# Money, Exchange rate and Wage Inequality

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## Abstract

In the existing literature, several channels have been suggested for the effects of monetary policy on income inequality. This paper explores an altogether different channel by examining the effect of an expansionary monetary policy on wage inequality between skilled and unskilled workers in a competitive general equilibrium framework of a small open economy. This issue assumes relevance since monetary policies are often pursued by the central banks to manage exchange rate fluctuations under a managed float regime, which may adversely affect the wages to low skilled workers. Under optimal allocation of wealth over a portfolio of cash, domestic assets and foreign assets, we show that an increase in the domestic money supply affects the wage inequality primarily in two ways. One is through larger investment, capital formation and consequent endowment effect; the other is through changes in the nominal exchange rate. Expansionary monetary policy aggravates wage inequality if the labour to capital share required to produce the traditional export good exceeds that needed in the skill-based export good. A contractionary monetary policy in the foreign country on the other hand, minimises wage inequality if the capital-cost share in the export good Z is highest followed by that in the composite traded good and that in the non-traded good is least.

**Keywords:** Monetary Policy, Wage inequality, Employment, Exchange rate, Portfolio choice.

**JEL Classification:** E52, F41, F11, E24

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## 1. Introduction

In recent times, income inequality in both advanced economies and the emerging markets of developing countries has been on the rise. The global economy has witnessed a harsh backlash of the pandemic that further exacerbated and raised awareness of the widening disparities. The relevance of the concern for mitigating inequality is well understood and perennial. Rising inequality trends, be it in the developed or the developing economies, is a major structural challenge that is closely related to other economic concerns that a country might be facing and so always fires the worry of policy makers and political leaders. Realising the graveness of the problem and its far reaching implications for the entire global economy, substantial research has gone behind establishing the existence, and finding cause and mitigation of income inequality over the years. Evidences of growing income inequality the world over has been sampled and studied by many; the most influential work being that of the French economist Thomas Piketty (2014). He found that the top 1 percent of U.S. households received more than a fifth of total U.S. income in 2013 as compared to one tenth in the late seventies and early eighties. What is even more concerning is that the extra income going to the top 1 percent did not trickle down to the remaining population thus, drawing a worse picture of income inequality. Similar observation was made in the World Inequality Database. For example, in some of the richest countries like Germany, just before the pandemic, more than one-third of pre-tax income went to the top 10% of earners. In the United States itself, the concentration of income is even larger – the top 10% accounted for 45% of pre-tax national income in 2019, up from 34% in 1980. In the Euro zone too, as in 2017, the bottom 40% of euro area households held only 3% of total assets, while the upper 10% owned nearly half of total assets. The situation is worse still in developing countries. For example, as per the 'World Inequality Report 2022', India is among the most unequal countries in the world, with rising poverty and an 'affluent elite.' The report highlights that the top 10% in India hold 57% of the total national income respectively while the bottom 50% share has gone down to 13%.

Many researchers have subsequently argued that there is evidence that recent inequality trends are not related to the distribution of national income between the factors of production but primarily to the rising inequality of labour income (Francese

and Mulas-Granados, 2015; Acemoglu and Robinson, 2015; Mare, 2016). And the major reason identified for unequal distribution of labour income is the rising skill premium or wage inequality between skilled and unskilled or low-skilled workers. It is this facet of inequality that we will concentrate hereupon. Evidence on the worsening of wage inequality over long and sustained periods of time in different countries dates back to the empirical studies in the late 1980s and early 1990s. These studies threw up several puzzles, namely, worsening wage inequality appearing to be almost a global phenomenon occurring in similar as well as dissimilar, and in both rich and poor (or developed and developing) countries.[1] Subsequent empirical studies have mostly found similar trends in wage inequality (Blum (2008), OECD (2008, 2011), Roy and Sinha Roy (2017)). Two alternative dogmatic positions have so far dominated the theoretical discourses trying to explain such global rise in wage inequality as a consequence of increase in the relative demand for skilled workers. One is innovation and advent of information technology that ushered in the rich nations in the 1970s and 1980s (Bound and Johnson 1992; Krugman 2000; Lawrence 1994); and the other is the significant and sustained episodes of trade liberalization across the globe during the 1980s and thereafter (Leamer (1995, 2000), Feenstra and Hanson (1996), Wood (1997), Marjit and Acharyya (2003,), Aizenman, Lee and Park (2012), Acharyya (2012), Marjit and Kar (2005), Ruffin (2009), Ganguly and Acharyya (2021)).

But, this large literature completely overlooks monetary policies contributing to wage inequality even though such policies are widely used by the central banks of developing and developed countries alike as instruments for controlling a wide range of macroeconomic variables such as employment, inflation and exchange rate volatility. Moreover, due to interdependences of countries through trade and capital flows, such policy effects originating in one country transmit or spill over to other countries. Thus, monetary policies are expected to affect wages and labour incomes and consequently wage inequality in a significant way.

[1] For an early survey of these empirical findings and theoretical discourses see Marjit and Acharyya (2003). More recent discussions can be found in Acharyya (2017).

Of late, major central banks in the world have initiated discussions on income distributional issues. Indeed, recent advances in economic theory have started questioning the interplay of monetary policy and inequality. Evidence that supports that monetary policy itself affects wage inequality have mainly focused on channels like the heterogeneity in income sources, financial market segmentation, portfolio and asset price effects, the heterogeneity in labour income responses, differential response of borrowers versus savers to rise in interest rates and so on (Coibion et. al, 2014, Bernanke 2015, Draghi 2016, Schnabel, 2021, Andersen et al. (2021), Dossche et al. 2021)). In another paper, Coibion et al (2012) showed that contractionary monetary policy shock raises inequality across households using household-level data from the Consumer Expenditures Survey (CEX) since 1980. Mumtaz and Theophilopoulou (2017) Cloyne et al. (2020) and Bartscher (2021) show that looser monetary policy decreases inequality in labour earnings, consumption, and expenditures. Albert and Gómez-Fernández (2018) come to the exact opposite conclusion, showing simulations that predict that the income and wealth of the poorest and wealthiest increase the most when monetary policy is loose. Studies on effect of exchange rate volatility on income distribution (Goldberg and Tracy, 2001; Aye and Harris, 2019; Carnevali, 2022), on the other hand, have examined effects of exchange rate changes as exogenous shocks. But, the central banks in many developing as well as developed countries use monetary policies to moderate or manage exchange rate fluctuations arising from external shocks for a variety of reasons. Thus, exchange rate changes are often the (managed) outcomes of monetary policies.

Given such a background, the interconnectedness of monetary policy and exchange rate fluctuations and implications that it may have on the skilled-unskilled wage gap through changes in the composition of aggregate output and consequent reallocation of resources across the sectors producing traded and non-traded goods, seems to have been largely overlooked. The present paper aims at bridging this gap in the existing theoretical literatures on the plausible causes of worsening wage inequality and on the impact of monetary policies on within-country distribution of labour incomes.

For the purpose, we construct a competitive general equilibrium framework of a small open economy suitably modified to incorporate effects of a monetary expansion on the real sector of the economy. Following Jones and Marjit (1992), Acharyya and

Jones (2001) and Marjit et al. (2020), we assume that the real sector of the economy under produces two traded goods – a composite traded good (T) and a skill-based export good (Z) – and a non-traded good (N). The composite traded good and non-traded goods are produced by capital and unskilled labour, while the Z good that is entirely exported, uses skilled labour and capital. Flexibility of all factor prices ensure their full employment. The endowments of skilled and unskilled workers are exogenously given. The stock of capital is endogenous and determined by the level of investment financed by borrowing loanable funds from the banks. The loanable funds that the banks receive, on the other hand, is the outcome of optimal allocation of wealth by the domestic wealth-holders over a portfolio of cash, domestic assets and foreign assets. This portfolio choice theory, or the asset approach, and preference for cash holding underlies exchange rate determination in this paper and links the money supply with the nominal exchange rate and causes monetary policies to affect real sector of the economy and consequently the wage inequality. In this set up, we show that an increase in the domestic money supply raises the wage inequality between skilled and unskilled workers if the cost share of unskilled labour in the composite traded sector exceeds that of skilled labour in the skill based export sector. A monetary contraction in the foreign country will on the other hand, mitigate the wage inequality unambiguously in the domestic country if the capital-cost shares in the skill-basd export sector is highest followed by that in the composite traded sector and least in the non-traded sector. In an alternative case of ranking of the capital cost shares, wage inequality may worsen if the elasticity of the exchange rate with respect to change in domestic interest rate is small as defined later.

The rest of the paper is organized as follows. Section 2 elaborates upon the model. Section 3 discusses the comparative static analysis of the effect of an expansionary monetary policy adopted in the domestic country and Section 4 that of a contractionary monetary policy adopted in the foreign country on wage inequality. Finally, Section 5 concludes the paper.

## 2. The Model

The small open economy under consideration produces three final goods: the composite traded good (T) formed by clubbing all the traditional low-skilled labour intensive traded goods; a non-traded good (N) and a skill intensive good Z which is not domestically consumed[2] but entirely exported. Goods T and N are produced by a primary factor of production, unskilled/low-skilled labour (L), along with capital (K), which is a produced means of production in the sense defined later. We denote this sub-sector of the economy as the (T, N) nugget[3]. The export good Z is produced using skilled labour (S) and capital. The number of unskilled/low-skilled and skilled workers are exogenously given, whereas physical capital is generated through investment and its supply is therefore endogenous. We will return to the specification and process of capital formation shortly[4]. Domestic markets for all the final commodities and markets for capital and unskilled and skilled labour are perfectly competitive. Thus, the rate of return to capital (r), the unskilled money wage (w) and the skilled money wage ($W_S$), all expressed in domestic currency, are fully flexible and adjust to clear the relevant factor markets. Production technologies for the composite traded and non-traded goods, henceforth T and N, follow CRS, and per unit input requirements are technologically fixed. The economy under consideration being small, faces given world prices of all its traded goods.

Perfect competition with free entry of firms leads to the following zero-profit conditions for T, N and Z:

$$P_T = eP_T^W = a_{LT}w + a_{KT}r \quad (1)$$

$$P_N = a_{LN}w + a_{KN}r \quad (2)$$

$$eP_Z^W = a_{SZ}w_S + a_{KZ}r \quad (3)$$

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[2] Since the economy is small, by demand irrelevance theory, even if we had assumed domestic consumption of Z, that would have no impact on domestic factor prices, and hence on export-quality.

[3]For an earlier exposition of such a production structure see Jones (1974). Subsequently, in the open economy macro-economy literature, similar structure is used to analyse both the role of RER changes on trade balance and productivity changes on RER (Helpman (1977), Jones and Corden (1979), Dornbusch (1980) and Obsfeld and Rogoff (1996)).

[4] We here abstract from skill formation, and assume that some people are borne with some specific skill or ability. Of course, this is purpose specific given our primary concerns here as mentioned earlier.

where, $P_T^W$ is the world price of good T; $e$ is the nominal exchange rate, which is the units of the domestic currency per unit of a foreign currency (say, USD) in terms of which world prices of all traded goods are quoted; $P_T$ is the domestic currency price of T; $P_N$ is the domestic-currency price of the non-traded good which is determined locally; $a_{ij}$, $i = L,K$; $j = T,N$, denotes technologically fixed per unit requirement of factor $i$ for producing good $j$.

On the demand side, we make a simplifying assumption without any loss of generality, that is, tastes are homothetic, so that the demand for N relative to that of T depends only on the relative price of the non-traded good: $\frac{D_N}{D_T} = f\left(\frac{P_N}{P_T}\right)$. Thus, we write the domestic market clearing condition for N as:

$$\frac{D_N}{D_T} = f\left(\frac{P_N}{P_T}\right) = \frac{X_N}{X_T} \qquad (4)$$

where, $p \equiv P_N / P_T$ denotes the relative price of non tradables, or reciprocal of the real exchange rate; and $X_N$ and $X_T$ are the output levels of non-traded good and composite traded good respectively.

Let us now turn to capital formation. There are small investment-firms which borrow money from banks or financial intermediaries to invest in capital formation. Abstracting from the detailed process of capital formation, and considering investment simply as the addition to capital stock as in the macroeconomic and growth literature, we assume that investment worth of one domestic-currency unit generates $\phi(1)$ units of physical capital. Thus, if these investment firms together make investment worth I units of domestic currency, then the total capital stock generated is,

$$K = \phi(I),\ \phi(0) = 0,\ \phi' > 0,\ \phi'' = 0 \qquad (5)$$

With no initial stock of capital, $K$ in (5) also means addition to capital stock. Note that in (5) we assume a proportionality rule: one percent increment in capital stock would require one percent additional investment. The investment-firms borrow money from the banks/financial intermediaries at the rate $i_b$. This lending rate of the banks is higher than the market interest rate $i$ that these banks pay on bonds and deposits held

by the domestic income earners (or, wealth-holders). Banks have no influence on this market interest rate ($i$), which is determined by the money market equilibrium condition stated later. The premium or the margin over the market interest ($i_b$ - $i$) charged by the banks for each unit of investment fund borrowed by the investor-firms covers the institutional costs, training costs and service charges. This margin is determined and varied by the banks according to the demand for and supply of loanable funds. We model this premium in the simplest possible manner as follows. Banks employ workers to facilitate the lending process, such as processing applications for investment loans and carrying out related administrative works. We assume that such tasks can be performed by the same low-skilled/unskilled workers who produce the composite traded good and the non-traded good. The unskilled workers employed by the banks from the pool of unemployed, have to undergo an on-job elementary/basic training programme to be acquainted with how to process such investment loans and other related office works. We make a simple assumption that the bank incurs a fixed training cost of $\psi$ units per worker. So these trained unskilled workers are paid the minimum wage $\overline{w}$ plus $\alpha$, which can be interpreted in various ways such as incentives or return for some additional services they provide. Suppose each worker can manage investment fund worth one unit in domestic currency.[5] Thus, for each investment-firm the cost of borrowing unit value of investment fund is $i_b = (\alpha + \overline{w} + \psi + i)$. Setting aside any other costs of capital formation whatsoever, if each investment-firm borrows funds worth $\tilde{I}$ then, by (5), the unit cost of capital formation equals $\frac{i_b \tilde{I}}{\phi(\tilde{I})} \equiv \frac{(\alpha + \overline{w} + \psi + i)\tilde{I}}{\phi(\tilde{I})}$. The capital market offers $r$ as the rate of return to capital which is determined by the competitive market forces: derived demand for capital coming from producers of the three goods, and the stock of capital generated through investment (according to rule (5)). Free entry in the investment sector then forces each investment firms to break-even:

$$r = \frac{i_b \tilde{I}}{\phi(\tilde{I})} \equiv \frac{(\alpha + \overline{w} + \psi + i)\tilde{I}}{\phi(\tilde{I})} \qquad (6)$$

[5] Alternatively, this $\alpha$ can be viewed as a variable mark-up charged by the firm per unit of investment fund it lends out over and above the wage-cost and deposit rate $i$, which is paid out to each worker as "bonus".

The total value of investment ($I$) that can be made by the investment-firms and the consequent capital stock available for production of the three goods as per (5), however, depends on the loanable funds that can be borrowed from the banks or financial intermediaries. Following Krugman (1979), suppose foreign wealth-holders do not buy bonds denominated in home-country currency. Then the supply of such loanable funds comes entirely from the domestic wealth-holders buying domestic bonds -- assumed to be issued by these banks or financial intermediaries themselves – and/or holding deposits, with the banks lending out the entire amount of such loanable funds that it receives[6].

The total loanable fund received by the banks is an outcome of optimal allocation of wealth over a portfolio. Each income earner or wealth-holder holds $l$ proportion of wealth in zero return domestic currency, or cash, and the remainder $(1 - l)$ proportion on the interest bearing assets available.[7] Regarding interest-bearing assets, domestic wealth-holders have a choice to hold domestic currency denominated bonds or foreign currency denominated bonds, or both. Suppose, $m$ proportion of $(1 - l)$ proportion of wealth is held in domestic assets (bonds and/or bank deposits, all yielding the same domestic interest rate), and $(1 - m)$ proportion on foreign-currency denominated assets/bonds. We assume that all economic agents have identical and homothetic preferences for allocating their wealth over cash and the two types of assets/bonds. Thus, all wealth-holders allocate the same $l$ and $m$ proportions, which are outcome of their utility maximizations given the wealth-budget constraint. Cash holding means foregoing interest earned on the two types of assets/bonds. While $i$ is the return earned against each unit of domestic bonds held, let the return earned against each unit of foreign bonds held be $i^*$ in foreign currency.[8] If $\tilde{e}$ is the exchange rate expected by the wealth-holders at any point of time, then the expected rate of return on a unit of foreign bonds is given as $i^* + \frac{\tilde{e} - e}{e}$. So more specifically, the opportunity cost of

[6] Of late, production of traded goods by taking loans or credit from banks has been studied by Beladi et al. (2018), Marjit and Mishra (2020) and Marjit and Ray (2021), which motivates our analysis, although we have a different point of concern altogether.

[7] The demand for cash may be for various reasons including precautionary and speculative purposes.

[8] By the small country assumption, any change in domestic demand for foreign assets will have no effect whatsoever on this $i^*$ and so it is given to the domestic wealth-holders. On the other hand, an unit of DCDB will yield a return of $i$ (in home currency).

holding cash is the weighted average of interest earnings in domestic currency forgone on the two types of assets with weights being the proportions (*m* and (*1-m*)) of wealth holding being allocated on domestic currency assets and foreign currency assets respectively:

$$m(.)i + [1 - m(.)]\left(i^* + \frac{\tilde{e} - e}{e}\right) \tag{7a}$$

While a ceteris paribus rise in the domestic interest rate *(i)* or in the foreign interest rate ($i^*$) will raise the opportunity cost of holding cash and induce a fall in cash holding, depreciation of the exchange rate i.e. a rise in value of *e* will lower the expected domestic currency return on foreign currency deposits and make it more worthwhile to raise cash holding. Accordingly the proportion of wealth held in cash would vary inversely with these interest earnings:

$$l = l\left(i, i^* + E\right), l_i' < 0, l_{i^*}' < 0, l_e' > 0 \tag{7b}$$

where, $E = \frac{\tilde{e} - e}{e}$ is the expected rate of depreciation.

The optimal allocation of fund over domestic and foreign bonds is determined solely by comparing the expected returns from these two types of assets, i.e. by the following (uncovered) interest parity condition[9]:

$$i = i^* + \frac{\tilde{e} - e}{e} \tag{8}$$

A ceteris paribus increase in the domestic interest rate (or a fall in the foreign interest rate) induces a larger proportion of wealth being put in domestic bonds i.e. *m* rises. On the other hand, for any given interest rates and expectations about the future exchange rate, a depreciation of a country's currency lowers the expected domestic currency return on foreign currency deposits. This will also induce *m* to rise. Thus,

$$m = m(i, i^*, e) \ , \quad m_i > 0, m_{i^*} < 0, m_e > 0 \tag{9}$$

Given these optimal allocations, the aggregate stock of wealth of the economy (*W*) and identical and homothetic preferences, the *aggregate* demand for cash, for domestic bonds and for foreign bonds can be written as:

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[9]We assume that the two types of assets are otherwise perfect substitutes. When assets are imperfect substitutes, they are differentiated by the element of *risk* and its degree, and this will become an additional reason for the expected returns to differ. Here we abstract from this dimension to keep our analysis simple.

$$M_d = l(i, i^* + E)W \quad (10)$$

$$B^D = m(i, i^*, e)[1 - l(i, i^* + E)]W \quad (11a)$$

$$FB^D = [1 - m(i, i^*, e)][1 - l(i, i^* + E)]W \quad (11b)$$

The aggregate stock of wealth of the economy consists of the stock of domestic money ($M$) supplied exogenously by the central bank, and the sum of bequests ($\Omega$) that some of the citizens are endowed with:[10]

$$W = M + \Omega \quad (12)$$

We are not concerned here about the distribution of wealth (and bequests) and implications of inequality in wealth distribution for consumption, aggregate employment of unskilled workers, and possibly for the export quality. As such, our assumption of homothetic preferences apply not only for the goods consumed but also for portfolio allocation over cash holding and other interest-bearing assets is purpose specific and is intended to rule out implications, whatsoever, of unequal distribution of wealth.

Two comments are warranted at this point. First, at equilibrium, domestic residents must be just willing to hold the stock of domestic money supplied by the central bank. So by the portfolio choice, the money market equilibrium can be stated as:

$$M = \frac{l(i, i^* + E)}{1 - l(i, i^* + E)}\Omega \quad (13)$$

Second, by (8) and (11b) the exchange rate for the domestic currency varies with the changes in $i$, $i^*$ and the stock of wealth for any given value of $\tilde{e}$ :

$$e = e(i, i^*, W), \frac{\partial e}{\partial i} < 0, \frac{\partial e}{\partial i^*} > 0, \frac{\partial e}{\partial W} > 0 \quad (14)$$

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[10] We assume that the bequests are received by the wealth-holders in the form of domestic financial assets which, depending on their portfolio choice, can be converted into cash and/or foreign assets. Many studies find quite large magnitudes of bequests in aggregate wealth (Kotlikoff and Summers, 1981; Lord, 1992; Modigliani, 1988; Piketty 2011). In their seminal study, Kotlikoff and Summers (1981) observed the share of bequests and other intergenerational transfers in total household wealth in the United States ranging between 46 and 81 percent depending on the calculation method used. For Denmark, Boserup et al. (2016) found that bequests account for 26 percent of average post-bequest wealth. Barthold and Ito (1992) calculated this share for both Japan and the United States in the range 25-40% in both countries. Campbell (1997) and Horioka, et al. (2002) also arrived at similar figures for Japan, viz. 23.4-28.1% and 23.9% respectively. See Davies and Shorrocks (2000) and Horioka, et al. (2002) for early surveys on such estimates.

The larger is the stock of wealth of the economy, larger is the demand for foreign-currency denominated assets or bonds, and consequently larger is the demand for foreign currency. This causes the domestic currency to depreciate. On the other hand, a higher domestic interest rate and/or lower foreign interest rate will cause the domestic currency to appreciate by lowering the demand for foreign assets through the portfolio-allocation effect. Essentially (14) reflects how the central bank can influence the nominal exchange rate by adopting expansionary or contractionary monetary policies.

We close the characterization of the real sector of the economy with the following full employment conditions for skilled labour, capital and the unskilled labour as follows:

$$\bar{S} = a_{SZ} X_Z \qquad (15)$$

$$K = a_{KT} X_T + a_{KN} X_N + a_{KZ} X_Z \qquad (16)$$

$$\bar{L} = a_{LT} X_T + a_{LN} X_N + L_b \qquad (17)$$

where, $L_b$ is the employment in the banking sector, which is equal to the total loanable funds held by this sector, or total investment *I*. Note from (15) that the output level of export good Z is fixed for any given endowment of skilled labour.

The equation system (1)-(6), (11a), (12), (13) and (15)-(17) comprising of twelve independent equations determines the twelve variables – $r, w, w_S, i, e, P_N, W, \alpha, I, K, X_T,$ and $X_N$ – given the values of the technology and policy parameters. The market clearing condition for non-traded good (4), the money market equilibrium condition (13) and the asset market (or foreign exchange market) equilibrium condition (8) are the three key conditions of the model reflecting interdependence of the three variables of interest – domestic interest rate *i,* price of the non-traded good $P_N$, and the nominal exchange rate *e.*

**3. Expansionary Monetary Policy and Wages**

In this neo-classical production framework with prices of all factors and the non-traded good fully flexible to ensure full employment of both labour and capital, any change in money supply can have an effect on wage inequality, only if the exchange

rate, along with the price of non-traded good, changes non-proportionately. Even without rigid unskilled money wage as in the Keynesian model, speculative motive of wealth-holders for holding idle cash is enough to generate these non-proportional changes so that money is not neutral in the Classical sense. This will be evident from the discussions below regarding how the exchange rate, price of the non-traded good and factor prices change. At this point, it is important to note that the domestic interest rate and the nominal value of the exchange rate are determined simultaneously from the money market equilibrium condition (given by 13) and the asset market equilibrium condition (given by 8) regardless of the value of $P_N$. To see how, first observe that a positive relationship between i and e follows directly from the money market equilibrium condition, for any given level of domestic money supply and foreign interest rate. A rise in value of e, lowers the domestic currency return on foreign assets and therefore the opportunity cost of holding cash falls. Wealth holders want to give up their foreign bond holding and convert it into cash holdings. As this raises the desired cash holdings over and above their actual cash holdings, it leads to an excess demand situation in the domestic money market for any given level of domestic money supply. This in turn raises the domestic interest rate and restores the money-market equilibrium. Algebraically, from the money market clearing condition (13), we have the following:

$$\hat{M} + \tilde{\mu}_{i^*}\hat{i}^* = -\tilde{\mu}_i\hat{i} + \tilde{\mu}_e\hat{e} \qquad (18)$$

where, "hat" over a variable denotes its proportional change; $\tilde{\mu}_j = \frac{l(i, i^* + E)\mu_j}{1 - l(i)} > 0$ and $\mu_j = -\frac{l'(.)\, j}{l(.)}$; $j = i, e, i^*$ is the absolute value of domestic interest, exchange rate and foreign interest rate elasticity of the proportion of wealth held in cash respectively.

This positive relationship between *e* and *i*, for any given level of domestic money supply and foreign interest rate is denoted by the *ii* schedule in Figure 1 which is the locus of combinations of *e* and *i* for which the domestic money market is in equilibrium. The other relationship between these two variables can be obtained from (14) using the uncovered interest parity condition. As mentioned earlier, a higher domestic interest rate will cause the domestic currency to appreciate by lowering the

demand for foreign assets through the portfolio-allocation effect. This negative relationship between *e* and *i* is denoted by the *ee* schedule in Figure 1 which is the locus of combinations of *e* and *i* for which the asset market is in equilibrium. Any change in the level of wealth or the foreign interest rate will affect the value of *e* through both the wealth effect as well as the portfolio-allocation effect. From (14) we can check this:

$$\hat{e} + e_i \hat{i} = e_{i*} \hat{i}^* + e_W W_M \hat{M} \qquad (19)$$

where, $e_i$ , $e_{i*}$ and $e_W$ are the absolute values of elasticity of nominal value of exchange rate with respect to change in the domestic rate of interest, foreign interest rate and the value of wealth respectively; and $W_M$ is the share of money stock in total wealth.

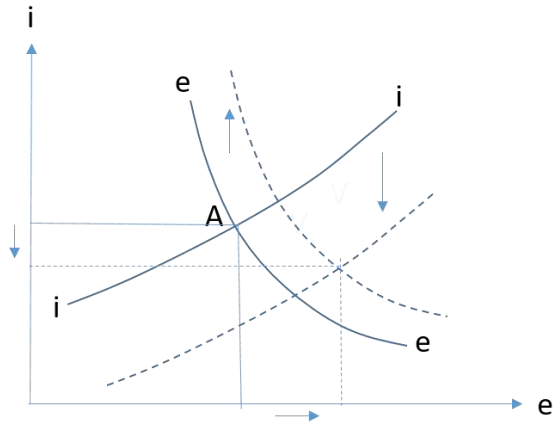


Figure 1: Simultaneous determination of e and i

Given the initial equilibrium values of domestic rate and nominal value of the exchange rate are determined at point A, now suppose the central bank prints new currency notes and puts into circulation, which increases the aggregate wealth of the economy proportionately. Accordingly, at the initial equilibrium domestic interest rate, the cash holding and demand for domestic and foreign assets all increase equi-proportionately. Thus, by the wealth-effect the supply of loanable funds in the banks increases. At the initial rate of return to capital, consequent excess supply of loanable funds forces the banks to lower the premium $\alpha$ to generate the demand from the investment-firms. The level of investment and capital formation thus increase. There are also subsequent portfolio-allocation effects triggered by these wealth-effects. First, a larger demand for foreign assets raises the demand for foreign currency and

thereby causes the domestic currency to depreciate in value. This is captured through a rightward shift of the *ee* curve as shown in Figure 1. Given the expectations about the future exchange rate, this lowers the expected domestic currency return on foreign currency deposits and induces the domestic wealth-holders to substitute foreign assets by domestic assets dampening the initial increase in the demand for foreign assets to some extent. Thus, a larger *proportion* of wealth will now be held in domestic assets, which raises the investment further. Second, increase in the demand for domestic bonds due to wealth effect raises the bond price and correspondingly lowers the domestic interest rate, as can be observed from the downward shift of the *ii* curve. Note that this fall in domestic interest rate and rise in nominal value of exchange rate are the direct effects of the initial rise in domestic money supply. These initial changes in i and e will again induce a secondary feedback effect on each other, which will be observed as movements along the *ii* and *ee* curves. The initial fall in domestic interest rate will cause the nominal exchange rate to rise along the *ee* curve and the initial rise in *e* will cause *i* to rise along the *ii* curve. So the overall change in the values of exchange rate and the domestic interest rate are given as follows:

$$\hat{e} = \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \hat{M} > 0 \qquad (20)$$

$$\hat{i} = -\frac{(1 - \tilde{\mu}_e e_W W_M)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \hat{M} < 0 \qquad (21)$$

In case of the exchange rate, it rises on both counts, initially with the rise in money supply as well as due to consequent the lowering of the domestic interest rate. So there is an unambiguous increase in the value of e. However, in case of the domestic interest rate, there are two opposing effects. Assuming the interest rate lowering initial effect of rise in money supply to be stronger in magnitude than the interest rate raising indirect effect generated through rise in the value of exchange rate, i.e. $(1 > \tilde{\mu}_e e_W W_M)$, we can expect that overall, domestic interest rate falls with rise in money supply. Hence, a smaller proportion of wealth will now be held in domestic assets or bonds. On this account the supply of loanable funds and correspondingly investment decline.

Now since these portfolio allocation effects are triggered by the wealth-effect that initially raised the demand for domestic bonds, so even if the *net* portfolio-allocation

effect is adverse[11], it is likely to be weaker so that, overall, an increase in the money supply raises the investment. Algebraically, this is given by the following *sufficient* condition (see appendix):

$$(m_i \tilde{\mu}_e e_W + \tilde{\mu}_i) > \frac{m_i + \tilde{\mu}_i}{W_M} \qquad (22)$$

where, the parameters are as defined earlier.

As the investment-firms can invest more, it raises capital formation, by (7). The consequent increase in the capital stock triggers an output magnification effect by which output of the composite traded rises and that of the non-traded good falls if the composite traded good is relatively capital intensive than the no-traded good:[12]

$$\frac{a_{KT}}{a_{KN}} > \frac{a_{LT}}{a_{LN}} \qquad (23)$$

The emerging excess demand for the non-traded good causes its price to rise. On the other hand, the rise in value of the nominal exchange rate induced by the money supply expansion will lead to reallocation of resources in the $(T, N)$ nugget for any given price of the non-traded good. We thus have contrasting effects on the rate of return to capital and the skilled wage. While the increase in $P_N$ lowers the rate of return to capital (under the factor intensity assumption in (23)) and raises the unskilled wage, the increase in $e$ changes those in the opposite directions. But, the price of the non-traded good will rise more than proportionately to the rise in the nominal exchange rate. This is because, while the rise in $e$ is a one-time direct effect of the rise in money supply, the change in $P_N$ is the outcome of an output magnification effect that follows from the rise in investment and capital formation which are driven by wealth effects and portfolio allocation effects of the rise in money supply (with the change in exchange rate is only one part of those effects). This can be verified from the following algebraic expression:

$$\hat{P}_N - \hat{e} = \frac{\beta}{\varepsilon_N \,|\, \lambda \,|} \hat{M} \qquad (24)$$

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[11] Note, a negative net portfolio-allocation effect means that the supply of loanable funds is an increasing function of the domestic interest rate.

[12] See Jones (1965) or Caves, Frankel and Jones (1997, or any other edition) for the output magnification effect.

where, $\beta = (m_e + \tilde{\mu}_e W_M)e_i + \tilde{\mu}_i W_M + (m_e + \tilde{\mu}_e)\tilde{\mu}_i e_W W_M + m_i \tilde{\mu}_e e_W W_M - m_i - \tilde{\mu}_i > 0$ , $\varepsilon_N$ is the price elasticity of demand for the non-traded good and $|\lambda|$ is the determinant of technology matrix in the (T, N) nugget which is negative under assumption in (23).

Thus, overall, the rate of return to capital would fall and the unskilled wage would rise. As the cost of production of good $Z$ falls, producers will raise output and the demand as well as wage to skilled labour will rise. All these changes imply that money in this Walrasian general equilibrium model is not neutral.

On the other hand, if the composite traded sector employs relatively less capital than unskilled labour per unit of output so that the reverse inequality in (23) holds, then an increase in the capital stock due to larger investment as a consequence of an increase in the money supply lowers $P_N$ due to the output magnification effect. This in turn lowers the rate of return to capital and raises the unskilled wage, thereby reinforcing similar effects of the exchange rate depreciation and corresponding increase in the domestic-currency price of the composite traded good. For reasons spelled out earlier, now a lower rate of return to capital raises the skilled wage. Hence,

**Lemma 1:** Under (22) and (23), $\hat{r} < 0, \hat{w} > 0$ and $\hat{w}_S > 0$ if $\hat{M} > 0$.

Proof: Follows from the above discussion.

Thus, an expansionary monetary policy changes the skilled and unskilled wages both on account of the rise in the nominal exchange rate as well as the price of the non-traded good in the same direction. The direction, however, depends on the factor intensity condition (21). Both wages increase when this condition holds, but decrease otherwise. This reflects the complementarity between skilled and unskilled wages established in Beladi and Marjit (1992) and Acharyya, Beladi and Kar (2019) in different contexts. Change in wage inequality is thus ambiguous and depends on the relative magnitudes of the two wage movements. As the following expression reveals (see appendix), the cost-shares of unskilled and skilled workers are relevant for this:

$$\hat{w}_S - \hat{w} = \frac{(\theta_{LT} - \theta_{SZ})\{\lambda_{LT} + \lambda_{LN} + \lambda_{Lb}(\lambda_{KT} + \lambda_{KN})\}\beta}{\Delta\theta_{SZ}\varepsilon_N |\theta|_{KL} |\lambda|_{KL}} \hat{M} \qquad (25)$$

So given the condition in (22), an expansionary monetary policy will widen the wage gap if:

$$\theta_{LT} > \theta_{SZ} \tag{26}$$

This result is summarized in the following Proposition:

**Proposition 1:** *Under (22), a monetary expansion worsens the wage inequality if labour-cost share in the composite traded good is larger than the labour-cost share in the export-good Z as defined in (26).*
Proof: Follows from (26).

Two observations are in order. First, this result does not depend on the factor intensity assumption in (23). Second, if the skill based export product Z is a manufacturing good like scientific instruments, which is relatively more capital intensive than skill, the condition in (26) is more likely to hold and wage inequality will be aggravated.

**4. Inflation-targeting Monetary policy in foreign country**

So far we have assumed that the interest rate abroad, or in the trading partner of our small economy under consideration, does not change. This essentially enabled us to rule out any transmission of effects of monetary policies adopted abroad. But, in the current scenario of US Federal Bank tightening its monetary policies and/or raising interest rates on dollar-denominated assets as it engages in inflation targeting, this assumption may be revisited. Thus, it is worthwhile to consider what repercussions a change in monetary policy adopted in the foreign country may have on our domestic country's level of investment, capital formation and output levels and consequently on the wage inequality.

Since in this comparative static analysis, we hold the domestic money supply fixed at its initial level, and with no change in the amount of bequest either, so an increase in the foreign interest rate i* -- due to say a contractionary monetary policy there – will generate only portfolio allocation effects. First, given everything else, it will raise the opportunity cost of holding cash and thereby lower the demand for cash holdings. An excess supply situation thus generated in the domestic money market will lead to a fall in the domestic interest rate. On the other hand, the contractionary monetary

policy adopted by the foreign country's central bank will also influence the nominal exchange rate. A higher foreign interest rate will cause the domestic currency to depreciate (see 14). By the portfolio-allocation effect, a larger demand for foreign assets raises the demand for foreign currency and thereby causes the domestic currency to depreciate in value:

$$\hat{e} = \frac{e_i \tilde{\mu}_{i^*} + \tilde{\mu}_i e_{i^*}}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \hat{i}^* \qquad (27)$$

Given the expectations about the future exchange rate, this lowers the expected domestic currency return on foreign currency deposits and induces the domestic wealth-holders to substitute foreign assets by domestic assets dampening the initial increase in the demand for foreign assets to some extent. The rise in the value of e will again cause the domestic interest rate to rise along the *ii* curve for reasons explained earlier. This will only dampen the initial fall in i but not reverse it such that overall an increase in the foreign interest rate i* lowers the domestic interest rate:

$$\hat{i} = \frac{(\tilde{\mu}_{i^*} - \tilde{\mu}_e e_{i^*})}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \hat{i}^* \qquad (28)$$

As the optimal portfolio-allocation of funds over domestic and foreign bonds is determined by the expected returns from these two types of assets, given by the (uncovered) interest parity condition (8), the increase in the foreign interest rate induces a larger proportion of wealth being put in foreign bonds i.e. *m* falls. Given these two observations, demand for domestic bonds and thereby the supply of loanable fund in the domestic country decreases by the portfolio-allocation effect. Algebraically, this is given by the following *sufficient* condition:

$$(m_{i^*} + m_e e_{i^*}) < 0 \qquad (29)$$

where, the parameters are as defined earlier.

At the initial rate of return to capital, this forces the banks to raise the premium $\alpha$ to balance the demand for the same from the investment-firms with the lower supply of loanable funds. The level of investment and capital formation thus decrease. The consequent decrease in the capital stock triggers an output magnification effect exactly opposite to that observed earlier when investment and capital formation increased under expansionary monetary policy. As the output of the composite traded falls and that of the non-traded good rises under the condition in (23), the excess

supply of the non-traded good causes its price to fall. By price magnification effect, this lowers the unskilled wage and raises the rate of return to capital. On the other hand, the rise in value of the nominal exchange rate will also lead to reallocation of resources in the $(T, N)$ nugget for any given price of the non-traded good. This further reinforces the effects on the factor prices that the fall in $P_N$ had led to, unlike the contrasting effects we had come across earlier. As the cost of production of good $Z$ rises with the rise in rate of return to capital, producers will lower output and the demand as well as wage to skilled labour will fall. Hence, Lemma 1 changes as follows:

**Lemma 2:** Under (22) and (23), $\hat{r} > 0, \hat{w} < 0$ and $\hat{w}_S < 0$ if $\hat{i}^* > 0$.

Proof: Follows from the above discussion.

Thus, a contractionary foreign monetary policy lowers both the skilled and unskilled wages under condition (23) on account of the rise in the nominal exchange rate as well as the fall in the price of the non-traded good. Based on the relative magnitudes of the two wage movements, change in wage inequality is given by the following expression:

$$\hat{w}_S - \hat{w} = -\frac{1}{|\theta|\theta_{SZ}}\{(\theta_{KZ} - \theta_{KT})\beta' + (\theta_{KN} - \theta_{KZ})e_i)\}\hat{i}^* \qquad (30)$$

where, $|\theta|$ is the determinant of cost share matrix in the (T, N) nugget and is negative under the assumption in (23). So what is evident from the above expression is that changes in wage inequality depend on the magnitudes of the capital cost shares in the three sectors. Given factor-intensity ranking as in (23), we have $\theta_{KT} > \theta_{KN}$, and it is also reasonable to assume that $\theta_{KZ} > \theta_{KN}$. Hence, the wage inequality should decline on account of exchange rate depreciation due to the increase in i* (which is captured through the second term in (30). Regarding the two traded sectors, there are two possibilities. $\theta_{KT} > \theta_{KZ}$ or $\theta_{KZ} > \theta_{KT}$. In the latter case, the first term is also negative so that the wage inequality unambiguously declines. In the former case, however, wage inequality may worsen if $e_i$ is small in value in the following sense:

$$e_i < \tilde{e}_i \equiv \frac{(\theta_{KZ} - \theta_{KT})\beta'}{-(\theta_{KN} - \theta_{KZ})} \tag{31}$$

This result is summarized in the following Proposition:

**Proposition 2:** *Under (23), a monetary contraction in the foreign country will mitigate the wage inequality unambiguously in the domestic country if the capital-cost shares in the three sectors are as* $\theta_{KZ} > \theta_{KT} > \theta_{KN}$ *. In case of* $\theta_{KT} > \theta_{KZ}$ *, wage inequality may worsen if the elasticity of the exchange rate with respect to change in domestic interest rate is small as defined in (31).*

Proof: Follows from above discussion and (31).

## 5. Conclusion

In this paper we have examined the effect of an expansionary monetary policy on the wage inequality between skilled and unskilled workers. In a competitive three sector general equilibrium framework with endogenous capital formation financed by the supply of loanable funds by the domestic wealth holders, we have shown that an increase in the domestic money supply aggravates wage inequality if the labour to capital share required to produce the traditional export good exceeds that needed in the quality differentiated export good. The paper lends itself readily for future extensions. One such extension is to consider alternative transmission mechanism of an expansionary monetary policy, such as credit expansion through commercial banks. In this context, another relevant future extension can be exploring the role of imperfect credit market with credit rationing. The level of financial development itself can be an important determinant and explanation for low-quality phenomenon in the developing country.

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## Appendix (available on request)