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The role of finance in production and international trade

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ABSTRACT

We introduce finance in a neo-classical general equilibrium model of production and international trade to integrate the core microeconomic theory with the theory of finance. The stock of credit, as past savings, finances employment and the acquisition of machines or capital goods. The availability of finance or international financial flows does not affect production or trade patterns, except for nominal factor prices, in undistorted competitive structures. However, distortions such as unemployment, imperfect credit markets, and factor mobility do affect real outcomes and trade. Our results are consistent with contemporary empirical evidence and have policy implications for financial development and institutional quality. Numerical illustrations provide further insights.

1. Introduction

Role of credit—finance capital and/or, entrepreneurial finance—in production organization of firms is crucial as we have seen in the context of financial debacles of 1998, the global financial crisis in 2007–2008, and of late, during the pandemic-induced disruptions. Typically, during these types of unprecedented crises, credit crunch, access to credit and distortions in the factors markets (capital or labor) affect severely the activities of the firms, such as, production, trade, innovation, purchasing materials, hiring labor services, so on and more crucial for the developing economies (see Sufi and Taylor 2021, Coutino and Zandi 2021, Marjit and Das 2024). In fact, World Bank (2022) highlighted the preponderant role of finance for sustained and recovery of economic activities to overcome inequality. However, traditional emphasis on financing exports-imports or logistics misses the significance of overcoming financial frictions in economies suffering from a more deep-rooted malaise of credit shortage to boost up production in the first place.

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Thus, a more general approach is necessary to emphasize the need for well-developed financial markets for financial inclusion. This is the starting point of the paper and for that, we elicit a mechanism to show how availability of finance affects production, resource allocation, factor returns, employment, output, and trade, etc. (Fig. 1).

The purpose of this paper is to integrate the theory of production and international trade with a simple theoretical framework of finance within a general equilibrium setup, enabling an analysis of how finance or credit can affect the volume and pattern of trade, factor flows, income distribution, and other economic variables. We examine in detail the results derived under an ideal no-distortion environment as well as scenarios involving unemployment and imperfect credit markets. While a distortion-free system assigns hardly any role to finance in affecting real variables, the presence of distortions makes financial factors pivotal.

The usual approach to incorporating the impact of financial problems in trade models has been to consider the role of trade finance. For example, in an empirical paper, Chor and Manova (2012) discussed the adverse impacts of tightened credit conditions, particularly access to trade credit, on export volumes. In another paper, Manova (2013) extended the analysis with similar implications within a firm-heterogeneity model featuring imperfect competition, discussing the role of financial market imperfections and frictions in shaping trade volume. Wittwer (2021) emphasized the role of connecting or integrating financial markets for achieving higher welfare and efficient transactions, while Loertscher and Riordan (2019) discussed the importance of cost reduction for vertical trade and outsourcing.

However, the importance of finance or credit for carrying out production for trade has received much less attention. This is different from the common parlance of typical 'trade-finance' literature, where the focus hinges essentially on financing of trade and commercial transactions to 'mitigate, or reduce, the risks involved in international trade transactions', involving two parties – the exporter and the importer.[3] In fact, in a recent empirical paper with a natural experiment for the closure of the EXIM bank and its impact on US industries' exports, Kabir et al. (2024) show that the effect of trade finance for boosting exports or global sales is pronounced for financially-constrained firms with finance-intensive products. This highlights the need for well-developed financial markets without resource misallocation. For example, Fuchs et al. (2022) have considered the role of credit availability and supply-side barriers for financially constrained vendors in the context of distribution in Uganda.[4]

In this paper, we examine the issue where credit finances purchase of factor input services, such as labor costs, capital goods, and other material inputs. We also consider the consequences of changes in the availability of this 'financial capital' and how it can alter production structure, trade patterns, and factor returns. The core reason for engaging in this exercise is that the existing literature on trade and finance has not yet incorporated financial capital into the analysis of issues related to production, trade, and growth. This has limited our understanding of the definitive role of finance (capital) in standard trade models.

The fundamental question we try to address in this paper is: How significant is the role of finance availability in an otherwise standard neoclassical general equilibrium trade model, when financial capital is necessary to purchase the services of labor and machines or capital goods to produce final goods?

Access to financial capital is crucial for firm performance, trade flows, economic growth, and employment. Trade volumes hinge on production capabilities. During financial crises, many firms struggle to survive due to disruptions in short-term financing. Despite the central role of credit in enabling production and trade, traditional trade models have largely overlooked the financial aspects of the problem. This paper aims to fill this gap by incorporating entrepreneurial finance and borrowing constraints into a standard general equilibrium (GE) trade framework. This methodological approach is highly pertinent, as it can provide novel and valuable insights into the role of credit constraints in financing production, shaping trade patterns, and explaining real-world phenomena such as financial crises and unemployment. While general equilibrium models have been widely used to study the effects of trade costs, technology diffusion, production clustering, global value chains, trade policy shocks, and resource allocations (Sampson 2024, Tyazhelnikov 2022, Spearot 2016, Bertoletti et al. 2018, Migrow and Severinov 2022), the explicit role of financial capital in these frameworks has been largely neglected.

This paper builds upon the work of Marjit and Das (2021), Marjit and Roy (2021), and Marjit and Nakanishi (2021) by incorporating financial frictions into a conventional general equilibrium trade framework.[5] In the model, a fixed amount of capital or credit is available to fund the costs of machinery and labor during the production process. Within this context, the paper derives two sets of interesting theoretical results in a fully specified Heckscher-Ohlin-Samuelson (HOS) general equilibrium model. First, even in the absence of distortions such as unemployment or credit market imperfections, a shortage of financing can affect nominal factor prices by impacting interest rates, thereby inducing factor movements and altering the pattern of trade. The mobility of capital and labor will, in turn, affect trade volumes and the composition of trade flows.

[3] Our focus is different. Finance only as 'Trade Credit' is a very restrictive approach as Finance has much deeper role to play via affecting production, purchase of inputs and materials, as well as volume and pattern of trade, and employment. Hence, financial capital could have neutral as well as non-neutral impacts on real interest rate, wage, and employment. These aspects are quite crucial to consider esp. after economies are hit hard due to financial crises or pandemic-led credit crunch. We take this more general approach and do not consider international trade credit issues in this paper.

[4] See for the issue of financing of trade, such as, exports and imports and overview https://www.gtreview.com/what-is-trade-finance/ at https://www.wto.org/english/news_e/news23_e/trfin_21mar23_e.htm accessed on 4th November 2023. Policymakers have emphasized the role of trade finance or credit for 'boosting trade growth' by overcoming 'shortfall in financing for small traders' and thus, overcoming the 'financial requirements for small businesses.' This is more so especially during the aftermath of crisis such as Pandemic and Financial debacle.

[5] These articles came out as Special Issue in Honor of Ronald W. Jones (https://www.sciencedirect.com/journal/journal-of-asian-economics/vol/77/suppl/C). Also see earlier works of Findlay (1984,1995).

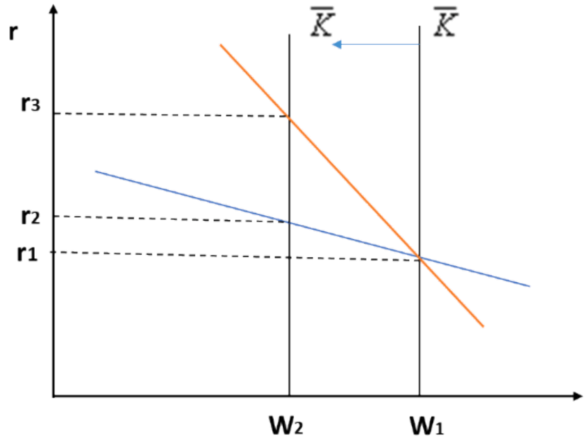

Fig. 1. Sensitivity of r-w and leftward shift of capital supply.

In this sense, finance is not neutral, unlike in neoclassical macroeconomic models, when international factor mobility is allowed. Finance becomes a non-neutral factor that can shape trade patterns in an open economy framework. However, the international movement of capital does not alter production or trade patterns, but rather shifts income distribution.

These results change dramatically in a model that incorporates unemployment and credit market imperfections. In such a setting, finance plays a much more significant role. Consequently, a shortage of finance – a hallmark of economies in the throes of a financial crisis – would affect each real economic variable, starting with employment levels. In the absence of such distortions, the framework partly echoes the classical macroeconomic paradigm, where money is neutral and do not impact real outcomes. However, with wage distortion, it has Keynesian outcome (non-neutrality).

However, in this paper, we reconstruct the seminal framework developed by Jones (1965) – which is still widely regarded as a major contribution to the trade modeling literature (see Markusen 2021, Jones 2018). This serves as the foundation for our analysis. Specifically, we extend the Jones (1965) model to incorporate 'capital (K)' as financial capital used to finance the homogeneous labor costs and the acquisition of machines (which embody the role of physical capital, working in tandem with labor (L)). Crucially, in our framework, capital is not directly employed as a factor of production within the production process itself. Thus, unlike the canonical neoclassical models, capital operates outside the production function to replicate the classic 2x2 trade model with two sectors and two inputs. There is a given supply of labor (L) and a stock of machines (M) that are required to produce two goods, X and Y. However, the wage bill and the expenses to acquire M must be financed upfront using the available stock of credit or financial capital, K. At the end of the production period, the outputs X and Y are sold, generating revenues that are used to repay the financiers (the owners of K) the principal and interest (r). Hence, the general equilibrium of this system determines the wage (w), the price of machines (p_m), the interest rate 'r', as well as the output levels of X and Y, and their relative price (P_x/P_y), given the underlying (relative) demand conditions. In this setup, the stock of M represents physical capital, while L denotes human capital – together they comprise the fixed factors of production. Conversely, finance (K) serves as the working capital required to facilitate the production process. We employ fixed-coefficient production functions to reflect the Ricardian or classical heritage of the problem. Importantly, the qualitative nature of our results would remain unchanged even if we were to use more flexible neoclassical production functions.

The key findings derived in this paper are as follows. First, in a full employment setting without any distortions, the level of available finance does not impact the pattern of trade. Instead, it only influences factor prices and the prevailing interest rate. Second, even in the absence of goods trade, factors of production and financial capital could still be traded across borders without any change in the relative returns to labor and capital, or in relative prices. Third, the direction of financial flows is the opposite of the direction of factor flows. While goods trade can lead to financial flows in either direction, the specific pattern depends on the relative financing intensity of labor versus capital in production. However, the absolute levels of factor prices are unambiguously affected by the availability of finance.

The role of imperfect credit markets within a rigorous trade-theoretic framework has been extensively studied in the literature. Prominent contributions include the works of Jones and Marjit (2001), Matsuyama (2005), Antras and Caballero (2009), Manova (2008, 2013), Manova et al. (2009), Amiti and Weinstein (2011), Egger and Keuschnigg (2015), Egger et al. (2018), and Marjit and Mishra (2020). For instance, Egger et al. (2017) have shown that credit constraints and asymmetric information can deter firms from entering and competing in the global economy. Conversely, financial market development that reduces such frictions can generate both pro-competitive and productivity-enhancing effects. Furthermore, the recent work by Antras (2023), drawing on the 'Austrian' theory of interest, provides an insightful analysis of how interest rates can play a pivotal role in driving the growth of world trade, production, and financial costs.

Our analytical framework differs substantially from the existing literature. Firstly, our goal is to explore what happens when finance is introduced into a standard competitive general equilibrium model. In this regard, our work belongs to the broader class of recent studies that have examined the usefulness of competitive trade models, including contributions by Jones and Marjit (1985, 2003, 2009), Marjit and Kar (2018), Jones (2018), Marjit, Mandal, and Nakanishi (2020), and Marjit, Das, and Mandal (2023).

Secondly, rather than using a standard neoclassical production framework, we develop a Ricardian-style model and introduce financial capital as a distinct factor outside the production process. Thirdly, through various extensions of our benchmark model, we explore how this finance-centric approach can provide new perspectives on several contemporary issues. For instance, we analyze how financial crises or unanticipated financial shocks can affect the entire economic system, how international financial flows, trade flows, and factor flows are interrelated, and how credit market imperfections impact unemployment. These analyses offer important insights on the role of financial development, institutions, governance, and financial access for economic growth. Moreover, they shed light on how financial crises can impact the international trading system in terms of output, trade patterns, and factor prices.

The core contribution of our analytical framework is its extension of the canonical production model in trade theory to explicitly incorporate the role of credit in financing production across different supplying countries. This allows us to derive numerical implications for how monetary policy or financial conditions can shape counterfactual scenarios, such as the dynamics of financial crises. Overall, the results from our model have important implications for understanding the macroeconomic effects of credit market imperfections, as well as the distributional impacts on production and trade patterns. The model is novel in that it helps elucidate the role of easy money policies, default risks, and entrepreneurial finance when reversals of economic fortune occur, as is commonly observed during financial debacles.

The paper is structured as follows. In section two we develop the model and describe the determination of equilibrium, the pattern of trade, the role of credit, and factor flows. The purpose is to compare the theoretical insights derived from this new Ricardian structure with the well-known trade theorems. The third section considers the effects of endowment changes and price variations on the model's outcomes. In the fourth section, we introduce three critical extensions to the core model: factor mobility, fixed wages and unemployment, and imperfect credit markets with credit rationing. The fifth section provides a numerical simulation with parametric changes. These have important insights for role of financial development, better institutions, governance, and financial access for economic growth. Finally, the last section concludes the paper.

2. The baseline model

The economy produces two goods X and Y with labour (L) and machines (M) with fixed coefficient production functions. We deliberately abstract from possibilities of substitution to retain the Ricardian flavour, thus, features of diminishing marginal returns (DMR) are set aside. Thus, factor-substitution is ruled out. At the beginning of the period the economy inherits K as the stock of credit of finance to be invested in production, a given supply of labour L and a stock of machines.[6] Demand for credit (K) is induced via demand for 'L' and 'M' and resultant cost. Thus, credit market equilibrium must enforce that 'K' is sufficient to finance ($WL+P_M.M$) where 'W' is the wage rate and p_m is the price of machines, to be determined via

$$K = WL + p_M.M \tag{1}$$

Production involves time. At the beginning of the period labour is hired and machines are purchased, financed by loans from the bank or financiers. After production and sale are over, the borrowed amount is returned with interest 'r'.[7] With perfectly competitive markets, price of goods will be just sufficient to cover average wage cost, machine cost and interest payments. The notations are as follows:

a_{ij}: fixed unit input requirement of 'i' per unit of j^{th} product, $i \in \{L, M\}$ and $j \in \{X, Y\}$.
a_{Lj}: fixed unit labor requirement per unit of j^{th} product, $j \in \{X, Y\}$.
a_{Mj}: fixed per unit requirement of capital equipment for the j^{th} product. $j \in \{X, Y\}$.
λ_{ij}: endowment shares of i^{th} resource in the production of X, Y
θ_{ij}: cost-shares of i^{th} resource in the production of X, Y
P_j: final good prices for $j \in \{X, Y\}$.
p_M: unit price of the machines.
P: relative price of X i.e. $P = \frac{Px}{Py}$. 'Y' is the numeraire good (i.e., $P_y = 1$).
$\widehat{V}$: proportional changes of any generic variable, V, such that $\widehat{V} = dV/V$

The following system of Competitive price equations [i.e., equation (2) and (3)], and the full-employment conditions for primary factor 'L and material inputs 'M' determine the supply side of the model as below:

$$(Wa_{Lx} + p_M a_{Mx})(1 + r) = P \tag{2}$$

$$(Wa_{Ly} + p_M a_{My})(1 + r) = 1 \tag{3}$$

[6] In a dynamic model, 'K' can change as in say, via typically perpetual inventory accumulation over time.
[7] However, we do not build intertemporal framework but as in different static equilibrium, production and sales occur at a single point of time. Without sale proceeds to pay interest rate, at a particular time 'credit-capital' can't be borrowed. Extending the model to 3-Sector with skill-unskilled split would transform eq. (1) as $K = WL + P_m.M + W_s.S$, where S is skilled and W_s is their wage. That does not change the pivotal elements.

$$a_{LX}X + a_{LY}Y = L \quad (4)$$

$$a_{MX}X + a_{MY}Y = M \quad (5)$$

where equations (2) and (3) are competitive price conditions, P=AC (average cost), and equations (4) and (5) are full employment constraints. With a given credit size 'K', specific size of the labor force, and fixed stock of machines at a point in time, with full employment of resources certain level of 'W' and 'p_M' are paid to the workers and the industrialists owning the machines of certain vintage. Given fixed coefficients a_{ij}, $\overline{L}$, and $\overline{M}$, X and Y are determined by (4) and (5) and depend only on (L, M) and technology, independent of P and K. From (2) and (3), W and p_M are determined as functions of P and (1 + r). Given (exogenous) P, we plug that into (1) to solve for (1 + r). Given P, L, M, r and a_{ij}'s where i∈{L, M}, we determine W, p_m, X, and Y from Equations (2)-(5). L and M are given as stocks of labor and machine from the last period. Hence,

$$K^d = W(r).L + p_M(r).M \quad (6)$$

As $W' < 0$ and $p'_M < 0$,

$$K'_d(r) = W'(r).L + p'_M(r).M < 0 \quad (7)$$

Financial market equilibrium condition is given by:

$$K^d(r) = \overline{K} \quad (8)$$

Left hand side (LHS) of equation (8) is demand for credit (K_d) to equilibrate with supply ($\overline{K}$), to determine 'r' (endogenous) in equilibrium where if $K^d(r) > \overline{K}$, 'r' will rise (monotonic). Since (P, L, M, K) are parameters,

$$r = r(P, \overline{L}, \overline{M}, \overline{K}) \quad (9)$$

Using Caves, Frankel and Jones (2011) and Feenstra (2003):

$$\widehat{X} - \widehat{Y} = \propto(\widehat{M} - \widehat{L}) \quad (10)$$

where $\alpha = \frac{1}{\lambda_{MX} - \lambda_{MY}} > 0$, and due to intensity assumption $\lambda_{MY} < \lambda_{MX}$. Or, via integration

$$\left[\frac{X}{Y}\right]^s = f\left[\frac{M}{L}\right], f' > 0 \quad (10a)$$

This is relative supply (RS) of X vis-à-vis Y with $f' > 0$.

We assume negatively sloped homothetic demand to express Relative Demand (RD) as below:

$$\left[\frac{X}{Y}\right]^d = D(P), D' < 0 \quad (10b)$$

Using (10a) and (10b) RS-RD conjointly determine market-clearing for X and Y so that equilibrium P=P_e can be expressed as:

$$P_e = F\left(\frac{M}{L}\right), F' < 0 \quad (10c)$$

This completes the determination of the general equilibrium. Thus, we determine X, Y; W, (1 + r), p_M, P and RD. Equation (1) representing credit-constraint plays crucial role to internalize the demand and supply of 'L' and 'M' as it represents matching demand and supply via two full-employment conditions.[8]

Note that from given "L" and "M" we can solve for relative output of X and Y [Equation 10a], and from homothetic demand we can determine "P" [Equation 10b]. So "P" is frozen by given "L" and "M" [Equation 10c]. However, as P rises, (1 + r) rises, W and p_m falls, K_d falls (endogenous). As everything is measured in terms of numeraire (Y), value of production at the end of a single period should be equal to nominal GDP and present value of investment or 'K'. So, the GDP equation is: $PX + Y = K(1 + r)$

Also, we can rewrite the credit demand and supply Equation (8), since Income = Expenditure, as

$$\frac{PX + Y}{(1 + r)} = K^d = WL + p_M M = \overline{K} \quad (8a)$$

[8] 'M' and 'L' represent the idea of 'fixed capital' and 'K' provides working capital to finance their services. 'M' is stock of machinery and equipment while 'L is stock of human capital so that together they comprise fixed composite capital (physical and human). 'K' finances them. These stocks are given from outside the system in the current running period with a specific productivity distribution in the period when production is carried out.

The LHS is the discounted value (PDV) of current period output. In our model X, Y, P all are effectively given by M and L, so (8a) determines "r" in equilibrium.

When international trade opens with a different P* in the *rest of the world*, production of 'X' and 'Y' do not change in the domestic economy (RS remains unaltered) as "M" and "L" do not change, and hence, demand adjusts to new relative price in the home. P is no longer determined by $\overline{X}, \overline{Y}$. If P*>P, then the country imports X (as domestic production does not change but ROW has more 'X' production) and exports 'Y' (conversely), lowering demand for "Y" and increasing demand for "X". With higher P, from (8a), given $\overline{K}$, 'r' must go up.[9]

Another way of looking at it is that if P rises the credit demand ($WL + p_M M = P.\overline{X} + \overline{Y}$) must go up independent of allocation of "K" into "X" or "Y" sector as real value of output must increase. So "r" will go up. Now we go to main propositions by doing some comparative-static exercises, viz., how credit expansion affects the real wage, relative prices, output and trade.

3. Changes in credit availability (K).[10]

To understand the role of availability of finance on production and employment, we need to consider the change in availability of "K". As "P" is given, following Caves, Frankel and Jones (CFJ 2011)—using (2) and (3), and assuming $\widehat{P} = 0$—-we derive that:

$$\widehat{W}\theta_{LX} + \widehat{p_M}\theta_{MX} = -(\widehat{1+r}) \tag{11a}$$

$$\widehat{W}\theta_{LY} + \widehat{p_M}\theta_{MY} = -(\widehat{1+r}) \tag{11b}$$

where $\theta_{LX} + \theta_{MX} = \theta_{LY} + \theta_{MY} = 1$

Assume X is relatively M−intensive, and Y is relatively L-intensive, $\theta_{MX} > \theta_{MY}$ and equivalently, $\theta_{LY} > \theta_{LX}$ Hence, $|\theta| = \theta_{LX}\theta_{MY} - \theta_{MX}\theta_{LY} = \theta_{MY} - \theta_{MX} = \theta_{LX} - \theta_{LY} \Rightarrow |\theta| < 0$.

Using (11a) and (11b), by Cramer's rule, $(\widehat{1+r}) = \widehat{-p_M} = |\theta|$. It is obvious that given P, from (2) and (3), $(\widehat{W}, \widehat{p_M}) < 0$ if $(\widehat{1+r}) > 0$. It is straightforward to show that (see CFJ 2011)

$$\widehat{W} = \widehat{P}\frac{\theta_{MY}}{|\theta|} \tag{12a}$$

$$\widehat{p_M} = -\widehat{P}\frac{\theta_{LY}}{|\theta|} \tag{12b}$$

Proposition 1. Availability of finance does not affect $\frac{W}{p_M}$, but it affects absolute values of 'W' and 'p_M' via changes in 'r'.

Proof. *Higher $\overline{K}$ will reduce 'r' to equilibrate financial market, increasing (W, p_M) in the same proportion. But at a given P, given $(1 + r)$, $\frac{W}{p_M}$ remains the same (as discussed above). Finance is neutral like money (QED).*

This is neutrality or classical dichotomy as in Neo-Classical Macro models. This result is analogous to the canonical macroeconomic systems where credit is similar to money supply and it has *neutrality* (i.e., classical dichotomy is valid) in the sense that it affects absolute factor prices p_M and W, but not the relative ones and the output itself as X and Y do not change.[11] Thus, the result shows that nominal variables (here, finance 'K') do not affect (i.e., neutral in effect) real variables, viz., output, employment, trade and relative prices of machines vis-à-vis workers (i.e., dichotomous)-see Patinkin (1965, 1987). Thus, abundance or scarcity of "K" inly affects wage and machinery price but not output and hence, doesn't affect pattern of trade as the relative prices remain unaltered, alike Quantity theory of money without any changes in relative prices of wage vis-à-vis machine.[12]

Proposition 2. ***Given*** $P = \overline{P}$***,*** $\widehat{L} = 0, \widehat{M} = 0$***,*** $\widehat{K_S} > 0$ does not affect trade patterns.

Proof. $\widehat{K_d} = 0$, $\widehat{K_S} > 0$ *means supply of credit increases resulting in lower* $(1 + r)$ $(\widehat{r} < 0)$.

As $\widehat{P} = 0$, from Eq. (11a&b), $(\widehat{1+r}) < 0$. 'p_M' rises along with '*W*'. Given $\widehat{L} = 0, \widehat{M} = 0$, via Eq (10c), ***M/L*** is unaltered meaning *RD-RS remains the same*, with no change in relative prices P_e. Thus, $\widehat{X} = 0, \widehat{Y} = 0$. Demand for L and M rises due to credit availability with fixed supply of resources causing p_M and W to rise (see Proposition 1 above). Real wage is unaffected and the output itself does not change as 'X' and 'Y' remain the same with no effects on trade pattern. (QED).

As before, this result is analogous to Marjit and Das (2021) in a Ricardian Specific Factor framework and reflects the neutrality

[9] For a small economy, 'P' is given and for large country case, 'P' is determined by supply and demand of X, Y.
[10] The detailed derivations are relegated to the Appendices 1.
[11] Separation of real and nominal variables are discussed in traditional text where nominal variables like money supply affects prices, nominal interests via monetary transmission mechanism and, hence, is neutral on production, employment, and real wages. Non-neutrality breaks down this dichotomy. See Patinkin (1987) for the exposition that real variables are independent of nominal variables in the Classical system.
[12] With changes in 'M' and 'L', relative supplies of X-Y will be affected and relative prices under autarky will change.

result. With perfect financial market, competitive firms can get as much ‘K’ as they want at given ‘r’ and hence, it does not play an important role *unless imperfection is built in*. In the full-employment distortion-free macro model, we saw that increase in credit supply (like cash-in-advance) does not alter relative prices a la quantity theory postulates confirming long-run neutrality and hence, increased supply of credit or money only inflates nominal cost without any changes in real side, such as, trade pattern or, relative factor prices.

Differences in credit availability (i.e., finance) and its allocation across home and the foreign (or, the rest-of-the-world-ROW) will cause changes in factor prices (viz., W and p_M) via factor movements discussed in entirely different model in the literature (Mussa, 1991, Lucas 1990, etc.). Also, Miranda-Agrippino and Ricco (2021) has shown that true monetary policy shock, tightening credit markets and informational rigidities matter for macroeconomy; in particular, contractionary effects –via fall in demand, deterioration in labor and credit market conditions are observed. In Marjit (2012), it has also been shown that if countries suffer from credit market imperfections and financial constraints, with differences in interest rates, fragmented production might lead to trade. In fact, scarcity of credit-financial or entrepreneurial finance-is one of the root causes for underdevelopment in the developing economies where low domestic capital formation translates into low growth and capital flow is still restricted. Not only that, distortions and imperfections in the labor or credit market along with credit constraints create frictions and hence, hinder production, trade and creates export barriers-see Bergin, Feng and Lin (2021), Kuamarasamy and Singh (2016). In this connection, it is also important to see how financial frictions and different types of capital flows could affect returns to factors, and income inequality −see Kumar and Dash (2024). In what follows, we discuss these aspects by extending the benchmark model.

4. Further extensions

4.1. Capital flows without distortions in the benchmark model

Consider two economies– home and foreign– with endowments being M, M*; L, L*, and K, K*. Suppose L=L*, and M=M*. As ‘K_d’ is endogenous (see the discussion in Section 2), richer countries with higher GDP and higher savings (S*), will have higher K* translating into exogenous boost to potential K in the home, lowering ‘r’ there in home. As now K>K*, $\widehat{K} = 0 \Rightarrow \widehat{W} = \widehat{p_M} = -\widehat{(1+r)}$ and $\widehat{K^*} = 0 \Rightarrow \widehat{W^*} = \widehat{p_M^*} = 0$. As explained earlier, this will mean at a *given P*, (1 + r) < (1 + r*), W>W* and p_M>p_M*. Higher ‘K’ finances intermediate goods and immigrations. *Without restrictions* on outflows of financial capital (K) and immigration, capital flight will occur from Home, as it is dearer abroad.[13] Gradually, outflow might make ‘K’ (relatively) scarcer at Home with upward pressure on ‘r’ to raise ‘r’ at home in the long-run (HOS is a long run model), ‘W’ and ‘p_M’ will start falling to arrest imports of machines and workers from abroad. Hence, the following proposition is in place:

Proposition 3. *Given M=M*, L=L*, and $\widehat{K} > 0$, without capital control, FPE will hold.*

Proof. *With identical endowments, since P remains the same and so are $RS(X/Y) = RS^*(X^*/Y^*)$, from Proposition 2, no goods trade occurs. As $\widehat{W} = \widehat{P}_m = -\widehat{(1+r)}$, $\widehat{W/p_M} = 0$ i.e., such trade does not disturb $\frac{W}{Pm}$. Thus, if only cross-country financial flows are allowed absolute factor prices will be equalized.*

Even if with K>K*, (1 + r) < (1 + r*), absolute factor prices will be different. i.e. W>W* and Pm > Pm* (a la Proposition 3) and with free financial flows across borders (i.e., *without Capital control*), perfect arbitrage ensures, (1 + r)=(1 + r*) and hence, r = r*, W=W*, p_M=p_M*. However, relative factor prices will always be the same, since it does not depend on (1 + r). Therefore, *without trade in goods*, factor flows or movement in credit across borders does not generate overall gains from trade. Even if with K>K*, (1 + r) < (1 + r*), absolute factor prices will be different. i.e. W>W* and $p_m > p_{m^*}$ (a la Proposition 3) and with free financial flows across borders (i.e., without Capital control), arbitrage ensures, i.e. (1 + r)=(1 + r*) and hence, r = r*, W=W*, p_M=p_{M^*}. Given P=P* in home and foreign country, with free *trans*-border capital flows, $\frac{W}{Pm} = \frac{W^*}{Pm^*}$ (QED).

With restrictions on financial flows, however, although ‘r’ will be low initially, but *no restriction* on labor movements or machine imports will cause (due to arbitrage) ‘W’ and p_M to fall at home, and ‘(1 + r)’ to rise as more L+L* and M+M* raises demand for K. Here factor trade is complementing commodity trade unlike HOS model. Unlike conventional theory–under some restrictive assumptions like same prices free trade, and identical technology—suggesting international trade in goods causes equalization of factor returns without factor mobility, here, on the contrary, FPE is occurring here due to movements of factors, and everything is equalized and without changes in factor endowments aggregate real outputs do not change with no effect on trade patterns.

4.2. Trade, unemployment in the benchmark model with perfect credit market

In the context of our benchmark model, we considered full employment without any minimum wage. Unemployment problem is quite common when labor supply exceeds demand. However, in the presence of wage fund or working capital imperfection in the credit market or borrowing constraints could have severe jolt in the labor market and hence, could affect production and trade pattern. Excess demand for funds to be borrowed creates this situation. Thus, depending upon the credit crunch and default risk unemployment

[13] Lucas (1990) and others on hindrances of capital flow from rich to poor countries despite higher rate of return. In the economic growth literature, several barriers to capital flows including institutional have been mentioned. For a small open economy as price taker, K moves to ROW or foreign and with less than perfect capital mobility FPE does not occur while with free financial flows with perfect mobility, FPE occurs.

problem could be severe (Calvo et al, 2012, Popov et al. 2018). In fact, that issue is quite pertinent for the consideration of financial development and interesting perspectives on the role of financial institutions for inclusive development (Rajan and Zingales 1998, Noack and Costello 2022). For example, Alexandre et al. (2021) has considered the case of financially distressed firms in case of minimum wage increases as it reduces employment growth and profitability, especially after the pandemic eroding the financial condition of firms. Aizenman et al. (2022) explored the role of bank lending in times of pandemic-led shock when government also comes forward with fiscal stimulus for expansionary effects. Egger et al. (2018) is also an important contribution to show empirically that removal of credit constraints via external funding to borrowers and abolishing frictions or information gap could have a joint productivity and competition effects translating into entry of otherwise less productive firms.

First, we consider the case Unemployment in this 2x2-model with no credit constraints. Just to reiterate, we start from a stock of finance or working capital or bank credit generated out of savings in the last period. For this section, we coin the financiers as bankers. There is a fixed minimum wage $\overline{W}$ for hiring workers. Let $W = \overline{W}$ and L_e be the level of employment of labor (L) such that $(\overline{L} - L_e)$ is unemployment at Home. Following three equations determine p_M, r and Le.

$$\frac{P}{(1+r)} = \overline{W}a_{LX} + p_M a_{MX} \tag{13}$$

$$\frac{1}{(1+r)} = \overline{W}a_{LY} + p_M a_{MY} \tag{14}$$

$$K = \overline{W}L_e + p_M.M \tag{15}$$

'M' is still given from last-period production of machines. Once 'L_e' is known, (L_e, M) determine X and Y. The interesting question is how the system responds to a hike in wage from W to $\overline{W} > W$, given (P, M). From (1) and (2) at a given $P = \overline{P}$, assuming a small economy facing P of the rest of the world (i.e., price-taker), average cost of production of X (C_x) and Y (C_y), we can write:

$$\frac{C_X}{C_Y} = \frac{p_M a_{Mx} + \overline{W}a_{Lx}}{p_M a_{My} + \overline{W}a_{Ly}} = P \tag{16}$$

Therefore, we have

$$\begin{array}{c} \widehat{C_X} - \widehat{C_Y} = 0 \\ \Rightarrow (\theta_{MX} - \theta_{MY})\widehat{p_M} + (1 - \theta_{MX} - 1 + \theta_{MY}).\overline{W} \end{array} = 0$$

Or,

$$\widehat{p_M} = \widehat{\overline{W}} > 0 \tag{17}$$

$$\widehat{r} < 0 \tag{18}$$

From (15), following Caves, Frankel and Jones (2011) we can write:

$$\lambda_{LK}(\widehat{\overline{W}} + \widehat{L_e}) + \lambda_{MK}\widehat{p_M} = 0 \tag{15a}$$

Therefore,

$$\widehat{L_e} < 0 \tag{19}$$

As $\overline{W}$ and P_M both rise, given $\overline{K}$, L_e must fall.

Since P and $\overline{W}$ are given, Cx and Cy both should change in the same proportion. A rise in $\overline{W}$, at a given 'r' increased Cx and Cy. But Cx rises less than Cy as X is assumed to be M−intensive. So the ratio will fall and to prevent this P_M will rise equiproportionately with $\overline{W}$. As both (P_M, $\overline{W}$) rise, 'r' must fall to satisfy (13) and (14). Given $\overline{K}$, L_e must fall. Thus, higher wage or a minimum wage leads to unemployment. The mechanism is completely different from the diminishing marginal productivity argument (*here a_{ij},s are fixed coefficients*).

As L_e drops, $\frac{L_e}{M}$ will fall and $\frac{X}{Y}$ will rise. So, a labour abundant economy will produce less of labor-intensive good. This will lower P in the large country case, reduce P_M and raise 'r'. Given $\overline{K}$ initial fall in L_e would recover to some extent. *The major result with unemployment is that now higher $\overline{K}$ will affect the pattern of trade, relative prices, etc.* Given $\overline{W}$, hence (P_M, r) at a given P, a higher stock of K must increase L_e and $\frac{L_e}{M}$ leading to greater export by the labor-abundant country increasing global production of Y and Y/X. Consequent rise in P (P_x) and P_M will increase demand for 'K' and reduce L_e. But initial excess supply of 'K' will prevail, and 'r' will drop in ultimate equilibrium.

The main takeaway from this section is that in a world ridden with unemployment, finance plays a pivotal role. Greater credit-finance (K) will increase global income and employment. But it will also adversely affect the terms of trade of the labor-abundant economy. Machine producers will be better off. This leads to the following proposition.

Proposition 4. *Financial boom ($\widehat{K} > 0$) or crisis ($\widehat{K} < 0$) affects patterns of trade, relative price 'P', $\frac{\overline{W}}{p_M}$, in a minimum wage driven unemployment equilibrium.*

Proof. *See the discussion above.* (*QED*).

If $\widehat{K} > 0$ and given P, in this unemployment model, extra cash-in-advance will increase employment and will determine L_e, X and Y (i.e., real changes or non-neutrality unlike the full employment scenarios in the previous section). This will increase Y from the full employment conditions. This country will export Y and import X. After trade, P will be lower. P_M will be lower and Le will rise furthest. So higher unemployment economy will export the labour-intensive good. But price changes or changes in levels of K will not affect wages (alike Keynesian case). This is an added theoretical feature.

4.3. Trade and unemployment in the presence of imperfect credit market

In this scenario all producers are assumed to have same internal finance based on their own capital (savings) and can borrow externally from banks or financiers with the cost of borrowing depending on 'r' and risk of default. If 'K' is less in supply, and 'r' is higher 'W' and 'Pm' will be lower. Recently, Antras (2023) has discussed this via extending Austrian theory of interest in trade context. Ours is completely different where imperfection in entrepreneurial finance is *modelled with borrowing constraints and credit rationing with some default risk where financiers collateralize defaulters' assets*. Production will suffer for both, affecting volume of trade without altering the trade pattern.

Stiglitz and Weiss (1981) as well as Williamson (1987) has discussed Credit rationing with imperfect information when borrower's riskiness of default and lenders loan interest as well as the monitoring cost matters. Let us assume that $K = \overline{K}$ is the total supply of fund in a country, where there are two sources of finance, viz., own entrepreneurial finance as source of internal fund (K_e) as well as external funds from banks or other financial sources (K_b) so that we write collaterals as:

$$\overline{K} = K_b + K_e \tag{20}$$

This is important for trade-finance and expansion of credit. We also have

$$K_b = (K_b - B) + B \tag{21}$$

Apparently, this identity tells us that 'B' is the fixed amount such that with credit rationing (K_b—B) is not lent out (leakage) due to imperfect credit market, and K_b is constrained by B^{max}.

Suppose there are 'n' entrepreneurs each with identical endowment of internal finance (k_e) such that

$$K_e = k_e \times n \tag{20a}$$

Let the lending by the banks be denoted by 'B' with 'R' being the *borrowing rate* (cost of borrowing). For internal finance, *opportunity cost is exogenous 'r'* ('r' $= 0$ with no other opportunities for investment). This is the deposit rate and $R>r$, implying that the entrepreneurs can borrow to augment their financial capital stock by paying R>r (the deposit or lending rate). For 'n' identical entrepreneurs each with *"b"* amount of disbursed credit, with total disbursement of 'B' fixed by Credit-rationing, we write:$B = K_b = b \times n$ (20b)

'B' is allocated endogenously to X-Y sectors via credit rationing depending on risk of default and corresponding appropriation of funds. Let '$0 < q < 1$' be probability of default and '$0 < S < 1$' be the proportion collateralized from the defaulters by the financiers. *'B'* will be more as 'K_e' rises because the later could be used as collateral in case of default. Bankers—when *'q'* is high (risky) –will hedge against risk by charging higher *'R'* and hence will have higher *'S'*. *'qS'* determines the degree of defaulter punishment. It is a parameter (exogenous) in this model. A relation between maximum loanable B^{max} and "R" will endogenise 'B'. As 'qS' becomes higher, 'R' is charged low, and 'B' rises. Using no-default constraint, it can be derived that (see Marjit and Das 2021):

$$B = \frac{qS}{(1+R) - qS} K_e \tag{22}$$

with $\lambda_e = \frac{K_e}{K_e + K_b}$ same across X-Y assuming same economy-wide 'qS'.

Now credit market equilibrium ensures that supply matches the funds required to purchase factor inputs, rewriting (15) as:

$$B + K_e = \overline{W} L_e + p_M M \tag{23}$$

As mentioned before, instead of 'r' now we have two rates –borrowing (R) and deposit (r) –with weighted average of both. Using (23), with dual sources of finance, we now rewrite (13) and (14) as:

$$(\overline{W} a_{LX} + p_M . a_{MX}) \left[\frac{k_b}{k_b + k_e} (1+R) + \frac{k_e}{k_b + k_e} (1+r) \right] = P_X \tag{24}$$

$$(\overline{W} a_{LY} + p_M a_{MY}) \left[\frac{k_b}{k_b + k_e} (1+R) + \frac{k_e}{k_b + k_e} (1+r) \right] = P_Y \tag{25}$$

$$\lambda_e = \frac{k_e}{k_e + k_b}, \lambda_b = 1 - \lambda_e = \frac{k_b}{k_e + k_b}$$

From the benchmark model, full-employment condition (4) is rewritten as:

$$a_{LX}X + a_{LY}Y = L_e \tag{4a}$$

$$a_{MX}X + a_{MY}Y = M \tag{5}$$

From (23), using (22) derive:

$$K_e\left[\frac{(1+R)}{(1+R) - qS}\right] = \overline{W}L_e + p_M M \tag{26}$$

With these specifications, we have 5 variables: P_M, R, L_e, X and Y. Given P_X and P_Y, Eqs. (24) and (25) determine P_M and R; then, (26) determines L_e, and (4a), (5) determine X, Y. Note that with credit-rationing (fixed "B"), increasing K_b has no role as "B" remains unaltered.

Let us consider two nations with identical endowments of collaterals where in autarkic equilibrium, $K_b = K_b{}^*$, $K_e = K_e{}^*$, and $\overline{W} = \overline{W}^*$. Suppose ceteris paribus, $(qS) > (qS^*)$ (same 'q' but degree of appropriation due to default differs contingent on rule of law or governance) which implies that probability of penalty of defaulter is higher in the home than in the foreign country thanks to better quality institutions, judiciary, or financial development.

Now from Eqs. (24) and (25), a la Jones (1965), we get:

$$\widehat{p_M}\theta_{MX} + \lambda_b\widehat{(1+R)} = \widehat{P_X} \tag{27}$$

$$\widehat{p_M}\theta_{MY} + \lambda_b\widehat{(1+R)} = \widehat{P_Y} \tag{28}$$

Solving, we get:

$$(\theta_{MX} - \theta_{MY})\widehat{p}_M = \widehat{P_X} - \widehat{P_Y} = \widehat{\left[\frac{P_x}{P_Y}\right]} \tag{29}$$

Now, rise in L_e would affect (X, Y) production and pattern of trade thanks to financial institution development couched in terms of rise in 'qS'. However, given (P_x, P_y) and r, (R, p_M) are not different.

But if Y is L_e intensive, rise in credit would cause Y, and hence, $\frac{Y}{X}$ to increase in autarky, resulting in $\widehat{\left[\frac{P_x}{P_Y}\right]} > 0$, and hence (R, p_M) would *now* be different. If $\widehat{\left[\frac{P_x}{P_Y}\right]} > 0, \widehat{p}_M > 0$ for $\theta_{MX} > \theta_{MY}$.

From (27) and (28), we can derive:

$$\widehat{(1+R)} = -\frac{\theta_{MX}\widehat{p_M} + \widehat{P_X}}{\lambda_b} = -\frac{\theta_{MY}\widehat{p_M} + \widehat{P_Y}}{\lambda_b} \tag{30}$$

For relative supply changes, following Jones (1965):

$$\widehat{X} - \widehat{Y} = -\frac{\widehat{L_e}}{|\lambda|} \text{ where } |\lambda| = \lambda_{MX} - \lambda_{LX} \tag{31}$$

Similarly, closing the model from demand relationship, changes in the ratio of X/Y consumption is:

$$\widehat{X_D} - \widehat{Y_D} = -\sigma_D(\widehat{P_X} - \widehat{P_Y}) \tag{32}$$

where σ_D is the elasticity of substitution between X and Y on the demand side. As prices adjust to clear the markets for X and Y in general equilibrium adjustments, we can write: $-\sigma_D(\widehat{P_X} - \widehat{P_Y}) = -\frac{\widehat{L_e}}{|\lambda|}$so that:

$$(\widehat{P_X} - \widehat{P_Y}) = \frac{\widehat{L_e}}{|\lambda|\sigma_D} \tag{33}$$

Choosing 'Y' as numeraire good so that $P_y = 1$ and relative price $P = P_x$, we further rewrite (33) as:

$$\widehat{P} = \frac{\widehat{L_e}}{|\lambda|\sigma_D} \tag{33a}$$

From (29), we can then find where $(\theta_{MX} - \theta_{MY}) = |\varphi|$,

$$\widehat{p}_M = \frac{\widehat{P}}{(\theta_{MX} - \theta_{MY})} = \frac{\widehat{L_e}}{|\varphi||\lambda|\sigma_D} \tag{34}$$

Hence, using (30),

$$\widehat{(1+R)} = -\frac{\theta_{MY}\widehat{p_M}}{\lambda_b} = -\frac{\theta_{MY}}{\lambda_b}\frac{\widehat{L_e}}{|\varphi||\lambda|\sigma_D} \Rightarrow \widehat{(1+R)} < 0 \tag{35}$$

As we have seen before, competitive price equation determines 'R' and given 'qS', B^{max} is determined. p_M is already determined. Intuitively speaking, for a given $\overline{P}$ in an economy with higher "qS" (due to better financial development and good quality institutions), credit-rationed is relaxed to supply more credit in keeping with "K_b", causing "L_e" to rise. Thus, demand for credit adjusts with rise in employment as supply of credit expands. As "X/Y" falls (Y is L-intensive relatively), with trade the general equilibrium adjustments trigger rise in "P", translating concomitant rise in p_M. Consequently, as more financing will be necessary for $p_M M$ further rise in credit demand is envisaged. But fall in (1 + R) –as explained before—will reduce default possibility or incentive. "B^{max}" will increase further. If γ_M is very high, $K_b > B^{max}$ (i.e., demand exceeds supply of credit), causing shrinkage of employment to some extent (i.e., $\widehat{L_e}<0$). However, general equilibrium adjustments where$\widehat{L_e} > 0$ and the trigger of chain of events described so far will stabilize the economy's adjustment to new equilibrium, and secondary effect can't outweigh the primary effect. This leads to:

Proposition 5. *Given $\overline{P}$, as $(qS) > (qS^*)$, we have $L_e > L_e^*$.*

Proof. *See above discussion.$L_e > L_e^*$ and right hand side of (26) must rise as increase in L_e at given Px, Py causes changes via (34) in p_M. If trade opens up (due to changes in relative price—P), Y will be exported. Even when P is changing, if $(qS) > (qS^*)$, $L_e > L_e^*$ (QED).*

Now, from Eq. (26), rewriting as:

$$K_e\left[\frac{1}{1 - qS/(1+R)}\right] = \overline{W}L_e + P_M M \tag{26a}$$

Taking total differentials on both sides, we get:

$$-\frac{d[1 - qS/(1+R)]}{1 - qS/(1+R)} = \gamma_L\widehat{L}_e + \gamma_M\widehat{p}_M \tag{36}$$

where γ_L, γ_M are cost-shares of L_e and p_M in finance respectively. On simplification, we get

$$[\widehat{qS} - \widehat{(1+R)}].\left[\frac{qS}{(1+R) - qS}\right] = \gamma_L\widehat{L}_e + \gamma_M\left[\frac{\widehat{L_e}}{|\varphi||\lambda|\sigma_D}\right] = \widehat{L}_e\left[\gamma_L + \gamma_M\frac{1}{|\varphi||\lambda|\sigma_D}\right] \tag{37}$$

Plugging in (35) into (37) and using (22), it simplifies to:

$$\left[\widehat{qS} + \frac{\theta_{MY}}{\lambda_b}\frac{\widehat{L_e}}{|\varphi||\lambda|\sigma_D}\right].\left[\frac{B}{K_e}\right] = \widehat{L}_e\left[\gamma_L + \gamma_M\frac{1}{|\varphi||\lambda|\sigma_D}\right] \tag{38}$$

We can write (38) succinctly as:

$$[\widehat{qS} + \widehat{L}_e.A2].\left[\frac{B}{K_e}\right] = \widehat{L}_e.A1 \tag{39}$$

where $A1 = \left[\gamma_L + \gamma_M\frac{1}{|\varphi||\lambda|\sigma_D}\right]$ and $A2 = \frac{\theta_{MY}}{\lambda_b|\varphi||\lambda|\sigma_D}$

Further with algebraic manipulation (39) simplifies to:

$$\widehat{L_e} = \frac{\widehat{qS}(B/K_e)}{A1 - A2.\frac{B}{K_e}} \tag{40}$$

As $(qS) > (qS^*)$, $L_e > L_e^*$ and,$\widehat{p}_M > 0$,$(1+R) < (1+R^*)$,$P > P^*$, affecting production and trade. With $(qS) > (qS^*)$,$(B/K_e) > 0$, $\widehat{L_e}>0$ iff $A1 > A2.\frac{B}{K_e}$ or $\frac{A1}{A2} > \frac{B}{K_e}$. This is the Stability Condition. This boils down to $\frac{\gamma_L[|\varphi||\lambda|\sigma_D] + \gamma_M}{\theta_{MY}} > \frac{B/K_e}{\lambda_b} = \frac{qS}{\lambda_b[(1+R) - qS]}$

In other words, despite rise in p_M might have a 'choking-off' impact on L_e, it cannot overturn as (B/K_e) or γ_M cannot be very high. Pivotal role is played by share of credit going to machine-sector as well as ratio of external finance to stock of capital ($\lambda_b = \frac{k_b}{K_e + K_b}$). This leads to the following proposition:

Proposition 6. *From Equation (39) and (40), it follows that given $\theta_{MX} > \theta_{MY}$, $|\varphi| > 0$, θ_{MY} is fairly low enough and $\gamma_M \rightarrow 0$, so that $\gamma_L \rightarrow 1$, and σ_D is high enough then stability condition will always hold and B/K_e will not be high enough. In other words, the condition $A1 > A2.\frac{B}{K_e}$ ensures that given quite low values of θ_{MY} and γ_M even if B/K_e is bit high, positive impact on $\widehat{L_e}$ could be insignificantly low, but not negative (i.e.,* *reduced*).

Proof. *See the discussion above.* (*QED*). *This is the* '*Stability condition*'.

In this section, we saw—unlike the full-employment and perfect credit market scenario—that, alike Keynesian postulates, greater availability of 'K' is conducive so that extra cash increases employment and affects output. Thus, it is non-neutral or non-dichotomous (i.e., credit is affecting real wages, employment, and output). Our extension incorporates finance or credit supply (like cash-in-advance) in the presence of unemployment and credit-rationing, and shows the importance of financial development for generating employment, higher output, trade. Also, the mechanism shows that better access to finance and developing quality institutions, accoutability could overcome the risks of default and collateralization for facilitating production and trade. Financial and institutional development play a pivotal role as higher working capital enables employment in a labour-abundant country by overcoming frictions.

5. Numerical simulation analysis

Following the theoretical results in the preceding section, we now proceed to show some numerical counterfactual exercises. We pick some key results that govern our conjectures. The primary objective of the simulation is to show the role of financial crisis or boom affecting supply of entrepreneurial finance and hence, the demand for credit for production. The purpose is to offer a heuristic tool for understanding the theoretical outcomes and gaining insights from the mechanism. The exercise is more of a qualitative nature without precise estimation of the parameters.

For that, following the conventions in the available studies we make the following table with core results based on main building block and extensions of our proposed analytical framework. Parameter choices are consistent with the standard approaches in mainstream literature. The first block is related to Propositions 1 and 2 for changes in K. The second one is related to the aspect of credit market constraints and unemployment with emphasis on roles of better financial institution to avoid risk of default (main Proposition 4, 5, 6). While considering the parametric changes the key assumptions underlying the values will be mentioned.

So far as 1st block is concerned, we consider relative prices changes of exogenous $\widehat{P_x} > 0, \widehat{P_Y} = 0$ and changes in demand for wage fund ($\widehat{K_d}$), and $\widehat{r}$. Crucial assumptions are: $\theta_{MX} > \theta_{MY}$, $\lambda_{MK}\theta_{LY} \gtreqless \lambda_{LK}\theta_{MY}$.

For a given K_d, changes in $\overline{K}$ will affect 'r'. During financial crisis, $\overline{K}$ falls and 'r' rises, while 'W' and 'p_m' fall. This causes K_d to shrink as $K'_d(r) < 0$ where $\frac{dK_d}{dr} = \frac{dp_m}{dr}M + \frac{dW}{dr}L$. 'r' and 'W' are inversely related. Now, given $\overline{K}$, effect of financial debacle on unemployment in the labor market will depend on the sensitivity or elasticity of K_d *w.r.t.* 'r' and the impact on $p'_M(r), W'(r)$.

This, in turn, will affect the relative changes in demand for machine and labor depending on fall in 'W' while 'r' changes. As $\overline{K}$ shifts left (during credit shortage or crisis) or shifts right (financial boom), employment impact will depend on how sensitive K_d to 'r' is i.e., the steepness. See the diagram 1 below. With the same fall in $\overline{K}$, the more elastic (flat) is the r-W curve would mean 'W' will be compressed more with respect to small changes in 'r' rise whereas inelastic (steep) schedule will mean for same decline in 'W', 'r' has to increase by more. Unemployment effect will vary accordingly. If K_d falls by more due to rise in 'r' thanks to financial crisis, 'L' could rise or fall depending on extent of fall in 'W' vis-à-vis 'p_m'.

For the 2nd block, we consider exogenous changes $[\widehat{P_x} > 0, \widehat{P_Y} = 0]$ with parametric variations—as shown in the Table for each set of simulations—and consider entrepreneurial finance (K_e), external credit (B) with borrowing cost (R) and '*qS*' as indicator of financial development. Given the benchmark case of parametric configurations, on top of the shares of these two sources of finance with 'R' as borrowing cost and 'r' as deposit rate, we consider σ_D,λ to determine $\widehat{L_e}$, $\widehat{p}_M$. Also, we see how variations in$\widehat{qS} > 0$ will affect $\widehat{L_e}$ positively monotonically so long as cost shares of labor in finance is high, θ_{MY} and γ_M low while ratio of credit to entrepreneurial finance$[B/K_e]$ is not so high.

From Table 2, the results exhibit that under some plausible benchmark conditions, the direction of established relationships is consistent and intuitive. In block 1, we corroborate the effect of 20 % change in price of X and under plausible conditions, trace that $\widehat{p_M} > \widehat{P} > 0 > \widehat{W}$ and$(\widehat{W} - \widehat{p_M}) < 0$, $\widehat{K_d}$>0. Further, as $\widehat{P}$ changes, keeping the parameters same, $\widehat{K_d}$ rises.

For the second block, same configurations of parameters are taken except newly introduced ones (qS, γ_M, γ_L, λ_{MX}, λ_b, σ_D) being

Table 1
Parameters changes and List of Variables.

1st Block: Based on Proposition 1 and 2		
Parameters and assumptions for share parameters: $\theta_{MX} > \theta_{MY}$,$\theta_{LY} > \theta_{LX}$,$\lambda_{LK} = 1 - \lambda_{MK}$,$\theta_{MY} = 1 - \theta_{LY}$,$\theta_{MX} = 1 - \theta_{LX}$$\lvert\theta\rvert = \theta_{MY} - \theta_{MX} = \theta_{LX} - \theta_{LY} < 0$,$\lambda_{LK}\theta_{MY} > \lambda_{MK}\theta_{LY}$, P_x = P (P_y numeraire) is exogenous, *See* Table 2 *for* Parameter values and Variables	Variables of Interest $\widehat{K_d}$,$\widehat{p_M}$, $\widehat{W}$, $(\widehat{W} - \widehat{p_M})\widehat{P} = 20$ %, 30 %	Key Equations (11a&b), (12a&b)
2nd Block: Based on Proposition 4, 5 and 6		
Parameters: *Additional ones*: 0 < q < 1, 0 < S<1, 0<(qS) < 1, $\lambda_b = 1 - \lambda_e$,$\lvert\lambda\rvert = \lambda_{MX} - \lambda_{LX} > 0$,$(\theta_{MX} - \theta_{MY})$=$\lvert\varphi\rvert > 0$,$\sigma_D$, A1, A2,$A1 > A2.\frac{B}{K_e}$	Variables of Interest $\widehat{L_e} = \widehat{p_M}\lvert\lambda\rvert\lvert\varphi\rvert\sigma_D$,$\widehat{p}_M$, $\widehat{(1+R)}$,$\widehat{L_e} = \frac{\widehat{qS}(B/K_e)}{A1 - A2.\frac{B}{K_e}}$	Key Equations(22), (23), (24), (25), (31), (32), (34), (35), (40)
See Table 2 *for Parameter values and Variables*		

assigned values as per the table with reasonable assumptions and approximations. The reason is that here we want to see variations of $\widehat{L_e}$ with 'qS' (for stability condition) and with price changes of Machine-intensive sector while share of machine being high in X ($\lambda_{MX} - \lambda_{LX} > 0$). As per Table 1, we find that in keeping with Proposition 5 and 6, when $A1 > A2.\frac{B}{K_e} > 0$, the stability condition is satisfied with insignificantly low positive impact on L_e whereas with $\widehat{P} = 20$ % and rise in 'qS', L_e rises. Looking at the values of the term $\left(A1 - A2.\frac{B}{K_e}\right)$ contingent on the configurations of the constituent parameters, we easily see that as it turns to positive from negative, $\widehat{L_e}$ goes up (insignificantly low) with rise in 'qS' while $\widehat{P}$ increases. Keeping that stability condition requires, as in Proposition 6 and captured in the simulated values in the Table, $\frac{B}{K_e}$ should not be high and $\gamma_M \rightarrow 0, \gamma_L \rightarrow 1$ while $\theta_{MX} - \theta_{MY} = |\varphi| > 0$. All these highlight the mechanism numerically and offer policy perspectives such that improving institutions and governance (captured by rise in 'qS' values) is good for employability.

In the above numerical exercise, we have considered the key propositions and illustrated their validity by considering the benchmark values and subsequent configuration of value changes in keeping with our objectives. The purpose is to highlight the underlying mechanism and offer some conjectures on policy perspectives. For instance, in the 1st block of simulation, we showed that rise in the relative price of the machine-intensive sector–demanding higher capital–will affect the cost of finance (capital) and if supply of capital remains unaltered or source of finance dries up, interest rate rises to suppress returns to labor and even machine. Hence, effect of financial crisis on labor market will depend on the interest rate elasticity of demand for finance. Thus, availability of finance (either boom or crisis) will affect employment depending on relative changes in wage and machine prices as interest rate keeps oscillating. In the 2nd block, we further showed that if there are distortions then role of finance (funds to sustain production) becomes pivotal to affect production, trade, and income distribution. In other words, external credit vis-à-vis entrepreneurial finance are crucial if credit market has imperfection causing unemployment. Hence, improving institutions and governance via say, collateralization of funds of defaulters (captured by, say, higher 'qS' values) is conducive for employability. With such higher prospects of penalty of defaulters, credit-rationed will be relaxed to cause flows of funds and that would, in turn, affect production, trade, and employment. This simulation further supports the policy implications of our work, i.e., finance is crucial to carry out production and trade, and with better policy design (banking the unbanked or quality of institutional architecture), financial development will ameliorate the problem of unemployment and/or, imperfection in an otherwise distorted economy.

6. Summary and conclusions

In contrast to the current wave of research exploring the role of "trade credit" in bolstering exports and global sales following economic recessions or post-pandemic downturns, our paper adopts a more general approach to address the more fundamental issues afflicting export performance. As the availability of finance or credit is crucial for production decisions, we investigate how the

Table 2
Numerical Illustration with Parametric changes.

BLOCK 1								$\widehat{P} = 0.2$			
θ_{mx}	θ_{Lx}	θ_{my}	θ_{Ly}	θ	λ_{mx}	λ_{mk}	λ_{Lk}	$\widehat{K_d}$	$\widehat{P_M}$	$\widehat{W}$	$(\widehat{W} - \widehat{p_m})$
0.6	0.4	0.2	0.8	−0.4	0.5	0.6	0.4	0.2	0.4	−0.1	−0.5
0.7	0.3	0.3	0.7	−0.4	0.6	0.7	0.3	0.2	0.35	−0.15	−0.5
0.8	0.2	0.4	0.6	−0.4	0.7	0.8	0.2	0.2	0.3	−0.2	−0.5
0.55	0.45	0.45	0.55	−0.1	0.7	0.55	0.45	0.2	1.1	−0.9	−2
								$\widehat{P} = 0.3$			
								$\widehat{K_d}$	$\widehat{P_M}$	$\widehat{W}$	$(\widehat{W} - \widehat{p_m})$
								0.3	0.6	−0.15	−0.75
								0.3	0.525	−0.225	−0.75
								0.3	0.45	−0.3	−0.75
								0.3	1.65	−1.35	−3
BLOCK 2											
σ	**γm**	**γl**	λ_{mx}	λ_{lx}	**Ψ**	**λ**	**A1**	**A2**	**qS**	**B/Ke**	**A1-A2.B/Ke)**
2	0.001	0.999	0.55	0.45	0.4	0.1	1.0115	4.166667	0.2	1	−3.16
2	0.01	0.99	0.6	0.4	0.4	0.2	1.0525	3.125	0.2	0.5	−0.51
2	0.1	0.9	0.65	0.35	0.4	0.3	1.316667	2.777778	0.2	0.45	0.07
2	0.11	0.89	0.7	0.3	0.1	0.4	2.265	9.375	0.85	0.2	0.39
λb	**θmy**	**θmx**	**Θmx − θmy**								
0.6	0.33	0.7	0.37								
							$\widehat{P} = 0.2$	$\widehat{P} = 0.3$			
						$\widehat{L_e}$ **(stability)**	$\widehat{L_e}$	$\widehat{p_M}$			
						−0.063	0.04	0.54			
						−0.196	0.08	0.54			
						1.35	0.12	0.54			
						0.436	0.16	0.54			

Source: Authors' own calculations. Fictitious data, for illustration purposes only.

incorporation of financial factors can influence production, trade volumes, trade patterns, and employment outcomes under various pertinent scenarios.

To show that, we have extended the traditional two-sector Neo-Classical trade model—the workhorse of the Heckscher-Ohlin-Samuelson model couched in the framework of Jones (1965)—by incorporating Ricardian wage fund theory à la Marjit and Das (2021). Incorporating finance in a general equilibrium trade model is quite novel, as it offers important and valuable insights into the role of finance in affecting production and trade patterns. With a perfect credit market and full employment, finance does not affect the trade pattern; however, it does affect the absolute values of wages and the price of machines via changes in the market interest rate. In the full employment model, with identical endowments in both the home and foreign country, no trade will occur, with the same price as in the world market price. With differences in endowments, similar to the Heckscher-Ohlin-Samuelson (HOS) model, trade will take place. With differences in the availability of capital and the mobility of financial capital, factor trade complements commodity trade, unlike the HOS model. The trade pattern is not affected. Without capital controls, factor prices will be equalized. Thus, when there are no distortions such as unemployment or an imperfect credit market, finance is neutral like the canonical Neo-Classical macro models, except when labor and machinery mobilities are allowed. Only then will the volume and pattern of trade be affected, even in the benchmark model.

With unemployment, however, a higher wage fund will affect the trade pattern as well as relative prices. With such distortions, a higher minimum wage will lead to unemployment without diminishing marginal productivity, and a labor-abundant economy might produce less of its labor-intensive goods. Financial crashes or booms, as exogenous shocks, can affect the pattern of trade and relative prices in a minimum wage-driven unemployment equilibrium. For example, given the prices of goods and machines and the interest rate, higher working capital will increase labor employment, translating into greater exports by a labor-abundant economy that initially lacked enough credit to finance trade. The main takeaway is that in a world riddled with unemployment, finance plays a pivotal role with an impact on global income and employment. However, it will also adversely affect the terms of trade of the labor-abundant economy. Machine producers will be better off.

With another distortion, such as an imperfect credit market and credit rationing, the story becomes more interesting and, of course, more realistic. This is because when the demand for loanable funds exceeds the supply to finance production and trade, then the risks of default and the quality of financial institutions, which determine the penalties for enforcing contracts, will matter to a great extent. The model shows that for two otherwise identical countries with the same initial conditions, the country with a higher degree of financial development (e.g., in terms of the judiciary, rule of law, accountability, etc.) will have higher stocks of finance and, hence, will lend more at a lower rate of interest, so that employment growth will occur. The country where entrepreneurs have better access to external finance, in addition to their own financial resources, will be better positioned to resolve the unemployment problem and participate in global trade. Furthermore, the model develops several empirically testable hypotheses, such as the role of financial institutions and financial development in fostering inclusive growth through job creation and employment.

In fact, Emara and Said (2021) have empirically demonstrated, in the context of African economies and emerging markets, that improvements in governance, supervisory and regulatory regimes, judicial independence, and contract enforcement, coupled with financial access, are conducive for economic growth. An empirical validation of our results, with numerical simulations of the cost-shares of machines versus labor along with changes in the prices of goods and factors, can be undertaken in a further extension of this research. However, our conjecture and mechanism differ from those of Stiglitz and Weiss (1981) and Williamson (1987). Our value-addition lies in developing a theoretical setup and showing a novel mechanism by blending the traditional Neoclassical 2x2 sector workhorse of trade models with finance, credit rationing, and the allocation of capital in production versus innovation. Our approach is more general than the restrictive approach of the trade-finance literature, where financing for exports or trade credit issues has been given sole primacy. Additionally, the non-neutrality of finance, with distortions or factor and machine mobilities affecting the volume and patterns of trade, are important value-additions.

A further extension of the model could account for the declining labor share (as documented by Barkai 2020, Acemoglu 1998, 2002, and Acemoglu and Restrepo 2018 & 2020; Das, Hati and Gupta 2024). This could involve eliciting a mechanism where the incentive to invest in R&D to induce technical progress in the machine sector could account for the secular decline in the labor share of income. Lastly, a valuable insight derived from this model is whether labor and machines are helped or hurt by trade or finance. This is highly pertinent in the context of the emergence of the Fourth Industrial Revolution, artificial intelligence (AI), and information and communication technologies (ICT), which are causing disruptions in sectoral adjustments and changing the landscape of the labor market, leading to a secular decline in the labor share of income − a trend that has raised concerns in the crisis-laden global economy.

CRediT authorship contribution statement

Sugata Marjit: Methodology, Formal analysis. **Gouranga G. Das:** Writing – original draft, Methodology, Formal analysis. **Lei Yang:** Writing – review & editing, Methodology, Formal analysis.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix 1

Mathematical appendix

Appendix a. Proof of Proposition 1

Following Caves, Frankel and Jones (2011) and Feenstra (2003), using (4) and (5)

$$\lambda_{LX}\widehat{X} + \lambda_{LY}\widehat{Y} = \widehat{L}$$
$$\lambda_{MX}\widehat{X} + \lambda_{MY}\widehat{Y} = \widehat{M}$$

Using Cramer's Rule: $\widehat{X} = \frac{\lambda_{MY}\widehat{L} - \lambda_{LY}\widehat{M}}{\lambda_{LX}\lambda_{MY} - \lambda_{MX}\lambda_{LY}}$, $\widehat{Y} = \frac{\lambda_{LX}\widehat{M} - \lambda_{MX}\widehat{L}}{\lambda_{LX}\lambda_{MY} - \lambda_{MX}\lambda_{LY}} \Rightarrow \widehat{X} - \widehat{Y} = \frac{\widehat{L} - \widehat{M}}{|D|}$,

where $|D| = \lambda_{LX}\lambda_{MY} - \lambda_{MX}\lambda_{LY} = \lambda_{LX} - \lambda_{LY} = \lambda_{MY} - \lambda_{MX} < 0$ as X uses more M (by assumption).

Thus, $\widehat{X} - \widehat{Y} = \frac{\widehat{L} - \widehat{M}}{|D|} = \alpha\,[\widehat{M} - \widehat{L}] > 0$ as $\lambda_{MX} > \lambda_{MY}$, and $\alpha = \frac{1}{\lambda_{MX} - \lambda_{MY}} > 0$(QED).

APPENDIX 2. PROOF OF PROPOSITION 2

From (2) and (3), via Jones (1965), when $\widehat{P} \neq 0$.

$\begin{pmatrix} \theta_{LX} & \theta_{MX} \\ \theta_{LY} & \theta_{MY} \end{pmatrix}\begin{pmatrix} \widehat{W} \\ \widehat{p_M} \end{pmatrix} = \begin{pmatrix} \widehat{P} - \widehat{(1+r)} \\ -\widehat{(1+r)} \end{pmatrix}$ and $|\theta| = \theta_{LX}\theta_{MY} - \theta_{MX}\theta_{LY} = \theta_{MY} - \theta_{MX} = \theta_{LX} - \theta_{LY} < 0$(by intensity assumption). Applying Cramer's rule yields:

$$\widehat{W} = \frac{1}{|\theta|}\begin{pmatrix} \widehat{P} - \widehat{(1+r)} & \theta_{MX} \\ -\widehat{(1+r)} & \theta_{MY} \end{pmatrix} = \widehat{P}\frac{\theta_{MY}}{|\theta|} - \widehat{(1+r)}$$

$$\widehat{p_M} = \frac{1}{|\theta|}\begin{pmatrix} \theta_{LX} & \widehat{P} - \widehat{(1+r)} \\ \theta_{LY} & -\widehat{(1+r)} \end{pmatrix} = -\widehat{P}\frac{\theta_{LY}}{|\theta|} - \widehat{(1+r)}$$

Using these and (11),

$$\widehat{K_d} = -\frac{\widehat{P}}{|\theta|}[-\lambda_{MK}\theta_{LY} + \lambda_{LK}\theta_{MY}] = \lambda_{LK}\left[\frac{\widehat{P}\theta_{MY}}{|\theta|} - \widehat{(1+r)}\right] + \lambda_{MK}\left[-\widehat{(1+r)} - \frac{\widehat{P}\theta_{LY}}{|\theta|}\right]$$

$\Rightarrow \widehat{K_d} = -\widehat{(1+r)}[\lambda_{LK} + \lambda_{MK}] + \frac{\widehat{P}}{|\theta|}[\lambda_{LK}\theta_{MY} - \lambda_{MK}\theta_{LY}] = -\widehat{(1+r)} + \frac{\widehat{P}}{|\theta|}[\lambda_{LK}\theta_{MY} - \lambda_{MK}\theta_{LY}]$**(QED)**

Given P, higher 'K' will imply lower (1 + r) or 'r'. With $\widehat{P} > 0$ from (2) and (3), derive:

$$\widehat{W}\theta_{LX} + \widehat{p_M}\theta_{MX} = -\widehat{(1+r)} + \widehat{P} = \widehat{W}\theta_{LY} + \widehat{p_M}\theta_{MY} + \widehat{P} \Rightarrow \widehat{W}(\theta_{LX} - \theta_{LY}) + \widehat{p_M}(\theta_{MX} - \theta_{MY}) = \widehat{P}$$

Thus,$\widehat{p_M} - \widehat{W} = \frac{-\widehat{P}}{|\theta|} = \frac{\widehat{P}}{\beta}$, where $|\theta| = \theta_{LX} - \theta_{LY} = \theta_{MY} - \theta_{MX} < 0, \beta = -|\theta|$

From above,$\widehat{K_d} = 0 \Rightarrow -\widehat{(1+r)} = \frac{\widehat{P}}{|\theta|}[\lambda_{LK}\theta_{MY} - \lambda_{MK}\theta_{LY}]$

Thus,$\widehat{P} - \widehat{(1+r)} = \widehat{P} - \frac{\widehat{P}}{|\theta|}[\lambda_{LK}\theta_{MY} - \lambda_{MK}\theta_{LY}] \Rightarrow \widehat{P} - \widehat{(1+r)} = \widehat{P}\left[1 - \frac{\lambda_{LK}\theta_{MY} - \lambda_{MK}\theta_{LY}}{|\theta|}\right]$

And$\widehat{P} - \widehat{(1+r)} = \frac{\widehat{P}}{|\theta|}[\theta_{MY}(1-\lambda_{LK}) + \lambda_{MK}\theta_{LY} - \theta_{MX}] = \frac{\widehat{P}}{|\theta|}[(\theta_{MY} + \theta_{LY})\lambda_{MK} - \theta_{MX}] = \frac{\widehat{P}}{|\theta|}[\lambda_{MK} - \theta_{MX}]$ (QED.).

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