investment in machinery (1%). In the short run, the demand for informal employees rises driving up their wages (0.25%); but, when the income of low-skilled workers falls, households offer more informal labor, driving down wages. High-skilled labor vary slightly, but their wages rise in the short run (0.1 %) because of the minimum wage pass-through and decrease in the long run (0.15 %) due to lower demand. Higher cost of production reduce output by around 0.1 % and create a negative output gap (0.04 %) in the short run. As a result of the higher minimum wage, low-skilled households increase their consumption on impact; however, as the economy transitions to the new equilibrium, their income sources decline, and so does their consumption. High-skilled households, on the other hand, perform worse in terms of consumption, since they finance investment and their sources of income decline. Finally, we observe slight increases in both inflation and nominal monetary policy. These results are qualitatively robust to different specifications of the model.

Besides analyzing the macroeconomic effects of changing the minimum wage, on a different exercise, we explore how the presence of the minimum wage affects the transmission of productivity, demand, and monetary policy shocks. Our findings suggest that the minimum wage increases the persistence of macroeconomic responses, and most of the adjustment in the labor market goes through quantities and not wages. These results are robust to alternative rules of adjustment that consider different measures for inflation and productivity. In terms of monetary policy, we observe that it becomes less efficient to control inflation in the short run, due to the rigidities generated by the minimum wage.

Our results differ from those in the literature for developed countries, especially the United States. Šauer (2018) studies the macroeconomic effects of the minimum wage in the United States and finds that the minimum wage has a negligible effect on macroeconomic variables, but an expansionary effect under a looser monetary

policy stance. Using a medium-scale DSGE model with a wide labor market specification, Šauer (2018) shows that, even though the macroeconomic effect is weak, a higher minimum wage causes unemployment among low-skilled workers but raises their income and consumption. The author also shows that the effort channel is crucial to how firms react to minimum wage increases, and that requiring more effort from workers leads to higher productivity and lower inflation. This effort channel makes it unnecessary for firms to substitute low-productivity workers with capital, which in turn means that the price of capital only changes slightly with minimum wage changes. Lastly, Šauer (2018) shows that, in terms of welfare, minimum wage workers are better off if it is indexed to wage inflation rather than price inflation, as this makes them more resilient to demand shocks.

Glover (2019) studies the interaction between the minimum wage and the zero lower bound (ZLB) in the United States. Using a more parsimonious DSGE model, Glover (2019) finds that, away from the ZLB, the macroeconomic effects of the minimum wage depend on the response of monetary policy. If the central bank maintains a hawkish stance, an increase in the minimum wage is contractionary. On the other hand, if the stance is dovish, the effect is expansionary. Glover (2019) also shows that the existence of a minimum wage dampens the negative effects on output and inflation of a demand-driven recession, stopping the deflationary spiral that often causes a severe contraction during a ZLB episode.

The structure of the paper is as follows: Section 2 provides a comprehensive overview of the methods used to set minimum wages in several countries, including an analysis of the actors involved, the frequency of adjustments, and the factors considered in minimum wage revisions. Section 3 introduces our model structure, which assumes an EME with heterogeneous labor. Section 4 details the calibration approach and parameter values specific to the Colombian economy. In Section 5, we examine both the direct and indirect effects of minimum wage changes on labor market and macroeconomic variables, analyzing the dynamics following an unexpected minimum wage increase. In this section, we also assess the impact of the existence of the minimum wage on the persistence of macroeconomic responses to demand, productivity, and monetary policy shocks. Finally, Section 6 presents a summary of our main findings and their implications for policy.

2 Different Approaches to Minimum Wage Adjustment

The minimum wage policy was introduced in 1894 in New Zealand to protect vulnerable workers.[1] Since then, it has extended over the world and countries have implemented minimum wage policies with different variations in terms of frequency, rules of adjustment, sectors and regions covered. This policy was first described in the International Labour Organization (ILO) Minimum Wage Fixing Convention Number 131, held in 1970, see ILO (1970). Recently, this policy has been implemented in 187 nations, and the number of countries that have adopted the recommendations made on this convention has increased considerably. Despite the fact that mechanisms for setting minimum wages differ significantly among countries, the ILO asks for the involvement of labor market actors and governments when setting its value, so the main interests of workers and employers are considered, and the new value of the minimum wage would represent an equilibrium between their interests. Involvement can vary from country to country, while in some countries, minimum wages are unilaterally determined by public authorities without consulting employers' and workers' organizations. In other countries, governments may establish value after consulting social partners. There could also be a tripartite process where minimum wages are set through the joint participation of representatives from the government, employers, and workers. Finally, in some countries, the minimum wage is determined by collective bargaining negotiations.

Irrespective of the involvement of labor actors, it is important when setting minimum wage to highlight some factors that may affect macroeconomic adjustment. These factors include whether the coverage is national or regional, the frequency of adjustments, and whether there are different minimum wages by the economic sector, occupation, or educational level. Approximately 48 percent of countries with minimum wage systems opt for a single widely applicable national minimum wage. This approach ensures equal wage protection for all

[1] https://www.ilo.org/global/topics/wages/minimum-wages/definition/WCMS_439071/lang--en/index.htm

workers and emphasizes meeting the needs of workers and their families, regardless of sector or enterprise size. However, variations in the costs of goods and services across different regions within a country pose challenges. Additionally, regional disparities in labor market conditions, with some areas experiencing robust economic activity and low unemployment, while others facing sluggish growth and higher unemployment rates, may necessitate regional wage differentials. To accommodate these variations, certain countries, such as Brazil, the Russian Federation, and the United States, have adopted a hybrid approach that combines a national minimum wage floor with provisions for higher regional rates.

With respect to the frequency of adjustments, Article 4 of Convention No. 131 suggests a periodic revision, and in practice, the actual rate of inflation is a significant economic factor to consider. For workers receiving minimum wages, there is often uncertainty regarding the extent to which their purchasing power will erode because of inflation. Similarly, employers face the risk of sudden and substantial increases in labor costs. To mitigate these concerns, many countries have established explicit requirements for periodic reviews of minimum wage. In most cases, these reviews occur either annually or biennially. According to the ILO, 134 countries adjusted their minimum wages at least once every three to five years between 2010 and 2019. Some countries employ yearly adjustments to provide predictability and gradual transitions complemented by more frequent revisions when inflation surpasses a predetermined threshold. For instance, in France, the minimum wage automatically increases when the annual inflation rate exceeds 2%. In addition to inflation, negotiations among parties and adjustment rules about the updating of the minimum wage may consider redistributing the fruits of economic growth by including other macroeconomic variables in the decision of adjustment, while others include the unemployment rate or wages.

In some countries, the adjustment is given by an explicit rule ILO (2016). For instance, in Brazil, the minimum wage is adjusted every four years using the arithmetic sum of inflation accumulated during the previous year and the economic growth in the first to last year due to the lag in publication. The adjustment in Costa Rica, also considers inflation and economic growth, but their formula considers expected inflation, a correction due to the difference between inflation and expected inflation in the previous year and between 20 % and 40% of the first to last year's GDP growth. The application of this formula is conditional on certain situations in the economy and labor market. [2] In Malaysia, the minimum wage rates for each region are set using a combination of socioeconomic indicators. Poverty Line Income (PLI) per worker and median wages are the main factors considered, while productivity growth, consumer inflation measured by the CPI, and unemployment rate are also considered. In France, the adjustment takes place every January and is linked to the evolution of the CPI as well as to the increase in the purchasing power of blue-collar workers' basic hourly wage. Finally, the Netherlands offers a more complex adjustment setup. It adjusts its minimum wage twice a year (January 1 and July 1) in line with changes in the weighted average of collectively agreed wages.

The indexation of current wage to past inflation was aimed at keeping the wage constant in real terms and guaranteeing the purchasing power of minimum wages. However, "indexation" introduces inertia, which may become an obstacle to reducing the current inflation rate and an additional concern for monetary policy. Summarizing minimum wage adjustment is periodic in the majority of countries, and there is a negotiation process between the parties in the labor market. Economic aggregates such as inflation, economic growth, and productivity are included to guarantee the purchasing power of agents and share economic progress. Additionally, some labor market variables, such as unemployment rate or wages, can be considered in its adjustment.

3 Model

We develop a general equilibrium model to study the effects of the minimum wage on macroeconomic variables in a small open emerging economy. Our model includes both high and low productivity workers. Low productivity workers are employed in both the formal and informal sectors. In the formal sector, low-productivity

[2] The inflation component is not included whenever inflation is greater than expected inflation plus one percentage point. Also, the economic growth component is not considered if the unemployment rate is greater than 8%, there was negative economic growth for four successive quarters, or there is more than a 15% change in the exchange rate.

workers earn the minimum wage, while in the informal sector they get paid below the minimum wage. Our model also distinguishes between two types of capital: machinery, which serves as a substitute for low productivity labor, and buildings, which complement labor. The minimum wage serves as a reference for other wages and is determined by a rule that takes into account price inflation and productivity. Monetary policy is set by the central bank according to a Taylor rule.

3.1 Households

Households are divided into two groups: high-skilled households $\left(N^H\right)$ and low-skilled households $\left(N^L\right)$. High-skilled households possess several characteristics that distinguish them from their low-skilled counterparts. Firstly, they offer a highly productive form of formal labor $\left(h_t^H\right)$. Secondly, they own the firms and receive the profits generated by these firms (Π_t). Thirdly, they own two types of capital: machinery (k_t^m) and buildings, $\left(k_t^b\right)$.[3] High-skilled households consume $\left(c_t^H\right)$, and invest in both types of capital $\left(i_t^m \text{ and } i_t^b\right)$. Additionally, high-skilled households have access to both domestic and foreign financial markets, b_t and a_t, respectively.

The representative high-skilled household maximizes the present value of its utility

$$\max_{c_t^H, h_t^H, b_{t+1}, a_{t+1}^f, i_t^b, i_t^m, k_{t+1}^b, k_{t+1}^m} E_0 \sum_{t=0}^{\infty} \beta^t e^{Z_t} \left[\frac{\left(c_t^H\right)^{1-\sigma}}{1-\sigma} - \psi_H \frac{\nu_H}{1+\nu_H} \left(h_t^H\right)^{\frac{1+\nu_H}{\nu_H}} \right],$$

where $Z_t = \rho_Z Z_{t-1} + \epsilon_t^Z$ represents a demand shock, subject to the intertemporal budget constraint

$$P_t \left(c_t^H + i_t^b + i_t^m \right) + a_{t+1}^f + b_{t+1} \leq b_t R_{t-1} + \Phi_{t-1} R_{t-1}^f a_t^f + W_t^H h_t^H + R_t^b k_t^b + R_t^m k_t^m + \frac{\Pi_t}{N^H}.$$

the adjustment cost of investment in buildings in machines,

$$i_t^j = k_{t+1}^j - \left(1-\delta^j\right) k_t^j + \frac{\phi_j}{2} \left(\frac{i_t^j}{i_{t-1}^j} - 1 \right)^2, j \in \{b, m\},$$

and the debt elastic interest rate,

$$\Phi_t = \Phi\left(A_t^f\right) = \widetilde{\phi} + \phi_a \left(\frac{A_t^f}{Y_t} - \frac{A_{ss}^f}{Y_{ss}} \right),$$

where Y_t and A_t^f denote output and the aggregate foreign asset, respectively.[4]

After normalizing the F.O.C by P_t we find the marginal rate of substitution between consumption and labor,

$$\psi_H \left(h_t^H\right)^{\frac{1}{\nu_H}} = \frac{w_t^H c_t^{H-\sigma}}{p_t},$$

the Euler equations for domestic and foreign bonds,

$$\left(c_t^H\right)^{-\sigma} = \beta e^{Z_{t+1}-Z_t} \frac{\left(c_{t+1}^H\right)^{-\sigma} R_t}{\pi_{t+1}},$$

$$\left(c_t^H\right)^{-\sigma} = \beta e^{Z_{t+1}-Z_t} \frac{\left(c_{t+1}^H\right)^{-\sigma} R_t^f \Phi_t}{\pi_{t+1}},$$

[3] The importance of considering both forms of capital is discussed in Subsection 3.2.

[4] The subscript ss denotes the steady state value of the variable.

capital in machinery and buildings,

$$\mu_t^j = \beta e^{Z_{t+1}-Z_t}\left(\left(c_{t+1}^H\right)^{-\sigma}\frac{r_{t+1}^j}{p_{t+1}}\right)+\mu_{t+1}^j\left(1-\delta^j\right) \text{ for } j\in\{b,m\},$$

and the corresponding two types of investment,

$$\left(c_t^H\right)^{-\sigma}=\mu_t^j\left[1-\phi_j\left(\frac{i_t^j}{i_{t-1}^j}-1\right)\frac{1}{i_{t-1}^j}\right]+\beta\left[\mu_{t+1}^j e^{Z_{t+1}-Z_t}\phi_j\left(\frac{i_{t+1}^j}{i_t^j}-1\right)\frac{i_{t+1}^j}{\left(i_t^j\right)^2}\right] \text{ for j}\in\{b,m\},$$

where $w_t^H = W_t^H/P_t$, $r_t^b = R_t^b/P_t$, $r_t^m = R_t^m/P_t$, and $\pi_t = P_t/P_{t-1}$.

Low-skill households face borrowing constraints and do not have access to financial markets. As a result, their only income comes from labor. These hand-to-mouth households consume $\left(c_t^L\right)$ and offer their labor force in both the formal sector $\left(h_t^F\right)$, where they earn the minimum wage $\left(W_t^F\right)$, and the informal sector $\left(h_t^I\right)$, where they earn a market wage lower than the minimum wage $\left(W_t^I\right)$.[5] The representative low-skilled household maximizes the present value of its utility,

$$\max_{c_t^L,h_{I,t},h_{F,t}} E_0\sum_{t=0}^{\infty}\beta^t e^{Z_t}\left[\frac{\left(c_t^L\right)^{1-\sigma}}{1-\sigma}-\psi_I\frac{\nu_I}{1+\nu_I}\left(h_t^I\right)^{\frac{1+\nu_I}{\nu_I}}-\psi_F\frac{\nu_F}{1+\nu_F}\left(h_t^F\right)^{\frac{1+\nu_F}{\nu_F}}\right],$$

subject to its budget constraint,

$$P_t c_t^L \le W_t^I h_t^I + W_t^F h_t^F + \frac{P_t T_t}{N^L},$$

where T_t are transfers from the government.

From the normalized F.O.C, we find the marginal rates of substitution between consumption and labor (formal and informal),

$$\phi_I\left(h_t^I\right)^{\frac{1}{\nu_I}} = \frac{\left(c_t^L\right)^{-\sigma}}{p_t}w_t^I,$$

$$\phi_F\left(h_t^F\right)^{\frac{1}{\nu_F}} = \frac{\left(c_t^L\right)^{-\sigma}}{p_t}w_t^F,$$

where $w_t^I = W_t^I/P_t$ and $w_t^F = W_t^F/P_t$.

Macroeconomic aggregates can be defined as follows: consumption is the sum of each representative household consumption multiplied by the number of households of each type, $C_t = N^H c_t^H + N^L c_t^L$. Investment in buildings and machinery is given by $I_t^b = N^H i_t^b$ and $I_t^m = N^H i_t^m$, respectively, since low-skilled households do not make investment decisions. Domestic demand is given by $D_t = C_t + I_t^b + I_t^m$. Aggregate labor supply for high-skilled, low-skilled formal, and low-skilled informal workers is defined as the total number of hours worked, $E_t^H = N^H h_t^H$, $E_t^F = N^L h_t^F$, and $E_t^I = N^L h_t^I$, respectively. Total employment reflects the total hours worked in the economy, $E_t = E_t^F + E_t^I + E_t^H$.

3.2 Production

The final good sector is perfectly competitive. It combines a continuum of differentiated intermediate goods ($Y_{t,j}$ with $j\in[0,1]$) into the final good (Y_t). This firm maximizes its profits according to

$$\max_{Y_{t,j}} P_t Y_t - \int_0^1 P_{t,j}Y_{t,j}dj,$$

[5] This specification captures the interconnection between the two types of labor in low-skilled households by reflecting mobility across formal and informal sectors. This is consistent with the main features of a standard two-sector model used to analyze the effect of the minimum wage, as shown, for example by Gramlich (1976) and Mincer (1976).

where,

$$Y_t = \left(\int_0^1 Y_{t,j}^{\frac{\xi-1}{\xi}} dj \right)^{\frac{\xi}{\xi-1}}$$

is the final good production technology and $P_{t,j}$ and P_t are the price of the jth intermediate good and the aggregate price, respectively. From the F.O.C. we find that the demand for input j depends on its relative price and the aggregate demand for domestic goods,

$$Y_{t,j} = \left(\frac{P_{t,j}}{P_t} \right)^{-\xi} Y_t,$$

and that the aggregate price index of domestic goods is an average of heterogeneous input prices,

$$P_t = \left[\int_0^1 P_{t,j}^{1-\xi} dj \right]^{\frac{1}{1-\xi}}.$$

The domestic production of the homogeneous good is allocated to consumption, investment, and net exports, $Y_t = D_t + NX_t$.

Each intermediate good is produced by a monopolistically competitive firm. The firm faces a Cobb-Douglas production function and makes static and dynamic decisions. Regarding the static decisions, each firm j minimizes its cost by choosing its optimal demands for capital in machinery and buildings, and its demand for each of the three types of labor: high-skilled formal, low-skilled formal, and low-skilled informal. The firm's optimization problem is given by:

$$\min_{K_{t,j}^e, K_{t,j}^x, L_{t,j}^H, L_{t,j}^I, L_{t,j}^F} \tau_t w_t^H L_{t,j}^H + w_t^I L_{t,j}^I + \tau_t w_t^F L_{t,j}^F + r_t^b K_{t,j}^b + r_t^m K_{t,j}^m,$$

where τ_t is a tax levied on the wage of high-skilled workers, subject to the technology

$$Y_{t,j} = A_t \left(K_{t,j}^b \right)^{\alpha} (L_{t,j})^{1-\alpha}, \tag{1}$$

where total factor productivity follows $A_t = \rho_a A_{t-1} + \epsilon_t^A$, being ϵ_t^A a productivity shock, and $K_{t,j}^b$ is the demand for capital in buildings which complements labor demand, $L_{t,j}$.

Labor demand for each firm j ($L_{t,j}$) is a nested CES function that aggregates the three types of labor and machinery. The CES structure provides enough flexibility to capture different substitution and complementarity effects among these inputs, which allows us to better capture the dynamics after a shock in the minimum wage. This structure is defined as:

$$L_{t,j}^L = \left[\theta_L \left(L_{t,j}^I \right)^{\frac{\eta_L - 1}{\eta_L}} + (1 - \theta_L) \left(L_{t,j}^F \right)^{\frac{\eta_L - 1}{\eta_L}} \right]^{\frac{\eta_L}{\eta_L - 1}}, \tag{2}$$

$$L_{t,j}^m = \left[(1 - \theta_m) \left(L_{t,j}^L \right)^{\frac{\eta_m - 1}{\eta_m}} + \theta_m \left(K_{t,j}^m \right)^{\frac{\eta_m - 1}{\eta_m}} \right]^{\frac{\eta_m}{\eta_m - 1}}, \text{ and} \tag{3}$$

$$L_{t,j} = \left[\theta \left(L_{t,j}^m \right)^{\frac{\eta - 1}{\eta}} + \left(1 - \theta \right) (L_{t,j}^H)^{\frac{\eta - 1}{\eta}} \right]^{\frac{\eta}{\eta - 1}}. \tag{4}$$

The structure of labor demand and its various levels of aggregation deserve further examination. At the bottom level, the demand for low-skilled labor, $L_{t,j}^L$, consists of the demand for low-skilled informal and low-skilled formal labor. These two types of labor are substitutes, giving firms the option of employing informal

labor at wages below the minimum wage at the expense of formal labor in response to minimum wage increases (Eq. (2)). At the intermediate level, the demand for the factor *labor-machinery*, $L^m_{t,j}$, is composed of the demands for low-skilled labor and for machinery capital. These two inputs are also substitutes, allowing firms to choose automation in response to minimum wage increases (Eq. (3)). At the highest level, the demand for labor, $L_{t,j}$, is a combination of the *labor-machinery* factor and the demand for high-skilled labor. Unlike the other levels of aggregation, these two inputs are complementary (Eq. (4)).

From the normalized F.O.C. we find the relative demand of factors as function of their relative prices,

$$\frac{w^m_t}{\tau_t w^H_t} = \frac{\theta}{1-\theta}\left(\frac{L^H_t}{L^m_t}\right)^{\frac{1}{\eta}},$$

$$\frac{w^I_t}{\tau_t w^F_t} = \frac{\theta_L}{1-\theta_L}\left(\frac{L^F_t}{L^I_t}\right)^{\frac{1}{\eta_L}},$$

$$\frac{r^m_t}{w^L_t} = \frac{\theta_m}{1-\theta_m}\left(\frac{L^L_t}{K^m_t}\right)^{\frac{1}{\eta_m}},$$

and

$$\frac{L_t}{K^b_t} = \frac{(1-\alpha)}{\alpha}\frac{r^b_t}{w_t}.$$

We also obtain the aggregate factor prices,

$$w_t = \left(\theta^\eta \left(w^m_t\right)^{1-\eta} + (1-\theta)^\eta \left(\tau_t w^H_t\right)^{1-\eta}\right)^{\frac{1}{1-\eta}},$$

$$w^m_t = \left((1-\theta_m)^{\eta_m}\left(w^L_t\right)^{1-\eta_m} + \theta^{\eta_m}_m \left(r^m_t\right)^{1-\eta_m}\right)^{\frac{1}{1-\eta_m}},$$

$$w^L_t = \left(\theta^{\eta_L}_L \left(w^I_t\right)^{1-\eta_L} + (1-\theta_L)^{\eta_L}\left(\tau_t w^F_t\right)^{1-\eta_L}\right)^{\frac{1}{1-\eta_L}}$$

and the real marginal cost

$$mc_t = \frac{1}{A_t}\left(\frac{\alpha}{r^b_t}\right)^\alpha \left(\frac{1-\alpha}{w_t}\right)^{1-\alpha}.$$

The dynamic decisions of intermediate firms are related to pricing. We adopt the framework proposed by Calvo (1983), in which intermediate firms set their prices to maximize profits given the demand for their products. In each period, a firm has an exogenous probability, $1-\phi$, of being able to change its price. The remaining ϕ firms that are unable to reset their prices in a given period apply indexation, adjusting their prices according to past inflation. The optimal decision for a firm that is able to change its price in period t is given by:

$$\max_{P_{t,j}} E_t \sum_{k=0}^{\infty} (\beta\phi)^k \frac{U_{c,t+k}}{U_{c,t}}\left[\left(\frac{\pi^{1_k}_{t+k-1}P_{t,j}}{P_{t+k}}\right)^{1-\xi} Y_{t+k} - mc_{t+k}\left(\frac{\pi^{1_k}_{t+k-1}P_{t,j}}{P_{t+k}}\right)^{-\xi} Y_{t+k}\right],$$

where 1_k is an indicator function that takes the value of zero if $k=0$ and one otherwise. From the F.O.C

$$P_{t,j} = \frac{\xi}{\xi-1}\frac{E_t \sum_{k=0}^{\infty}(\beta\phi)^k U_{c,t+k} mc_{t+k} P^{\xi}_{t+k} Y_{t+k}}{\sum_{k=0}^{\infty}(\beta\phi)^k U_{c,t+k} P^{\xi-1}_{t+k} Y_{t+k}}.$$

This equation implies that the optimal price of a firm that can change prices is given by

$$P_t^{\#} = \frac{\xi}{\xi - 1} \frac{X_{1,t}}{X_{2,t}},$$

where,

$$X_{1,t} = U_{c,t} mc_t P_t^{\xi} Y_t + \beta\phi E_t X_{1,t+1}$$

and

$$X_{2,t} = U_{c,t} P_t^{\xi-1} + \beta\phi E_t X_{2,t+1}.$$

By applying the law of large numbers to the continuum of firms, it can be demonstrated that aggregate prices may be expressed as a weighted average of optimal and lag prices, resulting from the optimal decision-making of individual firms,

$$P_t^{1-\xi} = (1-\phi)\left(P_t^{\#}\right)^{1-\xi} + \phi P_{t-1}^{1-\xi}.$$

After normalizing we find the inflation rate,

$$\pi_t^{1-\xi} = (1-\phi)\left(\pi_t^{\#}\right)^{1-\xi} + \phi \pi_{t-1}^{1-\xi},$$

where,

$$\pi_t^{\#} = \frac{\xi}{\xi - 1} \frac{x_{1,t}}{x_{2,t}} \pi_t,$$

$$x_{1,t} = C_t^{-\sigma} mc_t Y_t + \beta\phi E_t x_{1,t+1} \left(\frac{\pi_{t+1}}{\pi_t}\right)^{\xi},$$

and

$$x_{2,t} = C_t^{-\sigma} Y_t + \beta\phi E_t x_{2,t+1} \left(\frac{\pi_{t+1}}{\pi_t}\right)^{\xi-1}.$$

Finally, due to price rigidities, total output in the economy is given by:

$$Y_t = \frac{\left(K_t^b\right)^{\alpha} L_t^{1-\alpha}}{v_t^p},$$

where v_t^p is the price dispersion:

$$v_t^p = \int_0^1 \left(\frac{P_{t,j}}{P_t}\right)^{-\xi} dj = (1-\phi)\left(\frac{\pi_t}{\pi_t^{\#}}\right)^{\xi} + \phi\left(\frac{\pi_t}{\pi_{t-1}}\right)^{\xi} v_{t-1}^p.$$

3.3 Minimum wage

The model considers three types of workers, as mentioned above. The wage and employment of high-skill formal workers and low-skill informal workers are determined by the equilibrium between the supply and demand for their respective labor. In contrast, low-skill formal workers receive the minimum wage and therefore their level of employment is determined by the labor demand from firms.

The government sets changes in the nominal minimum wage $\left(\Delta W_t^F\right)$ according to a rule that takes into account inflation and productivity dynamics $(\Delta MP_{L,t-1})$, with some room for unexpected changes $\left(\epsilon_t^F\right)$. These changes are modeled as shocks that can be either permanent or transitory in nature,

$$\Delta W_t^F = \frac{W_t^F}{W_{t-1}^F} = \pi_{t-1}\Delta MP_{L,t-1}\left(1+\epsilon_t^F\right), \tag{5}$$

where

$$\Delta MP_{L,t} = \frac{\frac{Y_t}{Y_{t-1}}}{\frac{E_t}{E_{t-1}}}.$$

The rule in Eq. (5) which is commonly used in EMEs and particularly in Colombia, implies that changes in the nominal minimum wage are fully reflected in the real minimum wage.[6] Given this setup, the real minimum wage $\left(w_t^F\right)$ follows

$$w_t^F = w_{ss}^F + \Delta w_t^F,$$

where, $\Delta w_t^F = \Delta W_t^F - \pi_t$. For the wage setting to be relevant, we assume that in the steady state, the real wage of formal low-skilled workers, w_{ss}^F, is higher than the real wage that would be determined by market clearing.

Consistent with empirical evidence on the lighthouse/beacon effect of the minimum wage in EMEs, including Colombia (Bell, 1997; Maloney and Mendez, 2004; Neumark et al., 2004), we consider that there is a short-term transmission of minimum wage shocks to high-skill wages, as well as persistence in their adjustment. This results in a distortion of the competitive equilibrium of high-skill wages in the short-term, but ultimately ensures that the long-term equilibrium remains competitive. In particular, we consider that:

$$w_t^H = \left(w_{t-1}^H\right)^{\rho_H}\left(w_{t-1}^{H,market}\right)^{1-\rho_H}\left(\frac{w_t^F}{w_{t-1}^F}\right)^{\rho_F}, \tag{6}$$

where $w^{H,market}$ is the competitive equilibrium wage of high-skill workers.

3.4 Policy institutions

On the policy side the model considers two institutions: the central bank and the government. Regarding the central bank, we define a standard Taylor rule that depends on inflation and on the output gap,

$$log\left(\frac{R_t}{R}\right) = \rho_r log\left(\frac{R_{t-1}}{R}\right) + r_\pi log\left(\frac{\pi_{t+1}}{\pi}\right) + r_y log\left(\frac{4Y_t}{\sum_{j=1}^4 Y_{t-j}}\right) + \epsilon_r, \tag{7}$$

where, $\sum_{j=1}^4 Y_{t-j}$ is the annual GDP. The specification of the output gap enables us to account for changes in the steady state that do not result in permanent gaps. This is particularly useful when analyzing the impact of permanent changes in the real minimum wage. On the fiscal front, we assume that the government maintains a balanced budget each period, with tax revenues from formal high-skilled workers' wages equaling the lump-sum transfers provided to low-skilled households.

$$\frac{T_t}{P_t} = (\tau_t - 1)\left(w_t^F L_t^F + w_t^H L_t^H\right).$$

[6] In Appendix A we explore the effects of alternative rules.

4 Parameters, Calibration, and Adjustment to the Colombian Business Cycle

We take most of the parameter values from the literature for Colombia González et al. (2011), as well as from international findings (Whalen and Reichling, 2017; Krusell et al., 2000) while choosing the remaining ones to normalize the variables in the steady state or to match some particular stylized facts for Colombia (Table 2). Specifically, we calibrate θ and θ_L to match wage ratios of 2.70 between high- and low-skilled and 2.24 between formal and informal low-skilled workers. Parameters ψ_I and N_h generate a wage mass of 83 % for high-skilled workers and 52 % for this type of worker. These values were constructed using information from the Colombian Household Survey (GEIH) between 2010 and 2019.[7] We divide workers according to their productivity with respect to the thresholds of the minimum hourly wage. All employed workers with earnings above 1.1 minimum hourly wage are considered high-skilled, workers with hourly earnings between 0.9 and 1.1 minimum hourly wage are considered low-skilled and formal, while the remaining workers are low-skilled informal. The range for formal low-skilled employment is because sometimes workers would not respond to the wage value in the contract but to the amount they receive (discounting social security, for instance, or including the transportation subsidy). The initial level of the minimum wage (w_{min}) is targeted to generate a level of low-skilled formal employment 10% lower than that in a competitive market.

The capital share, α, and relative productivity of machines, θ_m, are calibrated to match 30% of investment over GDP and the share of investment in machinery of 30%. Additionally, we consider that in the long run, the domestic and foreign inflation rates are zero, implying that $\pi = \pi^f = 1$ because $\pi_t = p_t/p_{t-1}$. Net foreign assets, LR, are consistent with $\overline{a}^f = 50\%$ and the LR risk premium $\overline{\Phi} = 1.0037$ reflects the average value for Colombia, whereas labor taxes are 20%, $\tau_{ss} = 1.20$. The TFP value for the total factor productivity is targeted to generate an output level of 1 in the initial steady state. Capital adjustment costs and risk premium elasticity are calibrated to match some business cycle moments of the Colombian economy.

Finally, we compare some macroeconomic stylized facts from the Colombian economy with those implied by the simulated model with productivity, demand, and monetary shocks. For Colombia's business cycle moments, we used quarterly data for real GDP, Investment, Consumption, and the Trade Balance. We take the logs of these series (except the trade balance) and de-trend them using an HP filter. For the latter, we de-trend the series as a percentage of the GDP. Using the cyclical components, we calculate the standard deviations relative to GDP and the correlation with the GDP cycle.

We then simulate the model with productivity, demand, and monetary shocks, and with the simulated data, we follow the same procedure as in the data (logs and de-trend). As seen in Table (3) the model replicates the pro-cyclicality of Consumption and Investment and the countercyclicality of the trade balance, and the volatility of investment is close to that in the data, although consumption is less volatile in the model. Finally, according to the simulations, informal hours are highly counter-cyclical (-87%), while low-skilled formal employment is pro-cyclical (77%).

5 Results

We now explore the macroeconomic effects of the minimum wage through the lenses of our DSGE model. In subsections 5.1 and 5.2 we analyze the effects of an unexpected and permanent increase in the minimum wage (nominal and real), and we compare our results under different specifications of our model, to see how sensitive are the results to our benchmark assumptions. In subsection 5.3, we explore how the existence of the minimum wage affects the propagation of transitory productivity, demand, and monetary policy shocks.

[7] The GEIH is a continuous household survey made by National Administrative Department of Statistics (DANE, for its Spanish acronym). This survey investigates employment, income, hours, and other labor market-related variables. It started in July 2006 and replace the Continuous household Survey (ECH) that runs between 2001 and June 2006.

Parameter	Definition	Value	Source
σ	Intertemporal Elast. Subs	2.0	Glover (2019)
β	Discount factor	0.9878	González et al. (2011)
ν_H	Labor elasticity	1.0	Glover (2019)
$\nu_{FL} = \nu_{IL}$	Labor elasticity	2.0	
ψ_H	Disutility of Skill labor	1.0	Glover (2019)
$\psi_I = \psi_F$	Disutility of low skill labor	3.74	Calibrated
η	Elast. subs. L_x vs L_H	0.7	Krusell et al. (2000)
η_m	Elast. subs. L_L vs K_m	1.25	
η_L	Elast. subs. L_I vs L_F	1.50	Krusell et al. (2000)
α	Capital share	0.2537	Calibrated
θ	Productivity L_L vs L_H	0.3028	Calibrated
θ_L	Productivity L_{FL} vs L_{IL}	0.1586	Calibrated
θ_m	Productivity L_L vs K_m	0.3432	Calibrated
ϕ	Price rigidity	0.75	González et al. (2011)
ξ	Elast. subs. intermediates	12	González et al. (2011)
π	Long run inflation	$(1.0)^{0.25}$	Normalization
$\overline{A}^f$	Net foreign assets LR	-0.50	Data
$\overline{\Phi}$	LR risk premium	1.0037	Data
ϕ_a	Risk premium elast. to debt	0.50	Calibrated
ρ_r	Persistence R	0.70	González et al. (2011)
r_π	Taylor π	1.50	Glover (2019)
r_y	Taylor y	0.25	
w_{min}	LR real minimum wage	1.102	Calibrated
A	Productivity	1.0505	Calibrated
π^f	LR foreign inflation	$(1.0)^{0.25}$	Normalization
τ_{ss}	Labor taxes	1.2	Data
ψ_b	Capital adjustment cost k_b	0.0025	Calibrated
ψ_m	Capital adjustment cost k_m	0.0013	Calibrated

Table 2: Parameters. Description of parameters, values and sources.

Variable	Data$_{std/std_Y}$	Model$_{std/std_Y}$	Data$_{corr,Y}$	Model$_{corr,Y}$
GDP (Y)	0.01	0.01	1	1
Consumption	0.93	0.61	0.68	0.90
Investment	5.43	5.36	0.64	0.81
Net Exports/GDP	0.84	0.60	-0.51	-0.42

Table 3: Data vs Model. Except for Y standard deviations are expressed relative to GDP.

5.1 Unexpected and permanent increase in the minimum wage

We now present the response of the economy to an unexpected increase of 100 bp in the nominal minimum wage, which given the adjustment rule permanently distorts the real wage of formal low-skilled workers. We divide the analysis into three groups of variables. The first focuses on the dynamics of employment and wages (direct effects of the shock). The second group considers the effects on the main real macroeconomic variables (consumption, investment, and GDP), and the third group analyzes the response of inflation and the policy rate.

The unexpected increase in the minimum wage implies higher costs of hiring low-skilled formal workers, in respo firms reduce their demand and substitute these workers with informal labor and machines (Figure 1). Quantitatively, we observe that the response of low-skilled formal labor depends on the time horizon; this result

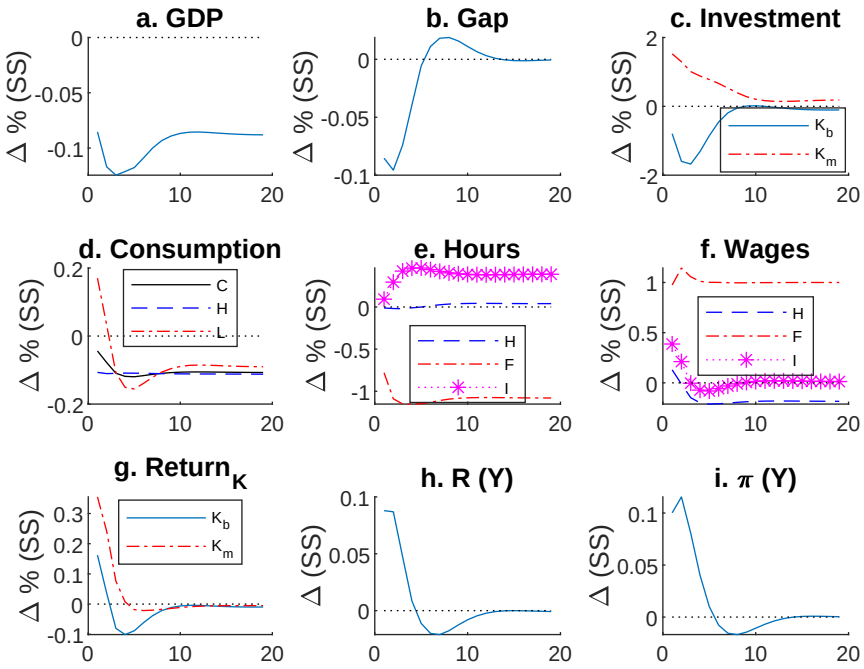

Figure 1: Impulse Response of Main Macroeconomic Aggregates to a 100 bp increase in the minimum wage. The vertical axis shows the percentage difference with respect to the initial steady state except for the interest rate, R, and inflation, π (annualized absolute difference). H stands for High-skilled, F for formal low-skilled, I for informal, and L for low-skilled.

is consistent with the recent literature Hurst et al. (2022). In the short run, substitution is weaker because of the presence of investment adjustment costs and the low response of informal jobs. However, in the long run, low-skilled formal labor falls more as substitution strengthens. These falls in low-skilled employment are similar in magnitude to previous findings in the literature that analyze industrial employment for Colombia, where the own wage elasticity ranges from 0.7 1.4 (L. Arango et al., 2019; Cardenas and Bernal, 2003). On the other hand, temporal differences in the responses of the informal labor market are also observed, in which demand forces play an important role due to labor substitution, and push wages up by 0.2% (Figure 1). In the long run, as low-skilled income declines, households supply more informal labor and wages fall; that is, we observe an additional worker effect.[8] Note that the unit labor costs, defined as the wage bill divided by the total number of hours worked, increase by 0.3% on impact, meaning that a 1% increase in low-skilled formal wages implies an increase of almost one-third in labor costs.

The re-composition of inputs following the impact and the short-term transmission of the minimum wage shock to high-skilled wages affects the demand for high-skilled workers and investment in buildings. On the one hand, high-skilled wages increase by about 0.1% on impact, while demand falls by 0.07%. In the long run, supply-side considerations are the main driver of the adjustment and there is a small increase in lower wage employment. On the other hand, investment in buildings rises on impact due to higher labor costs, but falls during the transition as high-skilled labor becomes cheaper. Quantitatively, the response of high-skilled hours

[8]Evidence of the added worker effect in Colombia is presented in Cardona-Sosa and Morales (2015) who showed that during the first six months after job loss of the main income receiver, spouses increase their participation between 9% y 20%. Additionally, L. E. Arango et al. (2015) showed that participation increases six times more during recessions than in expansions, showing that during the Business cycle the added worker effect is higher than the discouraged worker.

is smaller than that of low-skilled hours (both formal and informal). Labor supply elasticities, hand-to-mouth constraints, and direct effects explain this behavior.

Regarding macroeconomic variables, low-skilled household consumption increases on impact, but less than 1% due to the fall in formal employment. During the transition, consumption starts to fall as formal labor income declines, and is not fully offset by the increase in informal labor (Figure 1). High-skilled households are also affected by the shock, however, their consumption falls both on impact and in the long run. The fall in consumption is due to lower income and the need to finance investment in machinery. Given the higher labor costs, firms reduce their production and the output gap turns negative, as GDP in the flexible price equilibrium fall less due to the competitive adjustment of high-skilled wages. Quantitatively, GDP falls on impact 0.12% and 0.08% in the long-run, while the output gap is around -0.05%.

As in any New Keynesian model, prices are determined by the present value of production costs, so the minimum wage increase raises total inflation and its expectations, Figure 1. On impact, annualized inflation increases by about eight bp, almost one-tenth of the overall minimum wage increase, and one-third of the increase in unit labor costs, implying a relatively low transmission of minimum wages to inflation. The monetary policy response depends on the sensitivity of the central bank to the output gap and the deviation of inflation from its target. In this application, the results show a slight increase in the nominal interest rate (about one bp), while the real interest rate falls given inflation dynamics. As for foreign variables, we observe a deterioration of about 20 bp in the trade balance as percentage of GDP and a 10 bp reduction in the net foreign asset position.

5.2 Sensitivity

We now explore how our main results change when we modify some of the model assumptions. In particular, we consider four scenarios that include: *i.* no machines (only one type of capital - buildings), ii. no informal labor (low-skilled households only offer formal labor), and iii. only one type of household with three types of labor. In all cases we re-calibrate the model to target the same moments.

Figure 2 shows the results of the main macroeconomic variables for the benchmark model and the alternative scenarios. As we can see, all the specifications are qualitatively consistent, however, the magnitudes differ across scenarios. For instance, with only one type of household the contractionary effects of increasing the minimum wage are magnified, since the drop in consumption is not compensated by higher wages of formal no-skilled labor, for this scenario we also observe the higher drop in employment, since the household can easily substitute the supply of formal low skilled labor for other types of labor. On the opposite side, when we only consider one type of capital (buildings), we reduce the substitution options for firms and the drop in employment, consumption and GDP are smaller. We finally observe that informal labor is important for the response in employment, however, due to its low productivity the effects over other macroeconomic aggregates its not significant.

In the Appendix we explore how the different assumptions affect the propagation of usual transitory shocks, such as productivity, demand, and monetary policy. In general we observe that for these shocks the results are not only qualitatively consistent, but also their magnitudes are quite similar, implying that the additional assumptions affect mainly the quantitative results of permanent shocks in the minimum wage.

5.3 Minimum wage as a propagation mechanism of conventional shocks

In this section, we analyze how minimum wage affects the propagation of three conventional shocks: total factor productivity, aggregate demand, and monetary policy. For comparison, we run an alternative model without labor market frictions (no minimum wage). Figures (3) and (4) plot the macroeconomic response to a productivity shock of 1% for the benchmark. In both cases, we see an expansion in economic activity and a drop in inflation, which is consistent with a positive supply shock. Given that the Central Bank reacts more to inflation than it does to the output gap, it reduces the policy interest rate.

From the comparison between models, we observe that the minimum wage amplifies the productivity shock, generating more persistence in the response of the main macroeconomic aggregates (GDP, Consumption, and

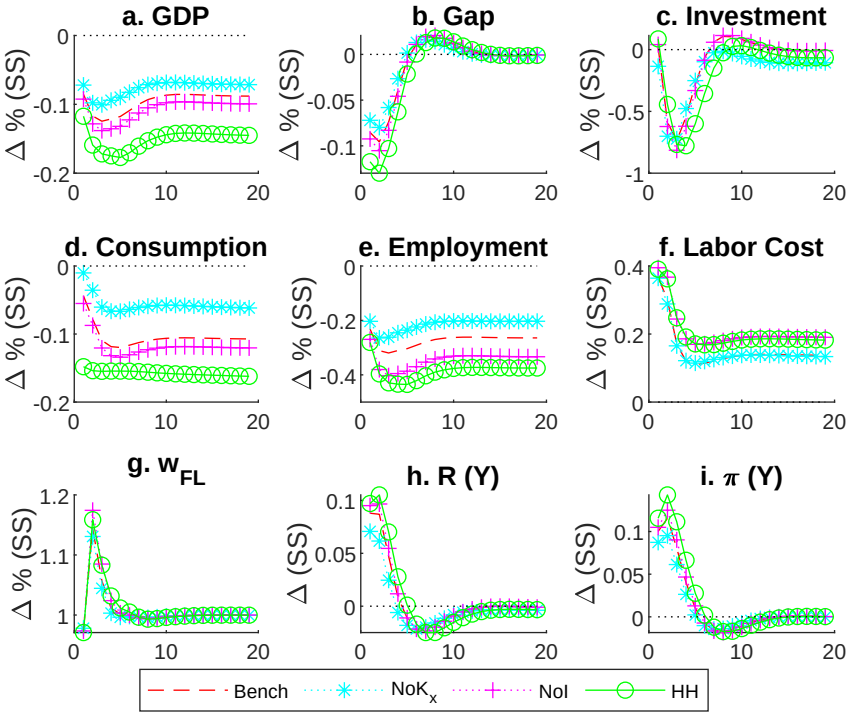

Figure 2: Impulse Response of Main Macroeconomic Aggregates to a 100 bp increase in the minimum wage. The vertical axis shows the percentage difference with respect to the initial steady state except for the interest rate, R, and inflation, π (absolute difference - annualized). Bench stands for the benchmark model, NoK_x for a model without machines, NoI for a model without informality, and HH for a model with only one household.

Investment) and inflation. One possible explanation for these effects is labor market response. As we can see in the last two panels of figure (3), most of the adjustments in the labor market for the model with minimum wage are through quantities and not too much through wages. It is important to note that the effect on inflation is smaller in the presence of minimum wages; however, due to the additional rigidities this friction generates, the effects are more persistent during the transition, forcing the Central Bank to maintain a lower interest rate for a longer period.

In terms of the labor market, in Figure 3 we observe that the hours and wages for low-skilled workers respond differently in the two models. On the one hand, given the minimum wage adjustment rule, the productivity shock increases labor productivity and pushes the minimum wage up. Higher labor costs reduce the demand for low skilled labor in the short term; however, as the real wage returns to a steady state, the demand for low-skilled workers increases. On the other hand, for the model without a minimum wage, the productivity shock reduces all wages on impact, causing a drop in low-skilled income. This drop increases the supply of formal and informal low-skilled labor. As wages return to the initial level, low-skilled labor decreases. Finally, we observe that minimum wage and its transmission to high-skilled wages have a positive effect on consumption for both high- and low-skilled households.

We now analyze the effects of a positive demand shock that increases the willingness of high-skilled households to consume more in the short term. By construction, this shock increases consumption, mainly of high-skilled workers, and reduces the resources assigned to investments, see figure 5. The higher demand for final goods also increases inflation in the short run and makes the Central Bank increase its policy interest rate. The drop in investment and increase in the interest rate generate a contraction in GDP. As in the previous case, we

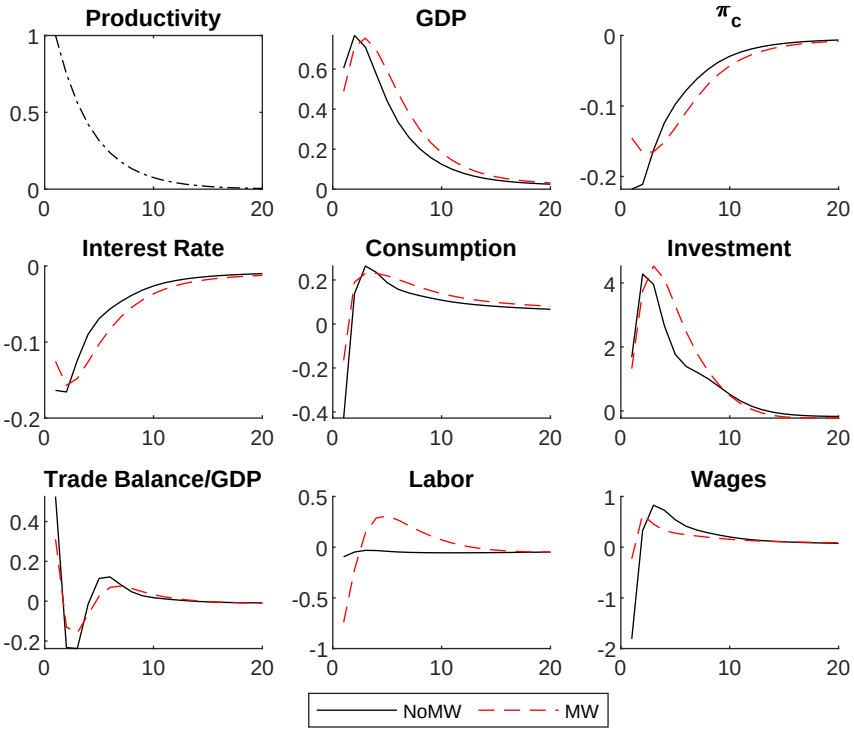

Figure 3: Impulse Response Functions to a 1% Total Factor Productivity (TFP) Shock. Except Trade Balance, variables are expressed in log deviations from the steady state.

observe that the presence of a minimum wage increases the persistence of a shock in terms of macroeconomic aggregates and prices. In this regard, while inflation increases less on impact it takes more time to return to the initial level, as a result of the behavior of labor costs.[9]

Finally, we consider the monetary policy shocks. As seen in figure 6 the presence of a minimum wage affects the transmission of monetary policy. For both models, the initial shock is a 1% increase in the policy interest rate; however, owing to general equilibrium forces, the model with the minimum wage requires a stronger increase in the interest rate. In addition, we observe that the policy is less effective in reducing the inflation rate because total labor costs are more rigid in this case. As in the previous scenarios, macroeconomic aggregates take more time to return to their initial levels.

Motivated by the evidence presented in Section 2, in the Appendix, we report the simulation results for alternative rules of adjustment for the minimum wage. These include adjusting only inflation (past or expectations) and alternative measures of productivity (total GDP growth and productivity of low skilled labor). We observe that as propagation mechanisms, the alternative rules are qualitatively consistent; however, some add more volatility to the business cycle than others, especially when the minimum wage is adjusted with the low-skilled labor productivity change.

6 Conclusions

The global adjustment of minimum wages has sparked public debate, particularly in times of high inflation (post-covid) and severe economic downturns (such as the Great Recession). The research is divided on the possible benefits and drawbacks of a minimum wage on the labor market and the economy as a whole. On the

[9]Here it is important to remember that low-skilled households are hand-to-mouth and the shock does not affect them directly.

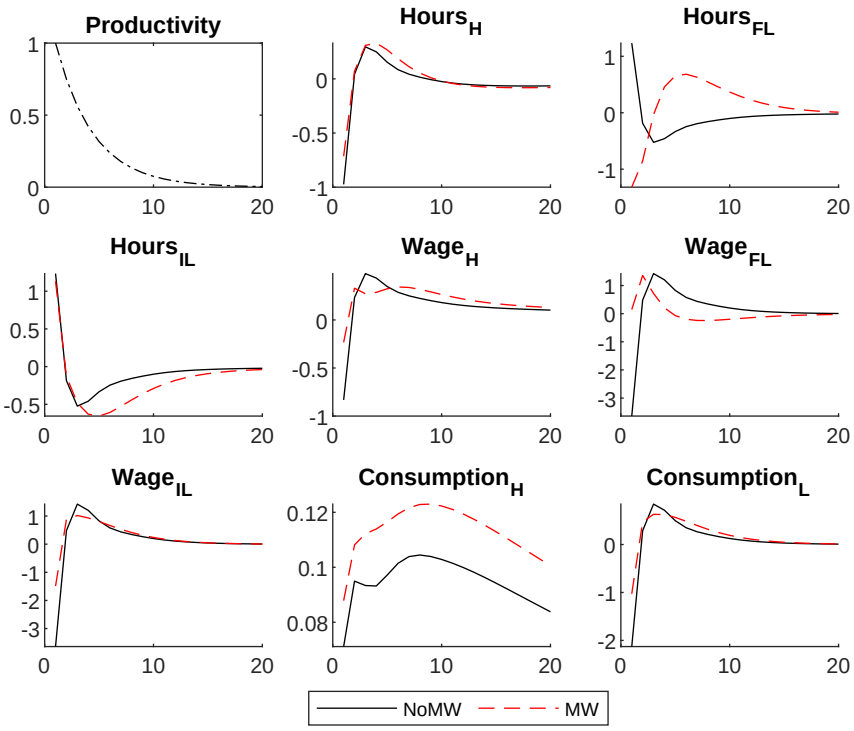

Figure 4: Impulse Response Functions to a 1% TFP Shock. All the variables are expressed in log deviations from the steady state.

one hand, opponents claim that raising the minimum wage decreases the well-being of less-qualified individuals by forcing them into informality and unemployment, and that it can lead to inflationary pressures due to greater production costs. Proponents, on the other hand, say that its negative impacts on employment are minor (even positive), and that it may help low-skilled people preserve or increase their income and consumption, as well as lessen income inequality.

We present a New Keynesian model to investigate the macroeconomic impacts of the minimum wage in a small open economy with labor heterogeneity in this research. Our model takes into account two households that differ in their access to financial markets, property rights, and labor productivity (low-skilled vs. high-skilled). Firms use labor and two types of capital in their production, differentiated by their substitutability with labor, and face pricing rigidities. The interest rate is decided by the central bank using the Taylor rule. Finally, there is a minimum wage that impacts low-skilled workers and changes based on productivity and inflation.

Our findings indicate that a permanent and unexpected increase in the (nominal and real) minimum wage has a significant impact on the main macroeconomic aggregates, particularly the labor market. These impacts, however, are dependent on the horizon under consideration. The responses of formal low-skilled labor, low-skilled household consumption, and the informal wage, in particular, vary significantly in the short, medium, and long run. These results are qualitatively robust to multiple model settings and adjustment procedures. We also investigate the impact of the existence of a minimum wage on the transmission of productivity, demand, and monetary policy shocks. Our findings suggest that this market friction causes a higher persistence in the response of macroeconomic aggregates.

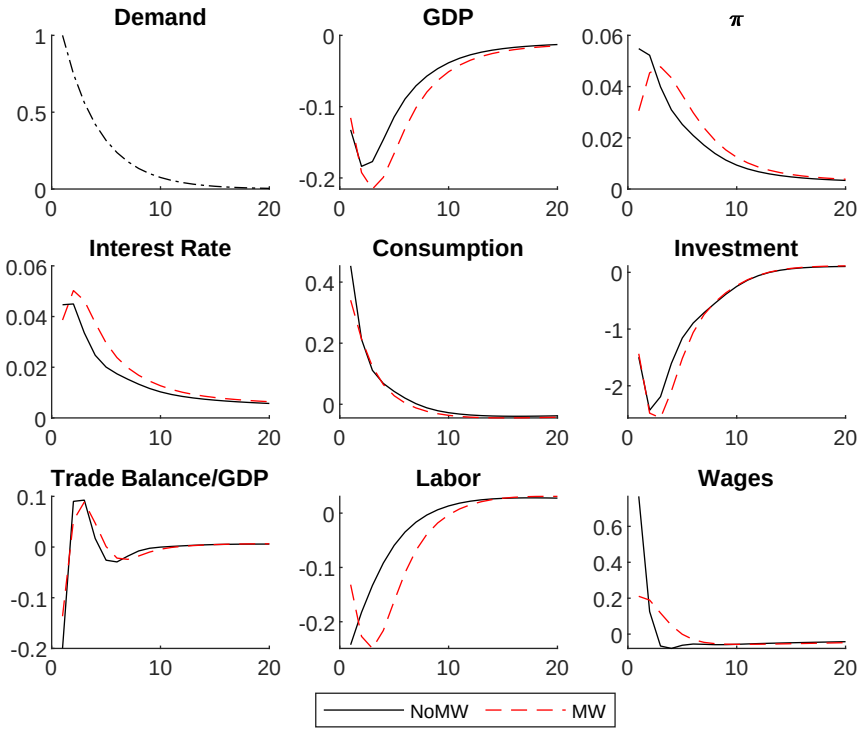

Figure 5: Impulse Response Functions to a 1% Demand Shock. Except Trade Balance, variables are expressed in log deviations from the steady state.

Figure 6: Impulse Response Functions to a 1% Monetary Policy Shock. Except Trade Balance, variables are expressed in log deviations from the steady state.

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A Appendix: Alternative Rules

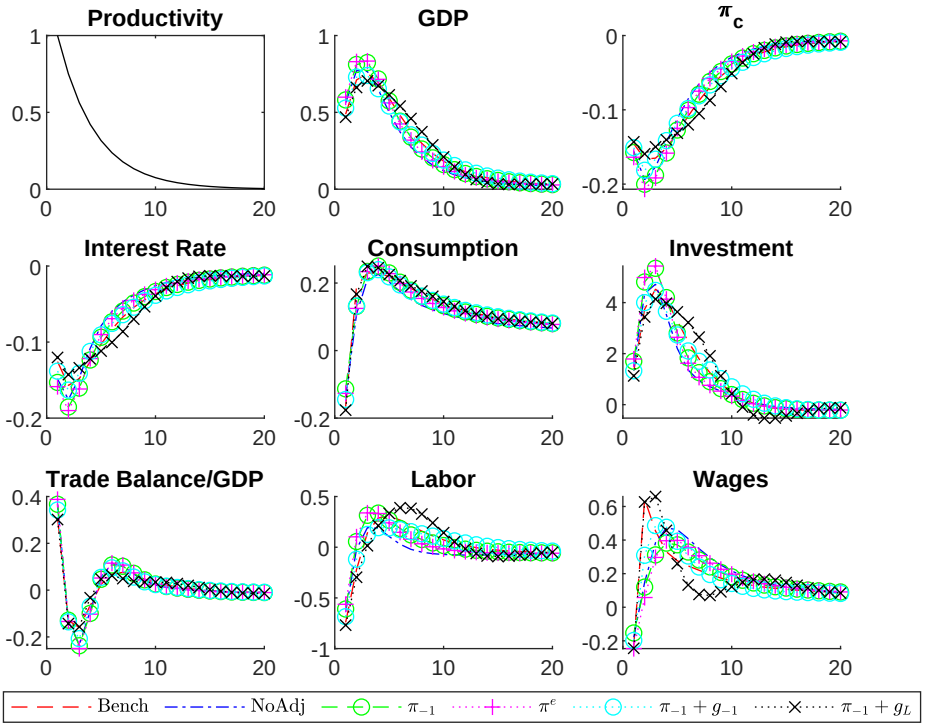

Figure 7: Impulse Response Functions to a 1% Total Factor Productivity (TFP) Shock. Alternative minimum wage rules. Except Trade Balance, variables are expressed in log deviations from the steady state.

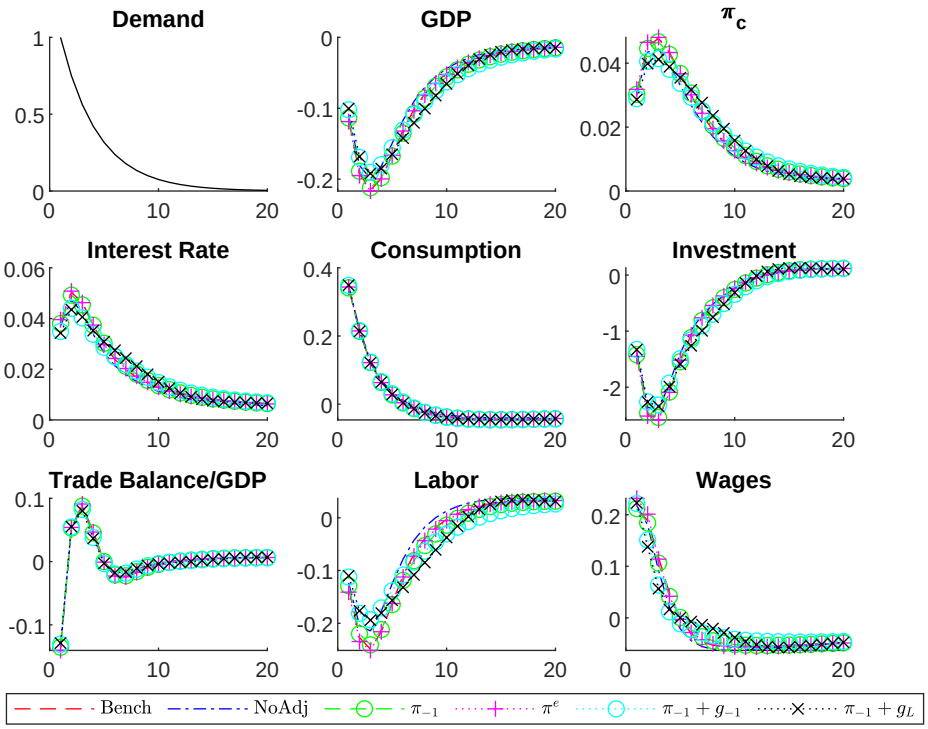

Figure 8: Impulse Response Functions to a 1% Demand Shock. Alternative minimum wage rules. Except Trade Balance, variables are expressed in log deviations from the steady state.

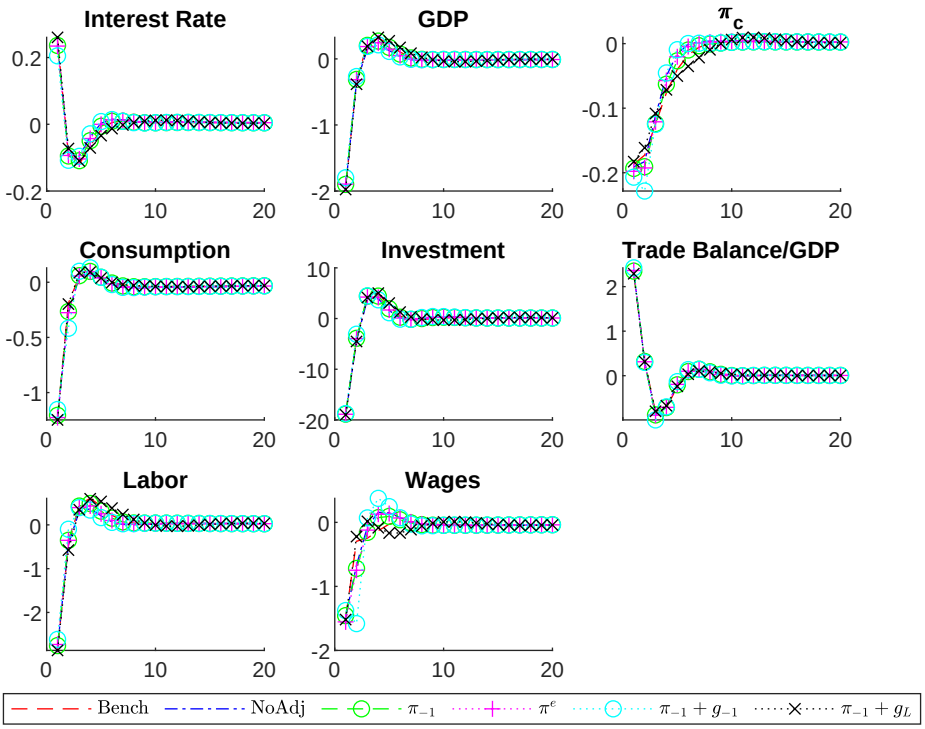

Figure 9: Impulse Response Functions to a 1% Monetary Policy Shock. Alternative minimum wage rules. Except Trade Balance, variables are expressed in log deviations from the steady state.

B Appendix: Sensitivity

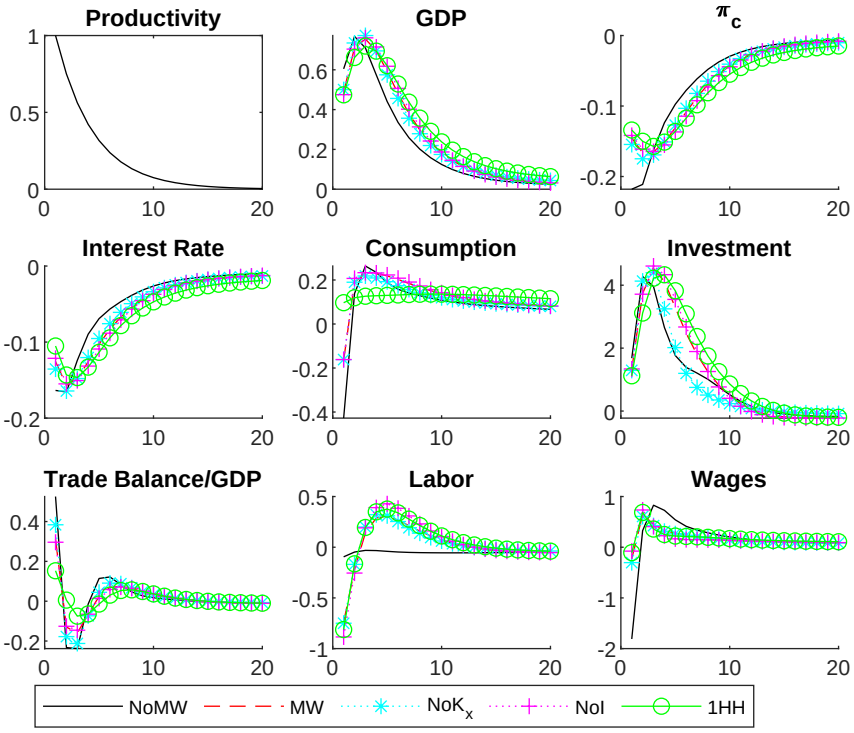

Figure 10: Impulse Response Functions to a 1% Total Factor Productivity (TFP) Shock. Different model assumptions. Except Trade Balance, variables are expressed in log deviations from the steady state.

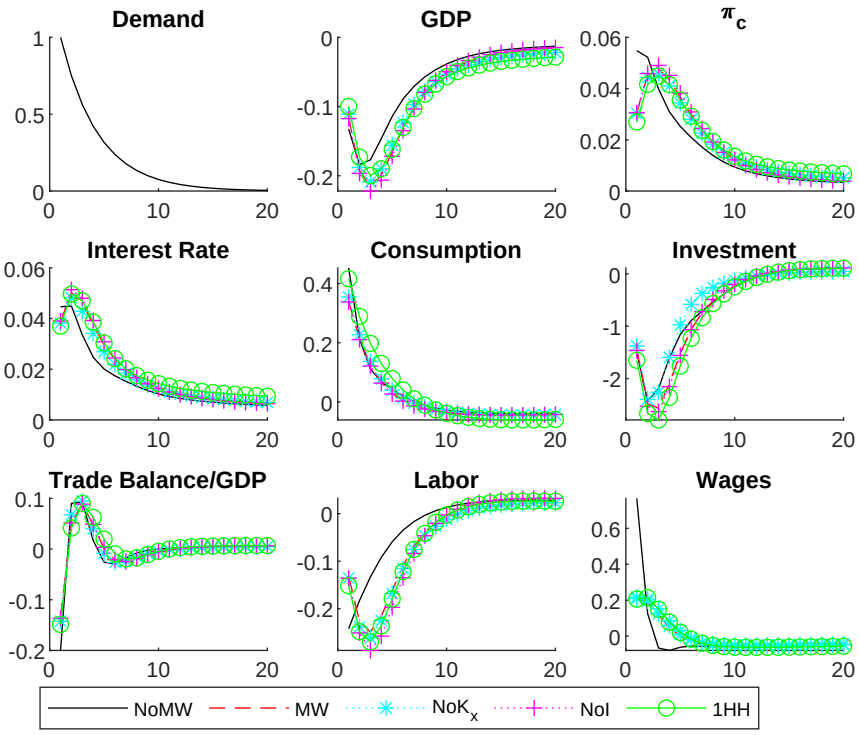

Figure 11: Impulse Response Functions to a 1% Total Demand Shock. Different model assumptions. Except Trade Balance, variables are expressed in log deviations from the steady state.

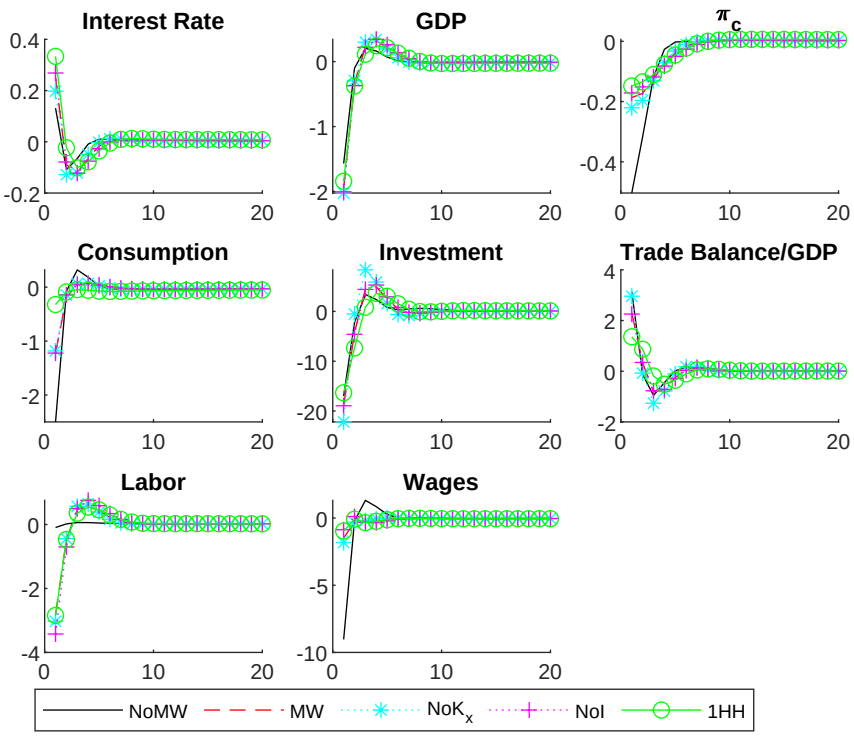

Figure 12: Impulse Response Functions to a 1% Monetary Policy Shock. Different model assumptions. Except Trade Balance, variables are expressed in log deviations from the steady state.

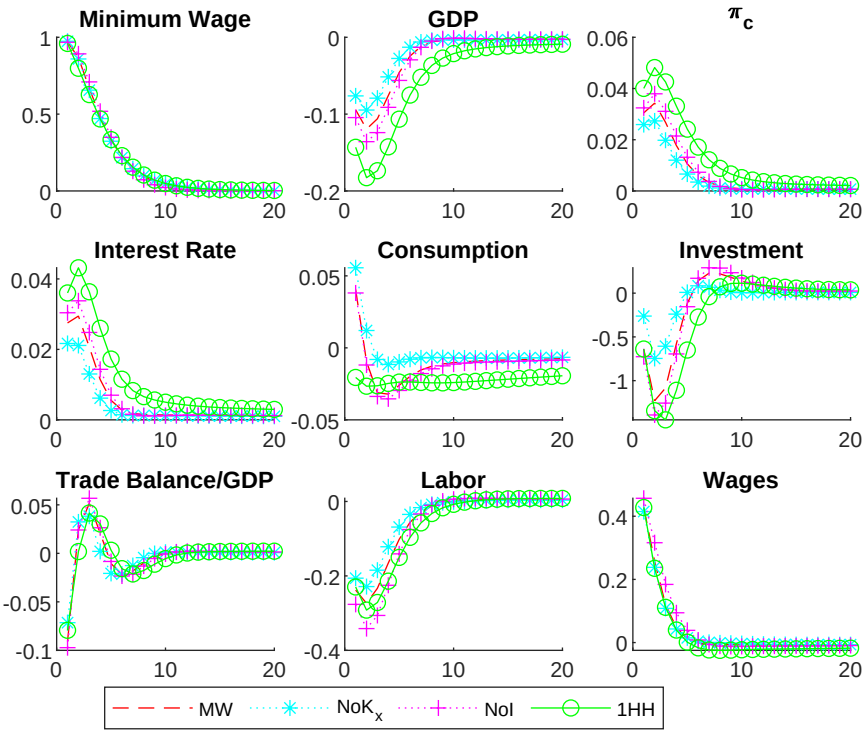

Figure 13: Impulse Response of Main Macroeconomic Aggregates to a transitory 100 bp increase in the minimum wage. The vertical axis shows the percentage difference with respect to the initial steady state except for the interest rate, R, and inflation, π (annual absolute difference)