Monetary Policy and Wealth Effects with International Income Transfers

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Abstract

I study how a system of international transfers based on dividend income affects monetary policy in a two-country model with incomplete asset markets. I show that macroeconomic shocks alter international transfer payments and determine cross-border wealth effects on labour supply, output and consumption. The direction of these effects depends on the nature of the underlying disturbance: technology and wage markup shocks cause wealth effects that stabilise consumption relative to output, whereas monetary and price markup shocks cause wealth effects that destabilise it. Numerical work shows that this affects the balance of monetary policy between inflation and output stabilisation.

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Keywords: Income transfers; Nominal rigidities; Cost-push shocks; Wealth effects; Monetary policy tradeoffs.

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1 Introduction

The global financial crisis that started in 2007-08 hit some areas of Europe particularly hard and exposed some weaknesses in its Economic and Monetary Union. Although emergency responses were implemented to mitigate the effects of the shock, the economic disruption opened wide interregional gaps in employment and real income growth, among other dimensions. Since these disparities persist today and are being corrected very slowly under the current institutional architecture—as shown by the European Commission (2017), among others—economists and policymakers initiated a debate on how to complete the union with mechanisms for economic re-convergence that leave member countries better prepared to absorbe future shocks[1]. One possible option is to establish a system of international income redistribution based on fiscal transfers. The question then arises as to whether and how its existence would change the kind of stabilisation policy that monetary authorities should follow.

In this paper I investigate how the presence of an international transfer scheme affects the transmission of macroeconomic shocks across borders and alters the objectives of monetary policy. To this end, I cast my analysis in a two-country, two-good dynamic stochastic general equilibrium (DSGE) model with monopolistic competition, nominal rigidities and incomplete international asset markets, which I solve using nonlinear methods. The distinctive feature of my framework is that it considers a system of transfers based on the collection and international redistribution of firms' profits, so that households

[1]See the so-called "Five Presidents' Report" by Juncker (2015) and the International Monetary Fund research paper by Berger, Dell'Ariccia, and Obstfeld (2018), among others.

effectively receive dividend payments from foreign firms. This simple arrangement determines cross-border wealth effects that affect labour supply, output and consumption over the business cycle. Under a conventional specification of preferences, technologies and macroeconomic shocks, I show that these effects can alter international risk sharing and change the priorities of monetary policymakers, i.e. the relative importance of price and output stability.

The foundation of my theoretical framework is an open-economy New Keynesian model similar to Clarida, Galí, and Gertler (2002) and Benigno and Benigno (2003). I depart from these pioneering works in two main dimensions. First, I dispense with the assumption of complete international asset markets. I allow households to exchange state-contingent securities within their own countries, so that my model maintains a representative agent formulation, but I assume that financial assets cannot be traded internationally. Second, while the early literature on monetary policy in open economies excluded the possibility that countries may transfer some output or profits to each other, I introduce an international redistribution system that leaves economies interconnected via two channels: a conventional trade linkage and a novel financial connection operating through international transfer payments.

My work is not the first to introduce some form of financial interdependence into a DSGE setting: earlier explorations are Tille (2008) and Devereux and Sutherland (2008). Neither work, however, focuses explicitly on redistributive transfers nor considers monetary policy tradeoffs. The former develops a model with exogenous portfolios of equity and bonds to investigate how different holdings of external assets and liabilities affect the transmission of macroeconomic shocks. However, it does not evaluate alternative monetary policies. The latter proposes a model with endogenous portfolio choice to explore how this mechanism interacts with monetary policy. Since it only considers productivity and interest-rate shocks as sources of uncertainty, the central bank faces no short-run tradeoff there[2]. By contrast, here I consider an economy where cost-push shocks determine a conflict between inflation and output stability. My contribution is that I investigate explicitly how the existence of a transfer scheme affects the priorities of central banks.

The new channel of international macroeconomic interdependence opened by transfer payments in my model works as follows. A supranational institution collects a fixed portion of the profits realised by firms in each country and pays them to the households of the other country. With this arrangement, net income transfers occur endogenously over the business cycle: when macroeconomic disturbances affect the profitability of firms asymmetrically across countries, differentials arise between the payments these economies make to each other. Since households receive these transfers in a lump-sum fashion, movements in profits determine cross-border wealth effects on labour supply that have implications for the short-run dynamics of economic activity. These spillovers interfere with the risk sharing provided by terms-of-trade movements. I show with numerical work that their strength depends on the size of the transfer system, while their direction depends on the nature of the

[2] In environments of that sort, negative productivity shocks open a *positive* gap between the level of output of the economy with nominal rigidities and its flexible-price counterpart, which causes inflation to rise. Both inflation and the output gap determine a loss of social welfare. There is no monetary policy tradeoff because the same response—i.e. an interest rate increase—tackles both problems.

shocks that cause macroeconomic fluctuations.

The connection between the direction of the wealth effects and the sources of business cycles is explained by the fact that transfers are tied to firms' profits, whereas the dynamics of consumption depends on that of output. As a consequence, whether international dividend payments stabilise consumption against fluctuations in economic activity or not depends on the comovement of output and profits. Such a comovement varies in response to different macroeconomic disturbances. Shocks to productivity and wage markups induce a positive comovement of output and profits. Conditional on these disturbances, households receive net transfer payments from abroad when domestic output is low, whereas they make net payments to foreigners when output is high; these countercyclical transfers of income stabilise domestic consumption relative to economic activity. On the contrary, shocks to interest rates and price markups induce a negative comovement of output and profits. Conditional on these disturbances, households receive net transfers when domestic output is high and make net transfers when it is low; these procyclical transfers of income exert a destabilising role on consumption.

The main point of the paper can be summarised as follows. The presence of an income transfer system based on the redistribution of profits creates wealth effects that impede an efficient sharing of risk via endogenous price adjustments. Whether these effects mitigate or exacerbate the volatility of consumption matters for monetary policy. More precisely, the stabilisation of output is important in economies where this variable displays large fluctuations compared to consumption; in that case, a policy of flexible inflation targeting (whereby some price stability is traded off for more output stability) can be desirable. Conversely, the stabilisation of output is less important in economies where this variable is less volatile than consumption; there, a policy of stricter inflation targeting tends to be more desirable. The fact that income transfers can alter the monetary policy mix has a key policy implication: a correct identification of what causes the business cycle is particularly important under an international redistribution system, because it provides guidance on how participating countries should conduct monetary policy.

The rest of this paper is organised as follows. Section 2 presents the model with competitive labour markets and Section 3 solves for its equilibrium. Section 4 discusses international income transfers, wealth effects and macroeconomic adjustment in that environment. Section 5 defines my welfare criterion and studies monetary policy tradeoffs. Section 6 concludes. The Appendix considers an economy with nominal wage rigidities and wage markup shocks.

2 Income transfers in a two-country model

I consider a two-country DSGE model with incomplete international markets and country-specific goods. Each country is populated by a continuum of measure one of infinitely lived households who get utility from consuming domestic and imported goods, and disutility from working. Households fully share risk within each country by exchanging a full set of contingent assets, so that attention can be limited to representative agents.

International financial markets are incomplete à la Heathcote and Perri

(2002): no private asset is available for trade between the countries. Households issue riskless one-period nominal bonds that cannot be traded across borders; these are in zero net supply as in Galí (2008) and Galí and Monacelli (2005), among others, and their prices are controlled by the local central banks. The model abstracts from different currencies: the prices of all goods are expressed in the same unit of account. As there is no international capital mobility, the countries keep independent monetary policies.

In each country, production takes place in two stages. First, monopolistically competitive firms employ local workers and produce a continuum of measure one of differentiated intermediate goods, indexed by i; these goods are not traded internationally. Second, perfectly competitive firms adopt a constant elasticity of substitution (CES) technology to aggregate domestically produced intermediates into final consumption goods, which are freely traded.

A supranational institution redistributes income across countries in the following way: it collects exogenously fixed portions of the profits of firms in each economy and transfers them to the households of the other country. These payments are a source of international spillovers of macroeconomic disturbances. The incompleteness of international asset markets emphasises this channel; the impossibility of borrowing and lending after uncertainty is realised exacerbates the impact of unexpected movements in dividend payments on employment, output and consumption. Although empirical evidence of internationally integrated markets for debt instruments, such as Lane (2013), lends interest to the study of economies where bonds are traded across borders, this mechanism would be blunted there because households could partly offset surpluses and shortfalls of transfer payments through intertemporal trade.

2.1 Households

All households within each country supply an identical labour service taking the wage as given. The Appendix extends the analysis to an environment where workers supply differentiated labour services in a monopolistically competitive market and set the wage for their labour type at random intervals.

2.1.1 Intertemporal problem: utility maximisation

Households choose consumption, saving and labour supply to maximise their lifetime utility

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u\left(c_t, n_t\right)$$

subject to the following budget constraint:

$$p_t c_t + q_t b_{t+1} = b_t + w_t n_t + \left(1 - \mathtt{s}\right) p_{h,t} \Pi_{h,t} + \mathtt{s} p_{f,t} \Pi_{f,t}.$$

p_t represents the consumer price index (CPI) of all domestically consumed goods, whereas $p_{h,t}$ and $p_{f,t}$ are the individual producer prices (PPIs) of home and foreign goods. q_t is the price of a nominally risk-free, one-period discount bond that is not traded internationally. b_t measures the holding of bonds that pay a return in the current period. w_t is the nominal wage and n_t measures the hours worked. $\Pi_{h,t}$ and $\Pi_{f,t}$ are the profits of the firms located at home and in the foreign country, denoted in units of the respective goods produced. By virtue of the international transfer scheme, the household of each country receives a fraction $\mathtt{s}$ of foreign profits and a fraction $1-\mathtt{s}$ of domestic profits[3].

2.1.2 Intratemporal problem: consumption allocation

Each period, households choose the bundles of goods that maximise consumption, defined as a standard Cobb-Douglas aggregator with imports share ζ. The static problem faced by households in the home country reads

$$\max_{c_{h,t},c_{f,t}} c_t \equiv \left(\frac{1}{1-\zeta}\right)^{1-\zeta}\left(\frac{1}{\zeta}\right)^{\zeta}(c_{h,t})^{1-\zeta}(c_{f,t})^{\zeta}$$

$$\text{s.t. } p_t c_t = p_{h,t}c_{h,t} + p_{f,t}c_{f,t}.$$

The price of the consumption bundle is measured by the index

$$p_t \equiv (p_{h,t})^{1-\zeta}(p_{f,t})^{\zeta}. \tag{1}$$

As foreign households have analogous preferences, the foreign CPI is similar.

2.2 Firms

2.2.1 Final goods producers

Perfectly competitive producers demand local inputs, indexed by i, to make final goods $y_{h,t}$ using standard CES technologies:

$$\max_{y_{h,t}(i)} p_{h,t}y_{h,t} - \int_0^1 p_{h,t}(i)\, y_{h,t}(i)\, di \qquad \text{s.t. } y_{h,t} = \left(\int_0^1 y_{h,t}(i)^{\frac{\varepsilon_t-1}{\varepsilon_t}} di\right)^{\frac{\varepsilon_t}{\varepsilon_t-1}}.$$

[3] As the two countries are equally sized, such a symmetric configuration of income transfers implies that these economies make zero net payments to each other in the long run.

The elasticity of substitution (ES) between varieties of intermediates (ε_t) is subject to exogenous innovations that cause cost-push shocks in the goods market. These disturbances determine fluctuations in the gap between the natural allocation and the efficient one, putting the monetary authority in the dilemma of stabilising prices or economic activity. The production of foreign goods $y_{f,t}$ involves analogous technologies and shocks.

2.2.2 Intermediate goods producers

In the home country, monopolistically competitive firms make intermediate goods i with the following technology[4]:

$$y_{h,t}(i) = a_t n_t(i) . \tag{2}$$

As workers are internationally immobile, labour is entirely supplied by locals. The productivity parameter a_t is common to all domestic firms and evolves exogenously over time according to a stochastic process specified below. Firms set the price of their goods to maximise profits in a Calvo-Yun fashion[5], subject to isoelastic demands by final goods producers:

$$\max_{\bar{p}_{h,t}(i)} \mathbb{E}_t \sum_{\tau=0}^{\infty} \theta_p^{\tau} q_{t,t+\tau} \left\{ y_{h,t+\tau}(i) \frac{\bar{p}_{h,t}(i)}{p_{h,t+\tau}} - \Psi\left(y_{h,t+\tau}(i)\right) \right\}$$

$$\text{s.t. } y_{h,t+\tau}(i) = \left(\frac{p_{h,t+\tau}(i)}{p_{h,t+\tau}} \right)^{-\varepsilon_t} y_{h,t+\tau},$$

[4]The model abstracts from physical capital accumulation. Investment would reduce profits and potentially alter the transmission mechanism of international transfers; see Coeurdacier and Rey (2012). I am grateful to an anonymous referee for pointing this out.

[5]The infrequent adjustment of prices implies that monetary policy has real effects.

where $q_{t,t+\tau} = \beta^{\tau}\mathbb{E}_t\left(\lambda_{t+\tau}/\lambda_t\right)$ denotes households' stochastic discount factor for τ periods-ahead real payoffs[6], θ_p is the index of price stickiness, the $\Psi\left(\cdot\right)$ function represents the real cost of production, and $\bar{p}_{h,t}\left(i\right)$ is the desired reset price. Foreign price setters face an analogous problem.

2.3 Monetary policy

The nominal returns on domestic and foreign bonds, defined as $R_t \equiv 1/q_t$ and $R_t^* \equiv 1/q_t^*$ respectively, are certain at the issuing date and represent the instruments of monetary policy. Central banks adjust them to stabilise prices and output according to the following Taylor rules:

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\gamma_R}\left[\left(\pi_{h,t}\right)^{\gamma_\pi}\left(\frac{y_{h,t}}{y_{h,t-1}}\right)^{\gamma_y}\right]^{1-\gamma_R} m_t, \tag{3}$$

$$\frac{R_t^*}{R^*} = \left(\frac{R_{t-1}^*}{R^*}\right)^{\gamma_R}\left[\left(\pi_{f,t}\right)^{\gamma_\pi}\left(\frac{y_{f,t}}{y_{f,t-1}}\right)^{\gamma_y}\right]^{1-\gamma_R} m_t^*. \tag{4}$$

R and R^* represent long-run targets for the gross nominal rates of interest; they are equal to the inverse of the discount factor β. The components m_t and m_t^* are exogenous disturbances whose properties are explained below.

Following Clarida et al. (2002) and Galí and Monacelli (2005), the interest rate rules are specified in terms of the PPI inflation rates $\pi_{h,t} \equiv p_{h,t}/p_{h,t-1}$ and $\pi_{f,t} \equiv p_{f,t}/p_{f,t-1}$, rather than the CPI inflation rates $\pi_t \equiv p_t/p_{t-1}$ and $\pi_t^* \equiv p_t^*/p_{t-1}^*$. Since the law of one price always holds, the relevant distortion is the dispersion of the prices of local intermediate goods. As shown by Engel

[6]The exclusive use of the discount factor of domestic households is due to the fact that they retain exclusive control over the firm despite the transfer of dividends to foreigners.

(2011)[7], the elimination of producer price inflation is sufficient to eradicate it.

The policy rates also react to movements in economic activity. These are specified in terms of output growth rates rather than output gaps, which makes rules (3) and (4) "operational" in the sense of Schmitt-Grohé and Uribe (2007).

2.4 Exogenous processes

Each country is affected by three sources of uncertainty: shocks to technology (a_t), to interest rates (m_t) and to the ES between intermediate products (ε_t). These variables follow first-order autoregressive processes in logs:

$$\log z_t = \rho_z \log z_{t-1} + e_{z,t},$$

where $z_t = a_t, m_t, \varepsilon_t/\bar{\varepsilon}$. $\bar{\varepsilon}$ represents the steady-state ES. The innovations ($e_{z,t}$) follow orthogonal i.i.d. normal processes with zero mean and constant variance. To highlight the endogenous transmission mechanism that operates in the presence of the income transfer scheme, I assume these innovations are internationally uncorrelated: $\text{corr}\,(e_z, e_z^*) = 0$.

3 Equilibrium conditions

In this section I present the optimality conditions associated with the problems of households and firms, the law of motion of prices and the market-clearing conditions. I limit my exposition to the equations that characterise the home

[7] This is true regardless of international income transfers: interest rate rules that include foreign price inflation yield lower social welfare in this environment, as argued below.

country; analogous equations hold in the foreign one.

3.1 Households

I consider an economy with competitive labour markets and flexible wages; monopoly power and nominal frictions in the labour market are introduced in the Appendix. Households supply undifferentiated labour services and optimise their labour effort taking the wage as given, according to the expression

$$-\frac{u_n\left(c_t, n_t\right)}{w_t/p_t} = \lambda_t.$$

The first-order conditions (FOCs) for the intertemporal optimisation of consumption and savings are standard: see the Appendix.

The demands for domestic and imported consumption goods are as follows:

$$c_{h,t} = (1-\zeta)\left(\frac{p_{h,t}}{p_t}\right)^{-1} c_t, \qquad c_{f,t} = (\zeta)\left(\frac{p_{f,t}}{p_t}\right)^{-1} c_t. \tag{5}$$

3.2 Firms

3.2.1 Final goods production

The input demand schedules that solve the problems of final goods producers in the home country are as follows:

$$y_{h,t}\left(i\right) = \left(\frac{p_{h,t}\left(i\right)}{p_{h,t}}\right)^{-\varepsilon_t} y_{h,t}. \tag{6}$$

The associated PPI implied by perfect competition is

$$p_{h,t} = \left(\int_0^1 p_{h,t}(i)^{1-\varepsilon_t} \, di \right)^{\frac{1}{1-\varepsilon_t}}. \tag{7}$$

3.2.2 Intermediate goods production

In a symmetric equilibrium, all price resetters face the same problem and choose the same reset price. Auxiliary variables $g^1_{h,t}$ and $g^2_{h,t}$ can be defined as outlined in the Appendix to rewrite the optimal price-setting conditions of firms in the home country as follows:

$$g^2_{h,t} = \mathcal{M}_{p,t} g^1_{h,t}, \tag{8}$$

where the desired "frictionless" price markup is $\mathcal{M}_{p,t} \equiv \frac{\varepsilon_t}{\varepsilon_t - 1}$.

3.2.3 Productivity, employment and aggregate output

As outlined in the Appendix, the input demand schedule (6) and the production function (2) can be combined with a labour market-clearing condition to get the exact aggregate production function for home-country goods:

$$y_{h,t} = \frac{a_t n_t}{d^p_{h,t}}. \tag{9}$$

Price dispersion in the home economy is defined as

$$d^p_{h,t} \equiv \int_0^1 \left(\frac{p_{h,t}(i)}{p_{h,t}} \right)^{-\varepsilon_t} di.$$

3.3 Dynamics of prices

Under the assumption that all resetters in a country choose the same price (symmetric equilibrium) and that the distribution of prices among non-resetters at time t corresponds to the distribution of effective prices at time $t-1$ (law of large numbers), the PPI (7) evolves as follows:

$$1=\theta_p\left(\frac{p_{h,t-1}}{p_{h,t}}\right)^{1-\varepsilon_t}+(1-\theta_p)\left(\frac{\bar{p}_{h,t}}{p_{h,t}}\right)^{1-\varepsilon_t}.$$

By the same logic, we can define an optimal relative price $\tilde{p}_{h,t}\equiv\bar{p}_{h,t}/p_{h,t}$ and rewrite the price dispersion index recursively:

$$d^p_{h,t}=\theta_p\left(\frac{1}{\pi_{h,t}}\right)^{-\varepsilon_t}d^p_{h,t-1}+(1-\theta_p)\left(\tilde{p}_{h,t}\right)^{-\varepsilon_t}.$$

3.3.1 Market clearing

Labour market clearing has been imposed in the calculation of the aggregate production functions. Goods market clearing requires the following conditions:

$$y_{h,t}=c_{h,t}+c^*_{h,t},\qquad y_{f,t}=c_{f,t}+c^*_{f,t}.$$

As assets cannot be traded internationally, bond market clearing requires

$$b_t=0,\qquad b^*_t=0.$$

The Appendix lists the whole set of equilibrium conditions for this economy.

4 Equilibrium dynamics

In this section I investigate how the presence of the transfer scheme affects the response of the main macroeconomic variables to exogenous shocks.

Period utility functions are specified as follows:

$$u(c_t, n_t) = \ln c_t - \frac{n_t^{1+\varphi}}{1+\varphi}.$$

The time interval of the model is a quarter. Table 1 displays the benchmark parameterisation adopted for the simulations[8]. The absence of home bias in consumption makes the preferences of home and foreign households identical. Since both the elasticity of intertemporal substitution and the elasticity of substitution between domestic goods and imports are unity, the Cole and Obstfeld (1991) result obtains in the absence of transfers: endogenous terms-of-trade movements fully neutralise output risks, so c_t and c_t^* always move one-to-one, as if international asset markets were complete. Transfers break down this risk-sharing mechanism: as movements in cross-border payments shift income across countries and cause wealth effects, c_t and c_t^* move asymmetrically despite the unit elasticities configuration[9]. The transfer scheme interferes with an efficient sharing of risk because the share of redistributed profits is fixed rather than adjusted over the business cycle.

The business-cycle properties of the economy with and without dividend

[8]While my objective is to illustrate the key mechanism that characterises an economy with income transfers within a small-scale model, I pick reasonable parameter values that are common in the New Keynesian literature: see Galí (2008).

[9]Trade imbalances mirror these income transfers, as current accounts must be zero because acquisitions and sales of foreign assets are not allowed.

Table 1: Parameter values for the model

Parameter	Value	Description
φ	1	Frisch elasticity of labour supply
$\bar{\varepsilon}$	6	Steady-state ES between intermediates
ζ	0.5	Share of imported goods in consumption
β	0.99	Subjective discount factor
θ_p	0.66	Price stickiness parameter
γ_R	0.7	Interest rate smoothing parameter in the Taylor rule
γ_π	1.5	Inflation parameter in the Taylor rule
γ_y	0.125	Output growth parameter in the Taylor rule
ρ_z	0.95	Serial correlation of exogenous processes $z_t = a_t, m_t, \frac{\varepsilon_t}{\bar{\varepsilon}}$
$\text{std}\,(e_z)$	0.01	Standard deviation of exogenous shocks to $z_t = a_t, m_t, \frac{\varepsilon_t}{\bar{\varepsilon}}$
$\mathtt{s}_0$	0	Share of redistributed dividends (no transfers case)
$\mathtt{s}_{1/2}$	0.5	Share of redistributed dividends (case with transfers)

transfers (labelled with $\mathtt{s}_{1/2}$ and $\mathtt{s}_0$, respectively) are reported in Tables 2 and 3. The impulse response functions (IRFs) to macroeconomic shocks under each arrangement are compared in the next section.

4.1 Technology shocks

Figure 1 shows the effects of a positive technology shock in the home country, which causes a decrease in the marginal cost of production and an increase in output. The real profits of domestic firms jump, and since both consumption and leisure are normal goods, home households reduce their supply of labour.

Without a redistribution scheme ($\mathtt{s}_0$, dashed red lines), home and foreign consumption expand equally thanks to the risk-sharing role played by the terms of trade. Foreign households do not receive any payment from abroad, so foreign labour supply is unaffected and foreign output is stable[10].

[10]Home and foreign products are independent in consumption with the configuration of elasticities adopted here. As shown by Corsetti and Pesenti (2001), shocks to the supply of

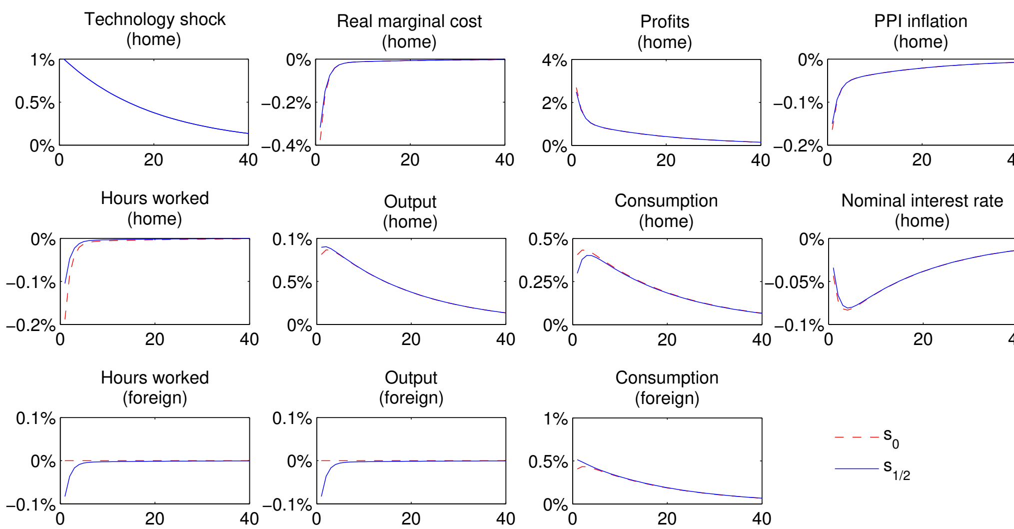
Table 2: Business cycle statistics with transfers ($\mathbf{s}_{1/2}$, variables in logs)

Variable	Standard deviation	Relative standard deviation	First-order autocorrelation	Contemporaneous correlation with output	Contemporaneous international correlation
Output	0.0451	1.0000	0.3634	1.0000	0.8918
Consumption	0.0682	1.5122	0.3752	0.7109	-0.1726
Hours	0.0434	0.9623	0.3323	0.9574	0.9710
CPI inflation	0.0873	1.9356	0.5259	0.6912	0.0356
Real wage	0.1039	2.3038	0.3536	0.8673	0.3875
Real int. rate	0.0320	0.7095	0.3344	-0.7391	-0.0276

Table 3: Business cycle statistics without transfers ($\mathbf{s}_0$, variables in logs)

Variable	Standard deviation	Relative standard deviation	First-order autocorrelation	Contemporaneous correlation with output	Contemporaneous international correlation
Output	0.0621	1.0000	0.3476	1.0000	0.0000
Consumption	0.0439	0.7069	0.3476	0.7071	1.0000
Hours	0.0610	0.9823	0.3314	0.9777	0.0000
CPI inflation	0.1116	1.7971	0.1796	0.8790	-0.3661
Real wage	0.0967	1.5572	0.3346	0.9377	0.6022
Real int. rate	0.0223	0.3591	0.3069	-0.6887	1.0000

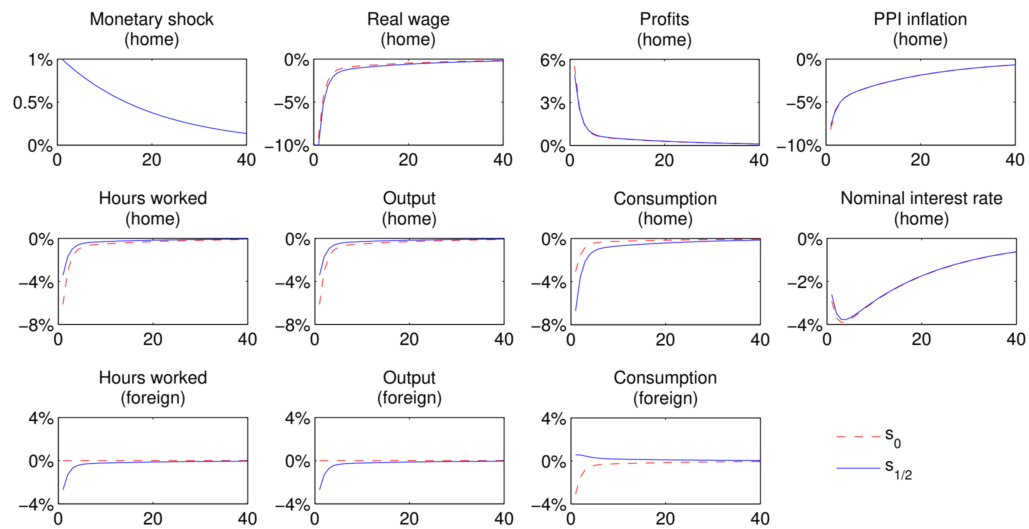
Figure 1: Impulse responses to a technology shock with and without transfers



With the redistribution scheme ($s_{1/2}$, solid blue lines), part of the extra profits of domestic firms are paid to foreigners in the form of transfers. This provokes a wealth effect on labour supply abroad: the lump-sum component of foreign households' income jumps, so labour effort is replaced by more leisure. As a consequence, foreign hours and output fall while the real wage rises. This triggers a second round of wealth effects: since the profits of foreign firms drop, households in the home country receive smaller payments from abroad and supply more labour. For this reason, output and hours worked in the home country exceed those observed without transfers. The combined result of these spillovers is a transitory redistribution of consumption to foreign households, as consumption rises more in the foreign economy than in the domestic one on impact.

one good do not spill over into the supply of the other in this case.

Figure 2: Impulse responses to a monetary shock with and without transfers



4.2 Monetary shocks

Figure 2 shows the impact of a contractionary monetary policy shock in the home country. The rise in the domestic real interest rate exerts a contractionary effect on output and pushes inflation down. Since nominal wages are flexible but prices are not, real wages fall and aggregate profits jump.

In the absence of redistributive transfers ($\mathbf{s}_0$, dashed red lines), both home and foreign consumption fall because the total supply of home goods has decreased. The decline in c_t and c_t^* is symmetric again due to the endogenous adjustment of the terms of trade. Since foreign households are insulated from the dynamics of home profits, there is no change in foreign hours worked, output and profits.

In the presence of transfers ($\mathbf{s}_{1/2}$, solid blue lines), international wealth effects come into play again. Foreign households receive extra payments from abroad and supply less labour, so foreign output and profits decline. Households in the home country, in turn, receive smaller dividend payments from foreign firms and step up their labour effort; as a consequence, domestic output is higher than in the previous case. These spillovers shift income across borders again: their impact is a pronounced fall in home consumption and a jump in foreign consumption[11].

4.3 Cost-push shocks

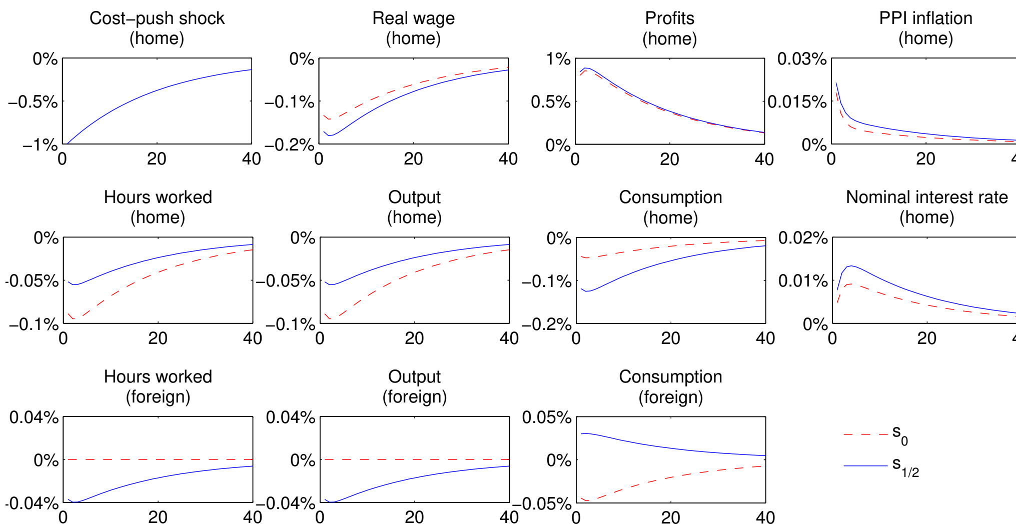
Figure 3 shows the impulse responses of selected macroeconomic variables to an adverse cost-push shock in the home country, which takes the form of an exogenous 1 percent decrease in ε_t. The shock temporarily boosts price markups in the home economy, expanding the wedge between the marginal product of labour and the marginal rate of substitution between consumption and leisure. Output, hours and real wages fall, while real profits rise.

In the presence of transfers ($\mathtt{s}_{1/2}$, solid blue lines), additional dividends are paid to foreign households, triggering a wealth effect that reduces their supply of labour; foreign output and profits fall. This triggers a second wealth effect: domestic households receive smaller dividends from abroad and supply more labour, aggravating the fall of real wages in the home country.

In the absence of transfers ($\mathtt{s}_0$, dashed red lines), foreign households are immune to changes in the profits of home firms, so labour supply and output are unaffected abroad. The extra profits of home firms are received entirely by domestic households, with stronger wealth effects on their labour supply.

[11] The sum of home and foreign consumption (not shown here) clearly falls, due to the decline in the production of home goods caused by the contractionary monetary shock.

Figure 3: Impulse responses to a cost-push shock in the goods market with and without transfers



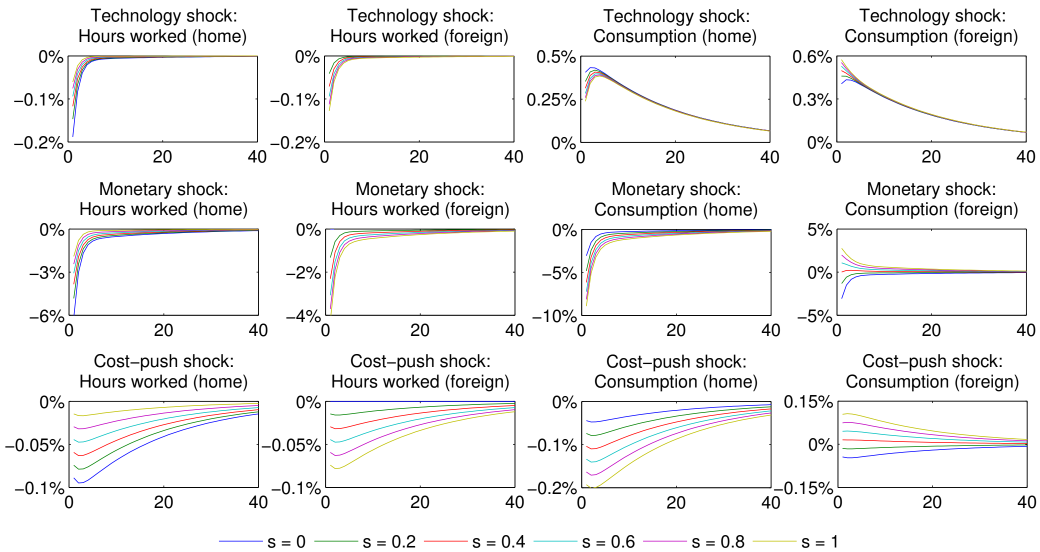
For this reason, domestic real wages are higher and output is lower than in the case with $\mathtt{s}_{1/2}$.

4.4 Wealth effects and the size of the transfer scheme

The magnitude of the cross-border wealth effects triggered by macroeconomic shocks depends on the size of the dividend transfers. I uncover this connection in Figure 4, where I plot the behaviour of hours worked and consumption in each economy conditional on the three shocks examined above as $\mathtt{s}$ ranges between 0 and 100 percent.

The symmetric configuration of dividend transfers makes it easier to visualise the spillover mechanism, because it implies that net transfers are nil in steady state, so consumption is identical across the two countries in the long run. International wealth effects only occur in the short run, when the

Figure 4: Size of the transfers and the international spillover of shocks



net transfers between these economies depart from zero. Asymmetric transfer schemes (whereby one country is a net receiver of dividend income in the long run) would affect the mechanism of interest quantitatively but not qualitatively.

The picture confirms that shocks to the home country leave foreign hours (and thus output) unaffected when there are no transfers. Because of the endogenous risk-sharing role played by the terms of trade, a perfect positive conditional correlation between domestic and foreign consumption is observed. As a larger and larger redistribution of dividends is introduced, stronger and stronger wealth effects are triggered by international transfers that cause larger and larger spillovers of macroeconomic disturbances across borders. These show up in larger and larger movements of foreign hours worked on impact (due to the first wealth effect), as well as smaller and smaller movements in domestic hours worked (due to the second wealth effect). Since the conditional correlation of consumption across countries declines, the redistribution scheme effectively reduces international risk sharing. This happens because the size of the transfer scheme ($\mathtt{s}$) is exogenous instead of being adjusted optimally over the business cycle.

5 Monetary policy and welfare

In this section I study monetary policy within the class of interest rate rules (3) and (4)[12]. In order to compare the performance of different parameterisations of these rules, I adopt a welfare-based criterion: I search for the Taylor rule parameters vector that maximises the conditional expectation of the total lifetime utility of households, given the current state of the economy.

I define the welfare of the home and foreign households as follows:

$$V_{h,t} \equiv \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t u\left(c_t, n_t\right), \qquad V_{f,t} \equiv \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t u\left(c_t^*, n_t^*\right). \tag{10}$$

These welfare measures are rearranged recursively and then appended to the competitive equilibrium conditions of the model. I depart from the practice of combining a second-order approximation of the welfare function with a first-order approximation of the remaining equilibrium conditions. That approach would be prone to large approximation errors with incomplete markets, be-

[12] The identification of the optimal monetary policy would be challenging in this environment, because one would have to maximise welfare subject to the whole system of nonlinear competitive equilibrium conditions of the economy. As explained below, a characterisation of optimal policy with a linear-quadratic approximation is not pursued for accuracy reasons.

cause some second-order terms of the welfare functions (10) would be ignored while others are included. As shown by Kim and Kim (2003), such a miscalculation can result in spurious welfare rankings.

Following Schmitt-Grohé and Uribe (2007), I compute a second-order accurate solution of the entire expanded system around its non-stochastic steady state. This has two main implications. First, I do not need to make the steady state efficient, so I dispense with the factor-input subsidies financed by lump-sum taxes that induce the perfectly competitive long-run level of employment. Second, I adopt recursive representations of the exact nonlinear dynamics of prices (and wages, in the Appendix) rather than New Keynesian Phillips Curves, so I must keep track of additional state variables that measure price (and wage) dispersion.

The identification of the most desirable monetary policy mix involves comparing welfare (10) across different calibrations of the Taylor rules. Expectations are taken conditional on the initial state of the economy being the competitive equilibrium non-stochastic steady state, which is independent of monetary policy; this ensures that the economy starts from the same point in all cases under consideration.

Numerical work indicates that welfare is decreasing in the interest rate smoothing parameter γ_R, increasing in the inflation response coefficient γ_π, and non-monotonic (namely, concave) in the output reaction coefficient γ_y. These results support a policy of "flexible inflation targeting" that trades off price stability against some output stability. The level of welfare of a non-stochastic economy can be approached by adopting Taylor rules with arbitrarily large inflation coefficients, no inertia in interest rates, and suitable output coefficients that depend on the size of the transfer scheme.

These well-established facts can be explained as follows. First, an inertial adjustment of interest rates is unnecessary because there is no need to stabilise the opportunity cost of holding money in a cashless economy. Second, inflation stabilisation reduces the need to reset prices and keeps the economy close to the "natural" or flexible-price allocation. Third, a policy of "leaning against the wind" reduces output volatility in the presence of cost-push shocks.

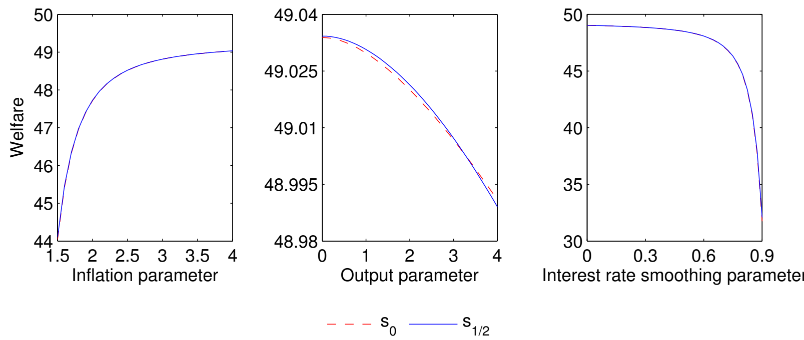
As observed above, the relevant inflation target in this economy only includes the price of domestic goods. Since the law of one price holds, central banks do not have to target movements of imports prices: these are regarded as efficient. Furthermore, as domestic and imported goods are independent in consumption, no cross-border supply spillovers create potential gains from monetary cooperation. In fact, interest rate rules augmented to respond to foreign inflation à la Clarida et al. (2002) would reduce welfare here.

Without cost-push shocks, central banks face no short-run tradeoff and inflation stabilisation is the sole objective of monetary policy, regardless of transfer payments. In that case, the welfare level of a non-stochastic economy is well approximated by the constrained[13] configuration of interest rate rules $(\gamma_R, \gamma_\pi, \gamma_y) = (0, 4, 0)$. Figure 5 shows how welfare changes as we vary each Taylor rule parameter around this combination, holding the others fixed[14].

[13]In principle, the welfare maximisation problem has no solution because the objective function is monotonically increasing in γ_π and the domain of this parameter is unbounded. Following Schmitt-Grohé and Uribe (2007), I rule out coefficients larger than 4 on the grounds that they would not be realistic in practice.

[14]The first panel cuts the welfare surface at $\gamma_y = 0$ and $\gamma_r = 0$. The second one is drawn with $\gamma_\pi = 4$ and $\gamma_r = 0$. The third one uses $\gamma_\pi = 4$ and $\gamma_y = 0$.

Figure 5: Cross-sections of the welfare surface with and without transfers



In the presence of cost-push shocks, instead, monetary authorities must strike a balance between different goals because the natural level of output departs from the efficient one, with the consequence that stabilising prices (in order to keep economic activity in line with its flexible-price counterpart) is no longer sufficient to address all the existing distortions; as is well known, some output stabilisation takes the economy closer to the socially optimal allocation under these conditions. What is distinctive about a world with transfer payments is that the international wealth effects mechanism shown above alters the balance of monetary policy between these two objectives.

The existence of a monetary policy tradeoff goes unnoticed when the volatility of cost-push shocks is as small as in Table 1; strict inflation targeting remains the welfare-maximising policy in that case. However, the monetary policy dilemma becomes visible if cost-push shocks get volatile enough. When $\text{std}(e_\varepsilon) = 0.25$, for instance, central banks can improve upon strict inflation targeting by putting some emphasis on output stability. As shown in Figure 6 and Table 4, the monetary policy mix that maximises welfare features

Figure 6: Output stabilisation and welfare with cost-push shocks

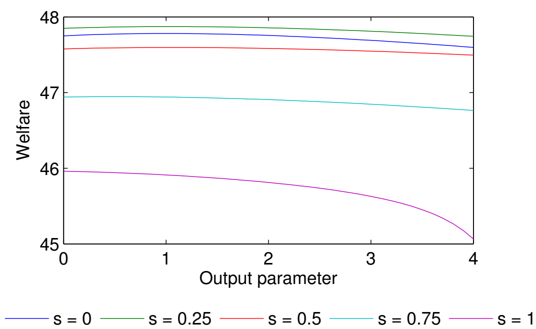


Table 4: Size of transfers and monetary policy mix with cost-push shocks

s	0%	25%	50%	75%	100%
$(\gamma_R, \gamma_\pi, \gamma_y)$	$(0, 4, 1)$	$(0, 4, 1)$	$(0, 4, 1)$	$(0, 4, 0.5)$	$(0, 4, 0)$

a positive output coefficient in this case, as long as the size of the transfer scheme stays between 0 and 50 percent (which is the most interesting range in practice). The output parameter declines quickly when s gets larger than that, because the international wealth effects observed in Figure 3 become strong; they reduce the volatility of economic activity and hours conditional on domestic cost-push shocks, tilting the balance towards inflation stability.

These results illustrate how the wealth effects associated with transfers tend to stabilise output relative to consumption when cost-push shocks affect the production of final goods. The Appendix adds monopoly power in the labour market and nominal wage rigidities to show that the opposite happens conditional on cost-push shocks that affect the supply of labour[15]: wealth effects destabilise output relative to consumption in that case.

[15]These shocks are modelled as exogenous movements in the elasticity of substitution between different types of labour, along the lines of Schmitt-Grohé and Uribe (2007).

Whether an international redistribution system based on dividend transfers mitigates or exacerbates the relative volatility of consumption and output depends on the direction of the wealth effects set into motion by exogenous shocks. This, in turn, depends on how output and profits comove conditional on each type of macroeconomic disturbance.

On one hand, output and profits comove positively under (i) technology shocks and (ii) cost-push shocks in the labour market, as shown in the Appendix. Conditional on these disturbances, the redistribution scheme stabilises consumption because it determines *countercyclical* income transfers: net payments are received from abroad when home output and profits are low, and vice-versa. On the other hand, output and profits comove negatively under (iii) monetary shocks and (iv) cost-push shocks in the goods market. Conditional on these disturbances, the redistribution scheme destabilises consumption because it determines *procyclical* income transfers instead: net payments are received from abroad when domestic output is high, and vice-versa.

The output stabilisation objective tends to be less important when economic activity experiences a relatively small volatility compared to consumption; *strict* inflation targeting tends to emerge as the most desirable monetary policy in that case. This is what happens in economies dominated by shocks (iii) and (iv). By the same logic, output stabilisation becomes more important in economies dominated by shocks (i) and (ii). A policy of *flexible* inflation targeting tends to yield the highest welfare there.

6 Concluding remarks

The possibility of establishing a supranational income redistribution system, as recently envisaged in Europe by Berger, Dell'Ariccia, and Obstfeld (2018), for instance, directs attention to the role of transfer payments in the international transmission of economic shocks. The purpose of the present work has been to explore the impact of one such mechanism on macroeconomic dynamics and the conduct of monetary policy in the context of an optimisation-based framework.

Within a fairly standard two-country New Keynesian model, I have shown that international wealth effects on labour supply materialise following technology, monetary and cost-push shocks if redistribution is implemented in the form of lump-sum transfers of a fixed portion of firms' profits. These effects reallocate consumption across countries, and cause macroeconomic adjustment to differ from what would be observed without a transfer system of this kind.

The key mechanism at work is as follows. As the comovement of aggregate output and profits varies in response to distinct kinds of disturbances, so does the direction of wealth effects—because these are tied to international dividend payments. The procyclicality or countercyclicality of such transfers, in turn, determines whether consumption is stabilised or destabilised relative to output under this system. The implication for monetary policy is that central banks should place more emphasis on output stabilisation in the presence of shocks that cause a positive comovement of output and profits (such as shocks to technology or to the wage markup), and less emphasis on such a goal in the presence of shocks that cause a negative comovement of output and profits (such as shocks to interest rates or to the price markup).

Since the choice of the monetary policy mix depends on the relative importance of different macroeconomic disturbances, a correct identification of the sources of business cycles is particularly important for monetary policy in the presence of an international system of income transfers based on the cross-border redistribution of profits.

Acknowledgements

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Appendix

Here I present an extended version of the model with imperfectly competitive labour markets and infrequent nominal wage adjustment. The households of each country are made up of a continuum of workers indexed on the unit interval, each supplying a differentiated labour service j. As these services are imperfect substitutes, workers can choose their wage subject to a Calvo-Yun friction. The total nominal labour income earned by domestic workers is $\int_0^1 w_t(j)\, n_t(j)\, dj$, where $w_t(j)$ and $n_t(j)$ denote each worker's nominal wage and hours worked. There is full risk sharing across workers in each economy.

Wage setting

Wages are subject to nominal rigidities. In each period, only a fraction $1-\theta_w$ of workers can reset their wage; the rest must keep their existing one, with no indexation. Assuming that utility is separable in labour and consumption, the relevant part of the Lagrangian for the optimal wage setting problem of workers in the home country is

$$\mathbb{E}_t \sum_{\tau=0}^{\infty} (\beta\theta_w)^{\tau} \left\{ u\left(c_{t+\tau}, n_{t+\tau}\right) + \lambda_{t+\tau} \int_0^1 \frac{\bar{w}_t\left(j\right)}{p_{t+\tau}} n_{t+\tau}\left(j\right) dj \right\}.$$

$\bar{w}_t\left(j\right)$ is worker j's current reset wage in nominal terms. The labour demand faced by this worker at time $t+\tau$ is

$$n_{t+\tau}\left(j\right) = \left(\frac{w_{t+\tau}\left(j\right)}{w_{t+\tau}}\right)^{-\psi_t} n_{t+\tau}.$$

Foreign workers solve an analogous problem.

In a symmetric equilibrium where all wage setters choose the same reset wage, recursive auxiliary variables $f^1_{h,t}$ and $f^2_{h,t}$ can be defined as shown below to rewrite the optimal wage-setting conditions compactly as

$$f^1_{h,t} = \mathcal{M}_{w,t} f^2_{h,t},$$

where the desired "frictionless" wage markup is defined as $\mathcal{M}_{w,t} \equiv \frac{\psi_t}{\psi_t - 1}$.

Employment agencies and labour demand

Firms demand a homogeneous labour service. Perfectly competitive contractors act as "labour packers" in each country: they purchase the differentiated labour inputs and turn them into a composite labour service. They maximise profits subject to a standard CES technology:

$$\max_{n_t(j)} w_t n_t - \int_0^1 w_t(j)\, n_t(j)\, dj \qquad \text{s.t. } n_t = \left(\int_0^1 n_t(j)^{\frac{\psi_t - 1}{\psi_t}}\, dj \right)^{\frac{\psi_t}{\psi_t - 1}}.$$

The elasticity of substitution between different types of labour (ψ_t) is subject to exogenous disturbances that make the wage markup volatile and determine cost-push shocks in the labour market. These disturbances follow a stochastic process analogous to that of the elasticity of substitution between intermediate goods (ε_t), with a steady-state level $\bar{\psi}$. They generate further fluctuations in the gap between the natural (i.e. flexible-prices and flexible-wages) allocation and its efficient counterpart, exacerbating the monetary policy tradeoff.

The labour demand schedules that solve the problem of labour packers in the home country are as follows:

$$n_t(j) = \left(\frac{w_t(j)}{w_t} \right)^{-\psi_t} n_t.$$

A zero-profit condition implies the following aggregate nominal wage index:

$$w_t = \left(\int_0^1 w_t(j)^{1-\psi_t}\, dj \right)^{\frac{1}{1-\psi_t}}.$$

Aggregate production function

The aggregate supply of labour is found by integrating the hours purchased by employment agencies over labour types j:

$$n_t^s = \int_0^1 n_t\left(j\right) dj = \int_0^1 \left(\frac{w_t\left(j\right)}{w_t}\right)^{-\psi_t} n_t^d dj = d_{h,t}^w n_t^d.$$

Notice that n_t^s depends on the aggregation technology adopted by the labour packers, and it includes a first source of inefficiency: nominal wage dispersion, measured by the index

$$d_{h,t}^w \equiv \int_0^1 \left(\frac{w_t\left(j\right)}{w_t}\right)^{-\psi_t} dj.$$

The aggregate demand for labour is found by integrating individual demands for composite labour services over intermediate goods producers i:

$$n_t^d = \int_0^1 n_t^d\left(i\right) di = \int_0^1 \frac{y_{h,t}\left(i\right)}{a_t} di = d_{h,t}^p \frac{y_{h,t}}{a_t}.$$

n_t^d depends on the aggregation technology adopted by the producers of final goods, and includes a second source of inefficiency: price dispersion.

Equating labour demand and supply, we obtain the exact relationship between aggregate output, employment and technology in this environment:

$$y_{h,t} = \frac{a_t n_t}{d_{h,t}^w d_{h,t}^p}.$$

With flexible wages, $d_{h,t}^w = 1$ so the aggregate production function (9) obtains.

Relative marginal cost

Comparing firm i's real marginal cost $mc_{h,t}(i) = w_t/p_{h,t}mpn_t(i)$ with the economy-wide average real marginal cost $mc_{h,t} = w_t/p_{h,t}mpn_t$ and using the individual and average marginal products of labour implied by the individual and aggregate production functions, we get an equation that facilitates the passage from individual to aggregate price dynamics in the optimal pricing problem:

$$mc_{h,t}(i) = \frac{mc_{h,t}}{d^w_{h,t}d^p_{h,t}}.$$

Aggregate profits

The total cost of production of a given variety i in the home country is

$$\Psi\left(y_{h,t}(i)\right) = \frac{w_t}{p_{h,t}}n_t(i) = \frac{w_t}{p_{h,t}}\frac{y_{h,t}(i)}{a_t},$$

which can be rewritten as a function of the price:

$$\Psi\left(p_{h,t}(i)\right) = \frac{w_t}{p_{h,t}}\frac{y_{h,t}}{a_t}\left(\frac{p_{h,t}(i)}{p_{h,t}}\right)^{-\varepsilon_t}.$$

Firms' aggregate profits are decreasing in the dispersion of prices and wages:

$$\begin{aligned}\Pi_{h,t} &\equiv \int_0^1 \Pi_{h,t}(i)\,di \\ &= y_{h,t}\int_0^1 \left(\frac{p_{h,t}(i)}{p_{h,t}}\right)^{1-\varepsilon_t} di - \frac{w_t}{p_{h,t}}\int_0^1 n_t(i)\,di \\ &= y_{h,t} - \frac{w_t}{p_{h,t}}\frac{y_{h,t}}{a_t}d^w_{h,t}d^p_{h,t}.\end{aligned}$$

Optimal price setting

By direct substitution of the constraints in the price setter's objective function, the problem becomes

$$\max_{\bar{p}_{h,t}} \mathbb{E}_t \sum_{\tau=0}^{\infty} (\theta_p \beta)^{\tau} \left(\frac{\lambda_{t+\tau}}{\lambda_t}\right) \left\{ y_{h,t+\tau} \left(\frac{\bar{p}_{h,t}}{p_{h,t+\tau}}\right)^{1-\varepsilon_t} - \Psi\left(y_{h,t+\tau}(i)\right) \right\}.$$

The FOCs written in terms of the economy-wide marginal cost are as follows:

$$\begin{aligned} &\mathbb{E}_t \sum_{\tau=0}^{\infty} (\theta_p \beta)^{\tau} \left(\frac{\lambda_{t+\tau}}{\lambda_t}\right) \left\{ \frac{y_{h,t+\tau}}{p_{h,t+\tau}} \left(\frac{\bar{p}_{h,t}}{p_{h,t+\tau}}\right)^{-\varepsilon_t} \right\} \\ &= \mathbb{E}_t \sum_{\tau=0}^{\infty} (\theta_p \beta)^{\tau} \left(\frac{\lambda_{t+\tau}}{\lambda_t}\right) \left\{ \frac{mc_{h,t+\tau}}{d^w_{h,t+\tau} d^p_{h,t+\tau}} \left(\frac{\varepsilon_t}{\varepsilon_t - 1}\right) \frac{y_{h,t+\tau}}{p_{h,t+\tau}} \left(\frac{\bar{p}_{h,t}}{p_{h,t+\tau}}\right)^{-1-\varepsilon_t} \right\}. \end{aligned}$$

If we define two auxiliary variables

$$g^2_{h,t} \equiv \mathbb{E}_t \sum_{\tau=0}^{\infty} (\theta_p \beta)^{\tau} \left(\frac{\lambda_{t+\tau}}{\lambda_t}\right) \left\{ y_{h,t+\tau} \left(\frac{\bar{p}_{h,t}}{p_{h,t}}\right)^{-\varepsilon_t} \left(\frac{p_{h,t}}{p_{h,t+\tau}}\right)^{1-\varepsilon_t} \right\},$$

$$g^1_{h,t} \equiv \mathbb{E}_t \sum_{\tau=0}^{\infty} (\theta_p \beta)^{\tau} \left(\frac{\lambda_{t+\tau}}{\lambda_t}\right) \left\{ \frac{mc_{h,t+\tau}}{d^w_{h,t+\tau} d^p_{h,t+\tau}} y_{h,t+\tau} \left(\frac{\bar{p}_{h,t}}{p_{h,t}}\right)^{-1-\varepsilon_t} \left(\frac{p_{h,t}}{p_{h,t+\tau}}\right)^{-\varepsilon_t} \right\},$$

we can rewrite the FOCs compactly as

$$g^2_{h,t} = \left(\frac{\varepsilon_t}{\varepsilon_t - 1}\right) g^1_{h,t}.$$

Additional manipulation yields a recursive formulation of these variables:

$$g^2_{h,t} \equiv y_{h,t} \left(\tilde{p}_{h,t}\right)^{-\varepsilon_t} + \theta_p \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}}{\lambda_t}\right) g^2_{h,t+1} \left(\frac{\tilde{p}_{h,t}}{\tilde{p}_{h,t+1}}\right)^{-\varepsilon_t} \left(\frac{1}{\pi_{h,t+1}}\right)^{1-\varepsilon_t},$$

$$g^1_{h,t} \equiv y_{h,t} \frac{mc_{h,t}}{d^w_{h,t} d^p_{h,t}} \left(\tilde{p}_{h,t}\right)^{-1-\varepsilon_t} + \theta_p \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}}{\lambda_t}\right) g^1_{h,t+1} \left(\frac{\tilde{p}_{h,t}}{\tilde{p}_{h,t+1}}\right)^{-1-\varepsilon_t} \left(\frac{1}{\pi_{h,t+1}}\right)^{-\varepsilon_t}.$$

Optimal wage setting

Since workers supply any quantity of labour that satisfies the demand at the chosen wage, the hours worked at time $t+\tau$ by a worker who has been unable to reset his wage since time t are as follows:

$$n_{t+\tau}(j) = \left(\frac{\bar{w}_t(j)}{w_{t+\tau}}\right)^{-\psi_t} n_{t+\tau} = \left(\frac{\bar{\mathrm{w}}_t(j) \prod_{s=1}^{\tau} \frac{1}{\pi_{t+s}}}{\mathrm{w}_{t+\tau}}\right)^{-\psi_t} n_{t+\tau},$$

where $\bar{\mathrm{w}}_t(j)$ is worker j's real reset wage, whereas w_t represents the real aggregate wage index

$$\mathrm{w}_t = \left(\int_0^1 \mathrm{w}_t(j)^{1-\psi_t} di\right)^{\frac{1}{1-\psi_t}}.$$

By direct substitution of this real labour demand schedule into the worker's budget constraint we obtain

$$\begin{aligned}
\mathcal{L} = \mathbb{E}_t \sum_{\tau=0}^{\infty} & \left(\beta\theta_w\right)^{\tau} u\left(c_{t+\tau}, n_{t+\tau}\right) \\
& + \left(\beta\theta_w\right)^{\tau} \lambda_{t+\tau} \left\{ \frac{b_{t+\tau}}{p_{t+\tau}} + \left(\prod_{s=1}^{\tau} \frac{1}{\pi_{t+s}}\right)^{1-\psi_t} \int_0^1 \bar{\mathrm{w}}_t(j)^{1-\psi_t} n_{t+\tau} \left(\mathrm{w}_{t+\tau}\right)^{\psi_t} dj \right. \\
& \left. + (1-\mathtt{s}) \mathscr{P}_{h,t+\tau} \Pi_{h,t+\tau} + \mathtt{s} \mathscr{P}_{f,t+\tau} \Pi_{f,t+\tau} - c_{t+\tau} - \frac{q_{t+\tau}}{p_{t+\tau}} b_{t+\tau+1} \right\}.
\end{aligned}$$

Assuming full consumption risk sharing across workers, the cost of supplying work is identical across labour types. Since the labour demand schedule is the same across labour types, we can focus on a symmetric equilibrium where all resetters choose the same reset wage $\bar{\mathrm{w}}_t$. The first-order conditions are

$$\mathbb{E}_t \sum_{\tau=0}^{\infty} (\beta\theta_w)^{\tau} u_n (c_{t+\tau}, n_{t+\tau}) n_{t+\tau} (-\psi_t) (\mathrm{w}_{t+\tau})^{\psi_t} (\bar{\mathrm{w}}_t)^{-\psi_t - 1} \left(\prod_{s=1}^{\tau} \frac{1}{\pi_{t+s}} \right)^{-\psi_t}$$
$$+ \mathbb{E}_t \sum_{\tau=0}^{\infty} (\beta\theta_w)^{\tau} \lambda_{t+\tau} \left(\prod_{s=1}^{\tau} \frac{1}{\pi_{t+s}} \right)^{1-\psi_t} n_{t+\tau} (\mathrm{w}_{t+\tau})^{\psi_t} (1 - \psi_t) (\bar{\mathrm{w}}_t)^{-\psi_t} = 0.$$

These can be rewritten compactly by means of two auxiliary variables:

$$f_{h,t}^1 \equiv \bar{\mathrm{w}}_t \mathbb{E}_t \sum_{\tau=0}^{\infty} (\beta\theta_w)^{\tau} \lambda_{t+\tau} \left(\prod_{s=1}^{\tau} \frac{1}{\pi_{t+s}} \right)^{1-\psi_t} n_{t+\tau} \left(\frac{\bar{\mathrm{w}}_t}{\mathrm{w}_{t+\tau}} \right)^{-\psi_t},$$

$$f_{h,t}^2 \equiv -\mathbb{E}_t \sum_{\tau=0}^{\infty} (\beta\theta_w)^{\tau} u_n (c_{t+\tau}, n_{t+\tau}) \left(\prod_{s=1}^{\tau} \frac{1}{\pi_{t+s}} \right)^{-\psi_t} n_{t+\tau} \left(\frac{\bar{\mathrm{w}}_t}{\mathrm{w}_{t+\tau}} \right)^{-\psi_t},$$

$$f_{h,t}^1 = \left(\frac{\psi_t}{\psi_t - 1} \right) f_{h,t}^2.$$

Additional manipulation yields a useful recursive formulation:

$$f_{h,t}^1 \equiv (\bar{\mathrm{w}}_t)^{1-\psi_t} (\mathrm{w}_t)^{\psi_t} \lambda_t n_t + \beta\theta_w \mathbb{E}_t \left(\frac{1}{\pi_{t+1}} \right)^{1-\psi_t} \left(\frac{\bar{\mathrm{w}}_t}{\bar{\mathrm{w}}_{t+1}} \right)^{1-\psi_t} f_{h,t+1}^1,$$

$$f_{h,t}^2 \equiv -u_n (c_t, n_t) n_t \left(\frac{\bar{\mathrm{w}}_t}{\mathrm{w}_t} \right)^{-\psi_t} + \beta\theta_w \mathbb{E}_t \left(\frac{1}{\pi_{t+1}} \right)^{-\psi_t} \left(\frac{\bar{\mathrm{w}}_t}{\bar{\mathrm{w}}_{t+1}} \right)^{-\psi_t} f_{h,t+1}^2.$$

Dynamics of wages

Applying the Calvo-Yun algebra to the nominal wage index, we obtain the law of motion of wages subject to nominal rigidities:

$$1 = \theta_w \left(\frac{w_{t-1}}{w_t} \right)^{1-\psi_t} + (1 - \theta_w) \left(\frac{\bar{w}_t}{w_t} \right)^{1-\psi_t}.$$

We can define an optimal relative wage $\tilde{w}_t \equiv \bar{w}_t / w_t$ and write the law of motion of wage dispersion recursively:

$$d^w_{h,t} = \theta_w \left(\frac{1}{\pi_{w,t}} \right)^{-\psi_t} d^w_{h,t-1} + (1 - \theta_w) (\tilde{w}_t)^{-\psi_t} .$$

Monetary policy

In order to reduce wage distortions, central banks must adjust their policy instruments in response to movements in nominal wages[16]. The Taylor rules (3) and (4) must prescribe that interest rates also react to the movements of the gross wage inflation rates $\pi_{w,t} \equiv w_t / w_{t-1}$ and $\pi^*_{w,t} \equiv w^*_t / w^*_{t-1}$:

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R} \right)^{\gamma_R} \left[(\pi_{h,t})^{\gamma_\pi} (\pi_{w,t})^{\gamma_w} \left(\frac{y_{h,t}}{y_{h,t-1}} \right)^{\gamma_y} \right]^{1-\gamma_R} m_t,$$

$$\frac{R^*_t}{R^*} = \left(\frac{R^*_{t-1}}{R^*} \right)^{\gamma_R} \left[(\pi_{f,t})^{\gamma_\pi} \left(\pi^*_{w,t}\right)^{\gamma_w} \left(\frac{y_{f,t}}{y_{f,t-1}} \right)^{\gamma_y} \right]^{1-\gamma_R} m^*_t.$$

Equilibrium conditions under sticky wages

Since nominal variables are not uniquely determined, the system of equilibrium conditions must be written in terms of real variables and relative prices for computational convenience. To do so, one can define the terms of trade as the

[16] As argued by Erceg, Henderson, and Levin (2000), the natural allocation cannot be obtained when both price and wage dispersion exist. To restore the natural level of output, zero inflation would be needed in the markets for labour and goods at the same time; this would impede the real wage adjustments that sustain the natural allocation.

ratio $s_t \equiv p_{f,t}/p_{h,t}$ and then rewrite all prices as PPI-to-CPI ratios:

$$\mathscr{P}_{h,t} \equiv \frac{p_{h,t}}{p_t} = (s_t)^{-\zeta}, \qquad \mathscr{P}_{f,t} \equiv \frac{p_{f,t}}{p_t} = (s_t)^{1-\zeta},$$

$$\mathscr{P}^*_{h,t} \equiv \frac{p_{h,t}}{p^*_t} = (s_t)^{\zeta-1}, \qquad \mathscr{P}^*_{f,t} \equiv \frac{p_{f,t}}{p^*_t} = (s_t)^{\zeta}.$$

Real wages are defined in a conventional way:

$$\mathrm{w}_t \equiv \frac{w_t}{p_t}, \qquad \mathrm{w}^*_t \equiv \frac{w^*_t}{p^*_t}.$$

With this notation, the equilibrium of the model is as follows:

$$c_{h,t} = (1-\zeta)\frac{c_t}{\mathscr{P}_{h,t}},$$

$$c_{f,t} = \zeta\frac{c_t}{\mathscr{P}_{f,t}},$$

$$c^*_{f,t} = (1-\zeta)\frac{c^*_t}{\mathscr{P}^*_{f,t}},$$

$$c^*_{h,t} = \zeta\frac{c^*_t}{\mathscr{P}^*_{h,t}},$$

$$y_{h,t} = c_{h,t} + c^*_{h,t},$$

$$y_{f,t} = c_{f,t} + c^*_{f,t},$$

$$u_c(c_t, n_t) = \lambda_t,$$

$$f^1_{h,t} = \mathcal{M}_{w,t} f^2_{h,t},$$

$$f^1_{h,t} = \bar{\mathrm{w}}_t\left(\frac{\mathrm{w}_t}{\bar{\mathrm{w}}_t}\right)^{\psi_t}\lambda_t n_t + \beta\theta_w \mathbb{E}_t(\pi_{t+1})^{\psi_t-1}\left(\frac{\bar{\mathrm{w}}_t}{\bar{\mathrm{w}}_{t+1}}\right)^{1-\psi_t} f^1_{h,t+1},$$

$$f_{h,t}^2 = -u_n(c_t, n_t)\, n_t \left(\frac{\bar{\mathrm{w}}_t}{\mathrm{w}_t}\right)^{-\psi_t} + \beta\theta_w \mathbb{E}_t (\pi_{t+1})^{\psi_t} \left(\frac{\bar{\mathrm{w}}_t}{\bar{\mathrm{w}}_{t+1}}\right)^{-\psi_t} f_{h,t+1}^2,$$

$$\mathcal{M}_{w,t} = \frac{\psi_t}{\psi_t - 1},$$

$$q_t = \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}}{\lambda_t}\frac{1}{\pi_{t+1}}\right),$$

$$c_t + \frac{q_t}{p_t} b_{t+1} = \frac{b_t}{p_t} + \mathrm{w}_t n_t + (1-\mathtt{s})\, \mathscr{P}_{h,t}\Pi_{h,t} + \mathtt{s}\mathscr{P}_{f,t}\Pi_{f,t},$$

$$b_t = 0,$$

$$u_c(c_t^*, n_t^*) = \lambda_t^*,$$

$$f_{f,t}^1 = \mathcal{M}_{w,t}^* f_{f,t}^2,$$

$$f_{f,t}^1 = \bar{\mathrm{w}}_t^* \left(\frac{\mathrm{w}_t^*}{\bar{\mathrm{w}}_t^*}\right)^{\psi_t^*} \lambda_t^* n_t^* + \beta\theta_w \mathbb{E}_t \left(\pi_{t+1}^*\right)^{\psi_t^*-1} \left(\frac{\bar{\mathrm{w}}_t^*}{\bar{\mathrm{w}}_{t+1}^*}\right)^{1-\psi_t^*} f_{f,t+1}^1,$$

$$f_{f,t}^2 = -u_n(c_t^*, n_t^*)\, n_t^* \left(\frac{\bar{\mathrm{w}}_t^*}{\mathrm{w}_t^*}\right)^{-\psi_t^*} + \beta\theta_w \mathbb{E}_t \left(\pi_{t+1}^*\right)^{\psi_t^*} \left(\frac{\bar{\mathrm{w}}_t^*}{\bar{\mathrm{w}}_{t+1}^*}\right)^{-\psi_t^*} f_{f,t+1}^2,$$

$$\mathcal{M}_{w,t}^* = \frac{\psi_t^*}{\psi_t^* - 1},$$

$$q_t^* = \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}^*}{\lambda_t^*}\frac{1}{\pi_{t+1}^*}\right),$$

$$c_t^* + \frac{q_t^*}{p_t^*} b_{t+1}^* = \frac{b_t^*}{p_t^*} + \mathrm{w}_t^* n_t^* + (1-\mathtt{s})\, \mathscr{P}_{f,t}^*\Pi_{f,t} + \mathtt{s}\mathscr{P}_{h,t}^*\Pi_{h,t},$$

$$b_t^* = 0,$$

$$y_{h,t} = \frac{a_t n_t}{d_{h,t}^w d_{h,t}^p},$$

$$y_{f,t} = \frac{a_t^* n_t^*}{d_{f,t}^w d_{f,t}^p},$$

$$mc_{h,t} = \frac{\mathrm{w}_t}{\mathscr{P}_{h,t}} \frac{d^w_{h,t} d^p_{h,t}}{a_t},$$

$$mc_{f,t} = \frac{\mathrm{w}^*_t}{\mathscr{P}^*_{f,t}} \frac{d^w_{f,t} d^p_{f,t}}{a^*_t},$$

$$d^w_{h,t} = \theta_w \left(\frac{\mathrm{w}_{t-1}}{\mathrm{w}_t} \right)^{-\psi_t} (\pi_t)^{\psi_t} d^w_{h,t-1} + (1-\theta_w) \left(\frac{\bar{\mathrm{w}}_t}{\mathrm{w}_t} \right)^{-\psi_t},$$

$$d^w_{f,t} = \theta_w \left(\frac{\mathrm{w}^*_{t-1}}{\mathrm{w}^*_t} \right)^{-\psi^*_t} (\pi^*_t)^{\psi^*_t} d^w_{f,t-1} + (1-\theta_w) \left(\frac{\bar{\mathrm{w}}^*_t}{\mathrm{w}^*_t} \right)^{-\psi^*_t},$$

$$\frac{\bar{\mathrm{w}}_t}{\mathrm{w}_t} = \left[\frac{1-\theta_w (\pi_{w,t}\pi_t)^{\psi_t - 1}}{1-\theta_w} \right]^{\frac{1}{1-\psi_t}},$$

$$\frac{\bar{\mathrm{w}}^*_t}{\mathrm{w}^*_t} = \left[\frac{1-\theta_w \left(\pi^*_{w,t}\pi^*_t\right)^{\psi^*_t - 1}}{1-\theta_w} \right]^{\frac{1}{1-\psi^*_t}},$$

$$d_{h,t} = \theta_p (\pi_{h,t})^{\varepsilon_t} d_{h,t-1} + (1-\theta_p) (\tilde{p}_{h,t})^{-\varepsilon_t},$$

$$d_{f,t} = \theta_p (\pi_{f,t})^{\varepsilon^*_t} d_{f,t-1} + (1-\theta_p) (\tilde{p}_{f,t})^{-\varepsilon^*_t},$$

$$\tilde{p}_{h,t} = \left[\frac{1-\theta_p (\pi_{h,t})^{\varepsilon_t - 1}}{1-\theta_p} \right]^{\frac{1}{1-\varepsilon_t}},$$

$$\tilde{p}_{f,t} = \left[\frac{1-\theta_p (\pi_{f,t})^{\varepsilon^*_t - 1}}{1-\theta_p} \right]^{\frac{1}{1-\varepsilon^*_t}},$$

$$\pi_{h,t} = \frac{\mathscr{P}_{h,t}}{\mathscr{P}_{h,t-1}} \pi_t,$$

$$\pi_{f,t} = \frac{\mathscr{P}_{f,t}}{\mathscr{P}_{f,t-1}} \pi^*_t,$$

$$g^2_{h,t} = \mathcal{M}_{p,t} g^1_{h,t},$$

$$g^1_{h,t} = y_{h,t} \frac{mc_{h,t}}{d^w_{h,t} d^p_{h,t}} (\tilde{p}_{h,t})^{-1-\varepsilon_t} + \theta_p \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}}{\lambda_t} \right) \left(\frac{\tilde{p}_{h,t}}{\tilde{p}_{h,t+1}} \right)^{-1-\varepsilon_t} (\pi_{h,t+1})^{\varepsilon_t} g^1_{h,t+1},$$

$$g_{h,t}^2 = y_{h,t} \left(\tilde{p}_{h,t}\right)^{-\varepsilon_t} + \theta_p \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}}{\lambda_t}\right) \left(\frac{\tilde{p}_{h,t}}{\tilde{p}_{h,t+1}}\right)^{-\varepsilon_t} \left(\pi_{h,t+1}\right)^{\varepsilon_t - 1} g_{h,t+1}^2,$$

$$\mathcal{M}_{p,t} = \frac{\varepsilon_t}{\varepsilon_t - 1},$$

$$g_{f,t}^2 = \mathcal{M}_{p,t}^* g_{f,t}^1,$$

$$g_{f,t}^1 = y_{f,t} \frac{mc_{f,t}}{d_{f,t}^w d_{f,t}^p} \left(\tilde{p}_{f,t}\right)^{-1-\varepsilon_t^*} + \theta_p \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}^*}{\lambda_t^*}\right) \left(\frac{\tilde{p}_{f,t}}{\tilde{p}_{f,t+1}}\right)^{-1-\varepsilon_t^*} \left(\pi_{f,t+1}\right)^{\varepsilon_t^*} g_{f,t+1}^1,$$

$$g_{f,t}^2 = y_{f,t} \left(\tilde{p}_{f,t}\right)^{-\varepsilon_t^*} + \theta_p \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}^*}{\lambda_t^*}\right) \left(\frac{\tilde{p}_{f,t}}{\tilde{p}_{f,t+1}}\right)^{-\varepsilon_t^*} \left(\pi_{f,t+1}\right)^{\varepsilon_t^* - 1} g_{f,t+1}^2,$$

$$\mathcal{M}_{p,t}^* = \frac{\varepsilon_t^*}{\varepsilon_t^* - 1},$$

$$R_t = \frac{1}{q_t},$$

$$R_t^* = \frac{1}{q_t^*},$$

$$\frac{R_t}{1/\beta} = \left(\frac{R_{t-1}}{1/\beta}\right)^{\gamma_R} \left[\left(\pi_{h,t}\right)^{\gamma_\pi} \left(\pi_{w,t}\right)^{\gamma_w} \left(\frac{y_{h,t}}{y_{h,t-1}}\right)^{\gamma_y}\right]^{1-\gamma_R} m_t,$$

$$\frac{R_t^*}{1/\beta} = \left(\frac{R_{t-1}^*}{1/\beta}\right)^{\gamma_R} \left[\left(\pi_{f,t}\right)^{\gamma_\pi} \left(\pi_{w,t}^*\right)^{\gamma_w} \left(\frac{y_{f,t}}{y_{f,t-1}}\right)^{\gamma_y}\right]^{1-\gamma_R} m_t^*,$$

$$\pi_{w,t} = \frac{\mathrm{w}_{t-1}}{\mathrm{w}_t} \frac{1}{\pi_t},$$

$$\pi_{w,t}^* = \frac{\mathrm{w}_{t-1}^*}{\mathrm{w}_t^*} \frac{1}{\pi_t^*},$$

$$\log a_t = \rho_a \log a_{t-1} + e_{a,t},$$

$$\log a_t^* = \rho_a \log a_{t-1}^* + e_{a,t}^*,$$

$$\log m_t = \rho_m \log m_{t-1} + e_{m,t},$$

$$\log m_t^* = \rho_m \log m_{t-1}^* + e_{m,t}^*,$$

$$\log\left(\frac{\varepsilon_t}{\bar{\varepsilon}}\right) = \rho_\varepsilon \log\left(\frac{\varepsilon_{t-1}}{\bar{\varepsilon}}\right) + e_{\varepsilon,t},$$

$$\log\left(\frac{\varepsilon_t^*}{\bar{\varepsilon}}\right) = \rho_\varepsilon \log\left(\frac{\varepsilon_{t-1}^*}{\bar{\varepsilon}}\right) + e_{\varepsilon,t}^*,$$

$$\log\left(\frac{\psi_t}{\bar{\psi}}\right) = \rho_\psi \log\left(\frac{\psi_{t-1}}{\bar{\psi}}\right) + e_{\psi,t},$$

$$\log\left(\frac{\psi_t^*}{\bar{\psi}}\right) = \rho_\psi \log\left(\frac{\psi_{t-1}^*}{\bar{\psi}}\right) + e_{\psi,t}^*,$$

$$\Pi_{h,t} = y_{h,t} - \frac{\mathrm{w}_t}{\mathscr{P}_{h,t}} \frac{y_{h,t}}{a_t} d_{h,t}^w d_{h,t}^p,$$

$$\Pi_{f,t} = y_{f,t} - \frac{\mathrm{w}_t^*}{\mathscr{P}_{f,t}^*} \frac{y_{f,t}}{a_t^*} d_{f,t}^w d_{f,t}^p,$$

$$V_{h,t} = u\left(c_t, n_t\right) + \beta \mathbb{E}_t V_{h,t+1},$$

$$V_{f,t} = u\left(c_t^*, n_t^*\right) + \beta \mathbb{E}_t V_{f,t+1}.$$

Equilibrium adjustment to labour supply shocks

I append the parameter specification in Table 5 to that in Table 1. To capture the fact that wages adjust slower than prices, my wage stickiness parameter implies a four-quarter average duration of wage spells, as opposed to a three-quarter average duration of price spells—in line with evidence by Druant et al. (2009), among others. The steady state value of ψ equals that of ε. The price and wage inflation coefficients in the Taylor rule are chosen so that their sum equals 1.5, which is the value of γ_π under the baseline calibration in Table 1[17].

[17] It is the sum of these two coefficients that matters for determinacy in economies with sticky prices and wages; see Galí (2008).

Table 5: Additional calibrated parameters

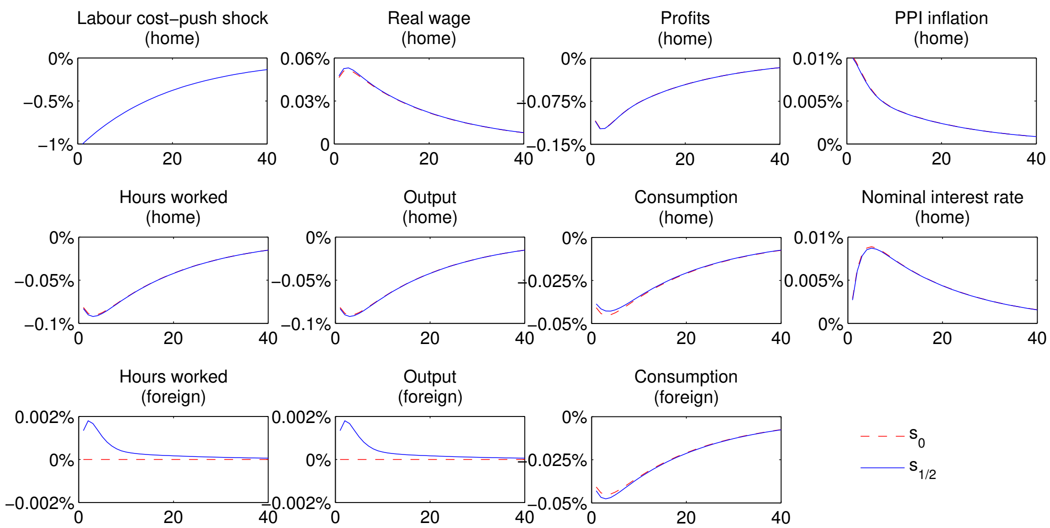
Parameter	Value	Description
θ_w	0.75	Wage stickiness parameter
$\bar{\psi}$	6	Steady-state ES between labour types
γ_w, γ_π	0.75	Wage and price inflation parameters in the Taylor rule
ρ_ψ	0.95	Serial correlation of the ES between labour types
$\text{std}\,(e_\psi)$	0.01	Standard deviation of labour market cost-push shocks

Figure 7 displays the IRFs of selected macroeconomic variables to an adverse cost-push shock in the labour market of the home country, brought about by a 1 percent drop in ψ_t. The shock raises local real wages and reduces profits. With transfers ($\mathtt{s}_{1/2}$, solid blue lines), the drop in dividend payments from the home country triggers cross-border wealth effects that boost foreign labour supply. This affects foreign profits and spills over into domestic labour supply, in turn, exacerbating the fall in domestic economic activity. These effects do not occur without transfers ($\mathtt{s}_0$, dashed red lines).

The response of real wages to the shock is hump-shaped due to the sluggish adjustment of both nominal wages and prices. This is reflected in the dynamics of aggregate domestic profits too. In the presence of a dividend redistribution scheme, wealth effects imply that the responses of foreign consumption, hours and output are hump-shaped as well.

The impulse responses to technology, monetary and cost-push shocks in the goods market are analogous to those observed under flexible wages.

Figure 7: Impulse responses to a cost-push shock in the labour market with and without transfers



Monetary policy and welfare

If shocks to the ES between labour types are as small as in Table 5, the cost of ignoring output fluctuations is negligible and the control of (price and wage) inflation remains the sole goal of the monetary authority. If cost-push shocks are large enough, though, the natural level of output departs significantly from its efficient counterpart and the stabilisation of economic activity becomes an important additional goal of monetary policy.

Table 6 shows how the welfare-maximising calibration of the Taylor rules (with γ_w constrained from exceeding 4 as well) varies with the share of redistributed dividends when $\text{std}(e_\psi) = \text{std}(e_\varepsilon) = 0.1$. The pattern that emerges resembles that observed in Table 4. The welfare-maximising γ_y is positive and constant as transfers range between 0 and 50 percent of profits; beyond that, γ_y declines due to the wealth effects mechanism outlined above.

Table 6: Size of transfers and monetary policy mix with labour supply shocks

s	0%	25%	50%	75%	100%
$(\gamma_R, \gamma_\pi, \gamma_w, \gamma_y)$	$(0, 4, 4, 2.9)$	$(0, 4, 4, 2.9)$	$(0, 4, 4, 2.8)$	$(0, 4, 4, 2.5)$	$(0, 4, 4, 2.1)$

To verify the claim that the impact of transfers on monetary policy depends on the direction of wealth effects and therefore on the sources of business cycles, let us increase the relative importance of the shocks to technology and labour supply by setting $\text{std}\,(e_a) = \text{std}\,(e_\psi) = 0.1$, while we keep $\text{std}\,(e_m) = \text{std}\,(e_\varepsilon) = 0.01$. Table 7 confirms that a greater emphasis on output stabilisation emerges as transfers get larger in this case.

Table 7: Size of transfers and monetary policy mix with large a and ψ shocks

s	0%	25%	50%	75%	100%
$(\gamma_R, \gamma_\pi, \gamma_w, \gamma_y)$	$(0, 4, 4, 1.1)$	$(0, 4, 4, 1.2)$	$(0, 4, 4, 1.3)$	$(0, 4, 4, 1.3)$	$(0, 4, 4, 1.3)$

Comparing Tables 6 and 7, we see that to draw conclusions about the most appropriate monetary policy mix under international trasfers one must take a stance on the sources of business cycles. This issue is still debated.

Smets and Wouters (2007) investigated the sources of business cycle fluctuations in the United States between 1966 and 2004 in the context of a log-linearised DSGE model with both price and wage stickiness. If the exogenous processes of my model were parameterised according to their estimates[18], technology shocks would be the dominant source of output and consumption fluctuations[19], so countercyclical transfers would prevail under a profits redistri-

[18]They indicate $\text{std}\,(e_a) = 0.45$, $\text{std}\,(e_m) = 0.24$, $\text{std}\,(e_\varepsilon) = 0.14$ and $\text{std}\,(e_\psi) = 0.24$.

[19]Domestic technology shocks would represent as much as 98% of the variance of output and almost 30% of the variance of consumption (with the remaining 70% being almost entirely explained by foreign technology shocks).

bution scheme. This would strengthen the case for flexible inflation targeting.

Two notes of caution are in order at this point. First, the Smets and Wouters posteriors make macroeconomic variables implausibly volatile in the present model. More reasonable volatilities would emerge under the Smets and Wouters priors: $\text{std}(e_a) = \text{std}(e_m) = \text{std}(e_\varepsilon) = \text{std}(e_\psi) = 0.10$. With that calibration, the welfare surface is quite flat along the γ_y dimension and the welfare-maximising monetary policy mix appears nearly invariant to the size of the income transfer scheme. Second, other studies such as Ireland (2004) point to monetary disturbances and cost-push shocks in the goods markets as the main drivers of macroeconomic fluctuations. For the reasons explained above, procyclical transfers are likely to prevail in that case, weakening the case for output stabilisation.

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