Interest Rates and World Trade: An 'Austrian' Perspective

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The world economy witnessed a period of significant trade integration in the late 1980s, 1990s, and 2000s. This same period was accompanied by a substantial decline in real interest rates and, more broadly, by a fall in the cost of capital faced by firms. Were these two phenomena unrelated? Or, perhaps, did the decline in the cost of capital partly fuel the growth in world trade? Answers to these questions are not only relevant for understanding past events, but they may also be informative in delineating possible scenarios for the future of world trade, particularly in current times, in which inflationary pressures have led to much talk about interest rates continuing their recent upward trend over the next few years.

The international trade literature has extensively studied the causes and consequences of increased trade integration, but this literature is typically silent on the interplay between global trade and interest rates. This is not too surprising given that international trade models are, for the most part, static in nature.

This paper develops a framework to study the interplay between world trade and real interest rates. To do so, I build on the 'Austrian' model in Antràs (2023a), which is in turn inspired by the work of Böhm-Bawerk (1889), among many others. The model incorporates an explicit notion of production length: the time lag between the beginning of production and the delivery of goods to consumers is an endogenously determined outcome. Letting the production process mature for a longer period of time increases labor productivity, but it comes at the cost of higher working capital needs for firms. Selling to foreign markets provides an additional source of operating profits for firms, but these sales are associated with an additional time lag between production and consumption. Changes in the interest rate affect production lengths, labor productivity, and the financial costs of exporting, and thus the model is a suitable tool for studying the implications of changes in interest rates on world trade.

Although I borrow extensively from the framework in Antràs (2023a), the model in the current paper is dramatically simpler in that I do *not* consider multi-stage production, which is a central aspect of the analysis in that previous paper. Conversely, in this paper I move beyond the constant-returns-to-scale and perfect competition assumptions in Antràs (2023a), and I consider an environment with scale economies and imperfect competition. This allows me to better connect with current workhorse models in the international trade field.

The main results of the paper gradually decompose the response of world trade to 'exogenous' changes in the interest rate into four components: (i) a labor productivity effect, (ii) a propensity to consume out of labor income effect, (iii) a temporal dimension of variable trade costs effect, and (iv) a selection into exporting effect. Due to space constraints, the results below are presented in a schematic fashion. For more details, readers can consult the longer version of this paper in Antràs (2023b).

I. Böhm-Bawerk Meets Krugman

There are three main building blocks to the theoretical framework. First, I introduce a model of international trade with product differentiation, scale economies, and monopolistic competition along the lines of the seminal work of Krugman (1980). Second, I incorporate a temporal dimension to production with its associ-

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ated working capital needs in the 'Austrian' tradition of Böhm-Bawerk (1889). Third, I close the model by incorporating a supply side to the capital market following Caballero et al. (2008). I develop the autarkic version of the model in this section, and later introduce international trade.

Time evolves continuously. Infinitesimal agents are born at a rate ρ per unit of time and die at the same rate; the population mass is therefore constant and equal to L. All agents are endowed with one unit of labor services which they supply inelastically to the market. Consumers value a final good which is costlessly put together by combining a continuum of differentiated varieties of intermediate inputs according to

$$U = Y = \left(\int_0^n (c_\omega)^{(\sigma-1)/\sigma} \, d\omega \right)^{\sigma/(\sigma-1)},$$

where c_ω is the consumption of input variety ω, $\sigma > 1$ is the elasticity of substitution across varieties, and n is the measure of varieties to be determined in equilibrium.

Input varieties are produced by a continuum of firms, each producing a single variety ω. The industry is monopolistically competitive, and there is free entry. Before any production takes place, firms need to incur a fixed overhead cost of f_e units of labor in order to be able to produce inputs. This fixed cost can be interpreted as an entry cost. After this cost has been incurred, firms can produce units of the input variety with a linear technology in labor. We can succinctly express technology as

$$y_\omega = \varphi_\omega \left(L_\omega - f_e \right),$$

where φ_ω is inversely related to the marginal cost of production, and L_ω is the total amount of labor hired by the firm producing variety ω.

I incorporate an 'Austrian' dimension to the model by acknowledging that production *takes time*, and that the more time is devoted to production, the more output will be obtained. More specifically, I let labor productivity φ_ω be a function of time, or $\varphi_\omega(t)$. Firms hire an amount of labor L_ω at the beginning of production, and they could instantaneously produce an amount $\varphi_\omega(0)(L_\omega - f_e)$ of output. But by 'waiting' and letting the production process 'mature', labor efficiency increases as a function of time, though at a diminishing rate. This assumption can be interpreted literally as workers improving their skills over time, or it could reflect the accumulation of some additional factor of production that enhances the productivity of labor. The assumption that labor is only paid at the very beginning of a stage's production is not important for the results below, but it simplifies the algebra.

Although lengthening the time taken to produce output enhances its efficiency, delaying production and sale comes at the cost of increasing the working capital needs of the firm, as firms need to borrow to cover the wage bill wL_ω. Given our continuous time environment, and letting the interest rate be given by r, firms face costs (inclusive of capital costs) equal to $wL_\omega e^{rt}$ after t periods.

I introduce a supply for capital into the model building on the work of Caballero et al. (2008). Remember that I have assumed that agents are born at a rate ρ per unit of time and die at the same rate. I now further assume that agents save all their income and consume the final good only when they (are about to) die. The parameter ρ is thus inversely related to the aggregate propensity to save of this economy, and therefore reflects the 'impatience' of agents. The final good is the only store of value in the economy: agents save accumulating claims on this good, which they can lend with interest to firms seeking to pay workers before selling their input varieties. Nevertheless, collecting interest demands that lenders incur monitoring costs m per unit of capital lent. In analogy to iceberg trade costs, I model these monitoring costs as 'melted' resources, and I interpret them as an inverse measure of financial development.

If K^s denotes aggregate savings, then aggregate consumption at any instant is ρK^s. In equilibrium, we must have income $wL + (r - m) K^s$ equal spending ρK^s and thus

$$K^s = \frac{wL}{\rho + m - r}. \tag{1}$$

Capital supply is thus proportional to labor income, with the factor of proportionality being positively affected by the interest rate r and negatively affected by impatience ρ and by financial underdevelopment m.

II. Closed-Economy Equilibrium

Because all firms face the same demand and have access to the same primitive technologies, I focus on a symmetric equilibrium in which all firms choose the same optimal production length t_ω and the same labor demand L_ω to maximize their (beginning of production) profits, which are given by

$$\pi = p_\omega \varphi_\omega (t_\omega) (L_\omega - f_e) e^{-rt_\omega} - wL_\omega,$$

with $p_\omega = A^{1/\sigma} (y_\omega)^{-1/\sigma}$, for some A that firms take as given. Following standard derivations, it is easy to solve for the optimal labor demand L_ω. Plugging back this solution into profits, the resulting optimal production length problem is then

$$\max_{t_\omega} \ \frac{1}{\sigma} A \left(\frac{\sigma w e^{rt_\omega}}{(\sigma - 1) \varphi_\omega (t_\omega)} \right)^{1-\sigma} e^{-rt_\omega} - wf_e.$$

Solving this problem, we can express the common optimal production length t^* for all firms as

$$\frac{\sigma - 1}{\sigma} \frac{\varphi'_\omega (t^*)}{\varphi_\omega (t^*)} = r. \tag{2}$$

This condition equates the marginal benefit of letting production mature to the marginal cost of waiting, which is related to the interest rate. The marginal benefit of lengthening production depends on the growth rate of labor productivity but also on the reciprocal of the markup charged by firms. Given the declining growth rate associated with $\varphi_\omega (t_\omega)$, the optimal length and labor productivity of all production processes is decreasing in the interest rate r and in the markup $\sigma / (\sigma - 1)$.

The fact that a high interest rate reduces the optimal length of production is perfectly intuitive, but it may be more surprising to some readers that the optimal production length is independent of the scale of operation, and that it is decreasing in the markup charged by firms. The reason for these results is that the marginal benefit of letting production mature is associated with a reduction in marginal costs, while the marginal cost of letting production mature is associated with delaying the collection of revenue. Because production costs and revenue are proportional to each other, the choice is independent of scale, but a large ratio of revenue to costs (i.e., a higher markup) makes longer production chains less desirable.

Although the main results to be derived below should apply more generally, I will hereafter focus on a specific case in which labor productivity is given by

$$\varphi_\omega (t) = \varphi t^\zeta, \quad \zeta < 1, \tag{3}$$

where ζ governs the extent to which a longer maturation of the production process translates into higher labor productivity. With the specific functional form in (3), the optimal production length is simply given by $t^* = (\sigma - 1) \zeta / \sigma r$, and results in a level of labor productivity equal to $\varphi (t^*) = (t^*)^\zeta \varphi$. A convenient feature of this log-linear case is that the cumulative interest e^{rt^*} is independent of the interest rate r, which will make this case particularly transparent in illustrating some of the main results below.

Having characterized firm behavior, we next turn to discussing the industry and general equilibrium of the model. Given the symmetry assumption, it is straightforward to invoke the zero-profit condition together with labor-market clearing to conclude that output per firm and the endogenous measure of firms are given by

$$\begin{aligned} y_\omega &= Lc_\omega = (\sigma - 1) f_e \varphi (t^*) ; \\ n &= L / \sigma f_e \end{aligned}$$

just as in the original Krugman (1980) model. Note, however, that labor productivity $\varphi (t^*)$ is endogenous and shaped by the interest rate. Firm output is thus higher in economies with lower interest rates.

To close the model in general equilibrium, I first set the final good as the numéraire, which results in an equilibrium wage rate

$$w = \left(\frac{L}{\sigma f}\right)^{1/(\sigma-1)} \frac{\sigma-1}{\sigma}\varphi\left(t^*\right)e^{-(\sigma-1)\zeta/\sigma}.$$

Clearly, the wage rate w is decreasing in the interest rate r because t^* decreases in r.

Finally, I consider a stationary equilibrium with a uniform time-invariant distribution of production processes at all possible levels of completion. This gives rise to an aggregate demand for capital equal to

$$K^d = \int_0^{t^*} wLe^{rt}dt = \frac{wL\left(e^{(\sigma-1)\zeta/\sigma}-1\right)}{r},$$

where in the last equality I have invoked (3). Equating this capital demand to capital supply in (1) delivers an equilibrium interest rate equal to

$$r = (\rho+m)\left(1-e^{-(\sigma-1)\zeta/\sigma}\right).$$

Naturally, the interest rate is higher, the higher the impatience of agents, and the higher are monitoring costs.

III. Free Trade

I now consider a world equilibrium with two countries, Home and Foreign, symmetric in all aspects. Given the absence of trade costs, it should be clear that the equilibrium of this world economy is identical to that of the closed economy, except for the fact that population and the labor force are now $2\times L$. Given the equilibrium equations above, it is then immediate that labor productivity, firm-level output and the interest rate will be *unaffected* by trade integration. Meanwhile, the number of available input varieties will double, and the real wage rate will increase by a factor of $2^{1/(\sigma-1)}$.

It is also straightforward to compute the volume of world trade. At any instant, consumers spend an amount ρK on the final good, and half of their spending is allocated to goods produced abroad. As a result, world exports (the sum of Home and Foreign exports) can be expressed as

$$T = 2\times\frac{1}{2}\times\rho K = \frac{\rho}{\rho+m-r}\times wL,$$

where in the second equality I have invoked equation (1).

How is the volume of trade affected by 'exogenous' changes in the interest rate r? Consider an increase in financial development, i.e., a reduction in m. From the capital-market equilibrium, the fall in m reduces the interest rate r. This in turn increases the production length t^*, labor productivity $\varphi\left(t^*\right)$, and the wage rate w. Furthermore, the ratio of spending to labor income $\rho/\left(\rho+m-r\right)$ also rises when m falls, and this further boosts world trade. Intuitively, lower monitoring costs raise capital supply, and consumption thereby increases. A fall in impatience ρ, perhaps reflecting a 'savings glut', generates more complex effects because the fall in ρ has a direct negative impact on the propensity to consume of agents (see Antràs (2023b) for details).

IV. Costly Trade

Consider next a situation in which, relative to domestic transactions, shipping goods across borders involves an additional interval of time d between the time at which production is completed and the time at which the shipment is received.

As I show formally in Antràs (2023b), the optimal production length t^* is again common for all firms and is given by the same equation (2) applying in the closed economy. Intuitively, and as explained above, the optimal production length is independent of scale whenever the markup charged by firms is independent of scale as well. Similarly, firm-level output and the number of input varieties produced in each country are independent of the level of trade costs.

Conversely, the wage rate and the interest rate *are* shaped by the level of trade costs. The (real) wage rate is a monotonically decreasing function of trade costs d and of the interest rate r. In the latter case, this is due to both the production length being decreasing in r as well as to effective trade costs e^{rd} being increasing in r.

Using the fact that the relative demand for foreign and domestic varieties must satisfy $p^x y^x / p^h y^h = \left(p^x/p^h\right)^{1-\sigma} = e^{-rd(\sigma-1)}$, we can solve for the volume of world trade:

$$T = \frac{2e^{-rd(\sigma-1)}}{1+e^{-rd(\sigma-1)}} \times \frac{\rho}{\rho+m-r} \times wL.$$

'Exogenous' decreases in the interest rate driven by a reduction in m affect world trade via the same two mechanisms as in the free trade case, namely by increasing labor productivity and wages, as well as the propensity to consume out of labor income. But costly trade introduces a third mechanism, captured by the term $e^{-rd(\sigma-1)}$, by which low interest rates boost world trade. In words, due to the temporal dimension of trade costs, lower interest rates lead to endogenously lower trade costs, and this further fosters deeper trade integration.

V. Böhm-Bawerk Meets Melitz

I finally expand the model to an environment with firm heterogeneity and fixed costs of exporting, as in Melitz (2003). In particular, I now assume that, upon paying the fixed cost of entry f_e, firms draw a core productivity level φ from some distribution $G(\varphi)$. Firms then decide whether to exit, produce only for the domestic market (with additional overhead cost f_h) or produce for both the domestic and foreign markets (with a total overhead cost of $f_h + f_x$). Firms also choose their optimal production length, but given our discussion above, it should be clear that because all firms charge the same markup, they will also choose a common production length t^*.

As in Melitz (2003), it is straightforward to solve for two thresholds φ_h and φ_x such that all firms with productivity $\varphi < \varphi_h$ exit upon observing their core productivity φ, all firms with productivity $\varphi \in [\varphi_h, \varphi_x]$ sell only in their domestic market, and all firms with $\varphi > \varphi_x$ additionally export to the foreign market. These thresholds can be shown to satisfy

$$\left(\frac{\varphi_x}{\varphi_h}\right)^{\sigma-1} = e^{rd(\sigma-1)} \times \frac{f_x e^{rd}}{f_h}. \tag{4}$$

The first term in the right-hand-side of (4) reflects the relative disadvantage faced by firms when selling in foreign markets due to the time lag d between shipment and delivery. This term was already present in the costly trade version of the model in the last section. The second term is new and governs the relative size of the overhead costs of selling domestically and internationally. Note that the foreign fixed cost is magnified by a factor e^{rd} because the temporal dimension of international shipping leads to larger working capital needs associated with the exporting fixed cost f_x relative to the working capital needs associated with the domestic fixed cost f_h. This second term thus introduces a new channel via which changes in interest rates may shape world trade flows, a channel that operates via the extensive margin of trade. In Antràs (2023b), I provide an explicit formula for world trade that precisely identifies this fourth mechanism.

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