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ABSTRACT

In this paper, we show that the existing models and descriptions of the transfer of capital between countries that are provided in international economics are inadequate because they fail to explain the causes of, or the consequences of, persistent trade imbalances and because the assumption that there is a world interest rate, r* at which all countries can theoretically lend or borrow is extremely misleading. Instead, we argue that a more fruitful modeling approach is to regard the world as consisting of a number of regions, each of which has a particular rate of return on capital, which is a function of the local marginal product of capital (MPK). We demonstrate that such a modeling approach can provide some additional insights into who gains and loses from persistent trade deficits and how this might be affected by the Trump Administration's tariff policy.

Keywords: Capital flows, capital market imperfections, capital mobility, capital transfers, current account deficits, current account imbalances, exchange rate, Feldstein-Horioka Paradox, Feldstein-Horioka Puzzle, financial frictions, financial market imperfections, globalization, goods market imperfections, international capital flows, international capital mobility, international financial markets, investment, marginal product of capital, MPK, net capital transfers, open economy macroeconomics, rate of return on capital, saving, saving-investment correlations, tariffs, trade barriers, trade costs, trade deficits, trade frictions, trade imbalances, trade policy, Trump tariffs, world interest rate

*Journal of Economic Literature* Classification Codes: E43, F13, F21, F32, F41, F62, G15

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## 1. Introduction

There is currently much discussion about President Trump's tariffs, the U.S. trade deficit, and its causes and impacts. The administration's principal concerns regarding the U.S. trade deficit are that (a) it has caused a reduction in the size of the U.S. manufacturing sector, with a consequent loss of well-paid jobs, a reduced level of innovation, and reduced economic growth, and that (b) it results in the accumulation of U.S. assets by foreigners, which the administration believes will cause the U.S. to be poorer in the future than it otherwise would be. These arguments have been set out recently by supporters of the Trump administration such as Robert Lighthizer (2020). However, that the U.S. trade deficit and consequent accumulation of U.S. assets by foreigners will reduce future U.S. prosperity is a longstanding concern (see, for example, Buffet, 2003).

President Trump himself is firmly of the view that the U.S. trade deficit is the result of unfair practices by the U.S.'s trading partners, a view that has some academic support (see, for example, Pettis and Hogan, 2024). Others close to the administration, notably Stephan Miran, have argued that the U.S. dollar is being used as a world reserve currency and that the consequent "financial inflows" drive up the value of the dollar, obliging the U.S. to have a trade deficit (see Miran, 2024).

There is no shortage of critics of the Trump Administration's analysis and policy (see, for example, Obstfeld (2025a) and Bordo and McCauley (2025). Nonetheless, there is no clearly and widely held alternative view on the cause of the persistent U.S. trade deficits nor on what, if anything, should be done about them. Economists Maurice Obstfeld and Joseph Stiglitz are on record as saying that the U.S. trade deficit stems from the low level of U.S. saving (Obstfeld, 2025a, and Stiglitz, 2006), essentially concurring with Buffet (2003). Paul Krugman has argued that the U.S. trade deficit is the result of the U.S. having more attractive investment opportunities than its trading partners (Krugman, 2024).

However, little has been offered in the way of economic modeling to inform the discussion regarding either the cause of the trade deficit or its immediate or eventual impacts. From the 1960s through the 1980s, numerous theoretical models were developed to try to explain the interaction among countries' economies and, in particular, to explain exchange rate movements, interest rates, and trade imbalances. Meese and Rogoff (1983) demonstrated that such models have little predictive or explanatory power with regard to predicting or explaining exchange rate movements; perhaps as a consequence, interest in international macro-models seems to have fallen by the wayside. This paper attempts to fill this lacuna by introducing a theoretical modeling approach to international trade imbalances that we developed recently, which elucidates both the causes and consequences of trade deficits.[1]

## 2. The Rationale for an Alternative Modeling Approach

Ford and Horioka (2017), Horioka (2024), and Horioka and Ford (2025b) address the Feldstein-Horioka Puzzle or Paradox (Feldstein and Horioka, 1980), which asks why domestic saving and domestic investment are correlated across countries despite the recent globalization of financial markets and financial capital apparently being perfectly mobile. Their proposed Solution to the Puzzle is that purely financial transactions cannot *by themselves* (as opposed to "in conjunction with goods market transactions") make net transfers of capital between countries. The globalization of financial markets

[1] A greatly condensed version of this paper can be found in Horioka and Ford (2025a)

allows an individual's capital to be "perfectly mobile" between countries because it allows the individual to transfer his or her capital between countries by exchanging assets with a counterparty. However, the net transfer of capital between countries that results from purely financial transactions is always zero because the movement of capital by the first party in one direction is fully offset by the movement of capital in the opposite direction by the counterparty.

While this Puzzle and its Solution may at first sight appear to be somewhat esoteric, we believe that the Solution has important corollaries that are of practical significance and application, particularly with regard to understanding the cause and effect of trade imbalances, and the impacts of international financial markets. Firstly, the Solution implies that, because financial markets cannot by themselves make net transfers of capital between countries, they cannot by themselves equalize returns on capital across countries. Consequently, there is no justification for supposing that there is some theoretical world interest rate r* at which all countries can access capital via financial markets. It follows that the impact of agents trying to lend to, or to borrow from, another country to try to take advantage of interest rate differences is primarily to change the real exchange rate vis-à-vis that other country, not to alter the domestic interest rate (see, for example, Krugman, Obstfeld and Melitz, 2022, Chapter 14).

When modeling the international economy, we submit that, instead of supposing that there is a world interest rate at which agents from any country can borrow or lend, a more coherent explanation of international economics results from regarding each country or region as having its own rates of return on capital across its own spectrum of assets, which depend upon the local marginal product of capital (MPK), offset by various risk premiums, as is routinely supposed in closed-economy economics. It is self-evident that purely financial transactions cannot alter the real capital stocks of countries and therefore that they cannot alter the local MPK. Consequently, in a simplified model, we should not expect financial markets to be able to alter "the interest rate." This approach not only has the merit of fitting the empirical evidence – risk-free interest rates are manifestly not equalized across countries – but it also allows us to model the international economy in a way that is concordant with models of closed-economy economics instead of being based on different assumptions.

The second important corollary of Ford and Horioka's (2017) Solution to the F-H puzzle is to remind us that a net transfer of capital (a capital account imbalance) between countries requires a trade imbalance (more accurately, a current account imbalance). Consequently, a trade imbalance can be regarded as the mechanism by which capital is transferred from one country to another. A trade imbalance involves a net transfer of financial capital between countries as well as a net transfer of real goods and services between countries; one cannot occur without the other. Horioka (2024) and Ford and Horioka (2017) remind us that openness in both financial markets and goods markets is necessary for a trade imbalance to occur and consequently that frictions in either goods markets or financial markets will impede the net transfer of capital between countries.

The most widely used models of exchange rates and trade imbalances are still versions of those put forward by Mundell (1963), Fleming (1962), and Dornbusch (1976). Such models suppose that, in the absence of frictions in financial markets, trade imbalances should adjust to rapidly equalize *risk-free* interest rates across counties via the impact of these trade imbalances on aggregate demand. This theoretical approach is still endorsed by esteemed economists currently working in international economics (see, for example, Obstfeld, 2025b, pp. 28-30, and Krugman, 2024).

These models recognize that financial markets and goods markets interact to cause trade imbalances. In a freely floating exchange rate regime, if risk-adjusted expected returns on capital are higher in one

country than another, agents are likely to bid up the currency value of the high-return country. This initial process of bidding up currency value involves no net transfer of capital. However, the stronger currency causes that country to develop a trade deficit, which entails a net transfer of goods and services into the deficit country, which is paid for by foreigners accumulating assets in the deficit country. In a freely floating regime, this represents a net transfer of capital to where risk-adjusted returns on capital are highest, which causes rates of return on capital to converge.

The principal point of difference between our modeling approach and the bulk of the literature concerns the mechanism by which the capital transfer inherent in a trade imbalance is expected to cause rates of return on capital across countries to converge.

The Mundell-Fleming-Dornbusch modeling approach focuses on the risk-free interest rate and on the impacts of a trade deficit on aggregate demand. It supposes that the rate of return on capital can be described by just the risk-free interest rate and that, in the absence of financial frictions, agents will bid up the price of the currency of an initially high interest rate country until the resultant trade deficit has a sufficiently negative impact on aggregate demand to bring the risk-free interest rate down to "the world interest rate."

By contrast, in our modeling approach, trade imbalances cause local rates of return on capital to converge only *in the long run* via their impact on capital stocks. With regard to the local return on capital, we do not focus on the risk-free interest rate but rather on the MPK, which we believe is a better proxy for expected returns on the full spectrum of assets in the long run.

We acknowledge that the "aggregate demand" (AD) modeling approach is of some value insofar as it helps explains, for example, how an exogenous, sudden change in the exchange rate might affect a short-run change in the domestic risk-free interest rate set by a central bank. Similarly, it might correctly describe the likely direction of an exchange rate movement in response to an economic downturn in one country that does not significantly affect its trading partners. However, it has a number of serious shortcomings, viz.:

1. Its prediction that risk-free interest rates should be rapidly equalized across countries is not supported by the empirical evidence. Risk-free interest rates are not equalized across countries (see, for example, Mishkin, 1984, and Chung and Crowder, 2004). Risk-free interest rates do display some tendency to move together in different countries, but we believe that this can be more convincingly explained by countries' economies being subject to similar shocks, such as the 2008 financial crisis, Covid-19, and energy price changes rather than by movements in exchange rates and changes in trade imbalances.

2. Such models assume that agents believe that a change in any component of demand will result in a permanent change in the risk-free interest rate. In reality, agents believe that a change to aggregate demand resulting from a change in the exchange rate or other shock will result in a short-term change in the risk-free interest rate but that this rate is likely to revert to some long-run level, sometimes referred to as the "neutral rate" or the "natural rate."

3. In reality, foreign agents do not invest in a country by exclusively buying government bonds yielding the risk-free interest rate. They also buy equities and property and engage in foreign direct investment. The expected returns on these other types of assets do not necessarily move in tandem with the spot interest rate.

4. As a consequence of 2 and 3, forward-looking agents do not continue to bid up the value of a country's currency whenever there is a difference in the spot risk-free interest rates across countries, as such models assume. Rather, they take a view on the likely difference in returns across a spectrum of assets, including the risk-free interest rate, but also take into account the probability that the impact of shocks on the risk-free interest rate may not continue indefinitely.

5. A key long-run consequence of a persistent trade deficit is the accumulation of assets in the deficit country by foreigners. However, this accumulation of assets by foreigners is wholly disregarded in the "aggregate demand" approach put forward by Mundell-Fleming, and described by Obstfeld, 2025b, pp. 28-30). Given that the accumulation of assets by foreigners is a principal concern of the Trump administration (see Lighthizer, 2023), and indeed given that Obstfeld himself argues at some point that a trade imbalance is likely to reverse itself because of the intertemporal budget constraint (Obstfeld, 2025b, p. 6), this a serious omission if the objective of the modeling is to describe the consequences of a persistent trade imbalance.

Hence, while we believe that this aggregate demand/financial flows approach is of value in understanding the short-run impacts of certain economic shocks, we believe that a different approach is needed to understand both the root causes of trade imbalances, the long-run impacts of a trade imbalance on the rates of return on capital across a wider range of assets, and how and why a trade imbalance might be expected to eventually reverse itself to meet what Obstfeld (2025b) describes as the "intertemporal budget constraint."

We believe that, rather than considering the impact of trade imbalances in terms of *financial flows* and their impact on aggregate demand, it is more fruitful to consider their impacts *on real capital stocks and the ownership thereof*. In closed-economy economics, it is routinely assumed that, in the long run, rates of returns on various capital assets in a country are related to the marginal product of real capital (MPK), although these specific rates of return may be reduced below the MPK by various risk premiums. Once the notion of there being a world interest rate is set aside in international economics, we are free to regard long-run rates of return on capital assets in any country as depending on the local marginal product of capital and hence upon the capital stock in that country, as closed-economy macroeconomists routinely do.

While there is substantial empirical evidence to contradict the supposition of aggregate demand models that exchange rates and trade imbalances adjust to quickly equalize risk-free interest rates across countries, we believe that the stylized facts support the hypothesis that the international financial system, in conjunction with goods markets, diverts capital from where it is relatively abundant and where MPK is relatively low to where it is relatively less abundant and where MPK is relatively high. At the time exchange controls were lifted in the 1970s, Germany and Japan had the highest saving rates and capital stock/GDP ratios amongst the G7 countries. For the subsequent few decades, these countries have generally had trade surpluses--i.e., they have exported capital. By contrast, the U.K. and the U.S. have had the lowest saving rates and capital stock/GDP ratios among the G7 countries and have generally had trade deficits--i.e., they have imported capital. (The emergence of China as an exporter of capital needs additional consideration because its currency has not been freely floating. Nonetheless, China's very high saving rate is consistent with its being an exporter of capital.)

We are not the first to put forward a two-country model in which (a) the difference in interest rates across countries causes a shift in the exchange rate, which in turn causes a trade imbalance, and (b) interest rates converge across countries because of changes in the stocks of assets in the two countries

(as opposed to this resulting from impacts on aggregate demand), and (c) the trade imbalance eventually reverses itself, as foreigners progressively repatriate more of their investment income. This was the basis of the Branson model (Branson 1980). However, Branson's very simplified model refers only to stocks of money and bonds. It makes no reference to stocks of real capital, and it supposes that the interest rate in both countries is a function only of stocks of non-interest-bearing money and stocks of bonds, again, with no reference to the real economy. Nonetheless, we believe that the model contained valuable insights regarding the cumulative impacts of trade imbalances, which have been largely disregarded.

The first model we are aware of that describes a trade imbalance as a mechanism to divert real capital between a country where MPK is low to a country where MPK is higher is that of Jurg Niehans (see Niehans, 1984, Chapter 6, pp. 105-131). However, Niehans attempted to reconcile the assumption of MPKs being different across countries with the assumption that interest rates must be equalized across those countries at all times by financial markets; i.e., he made the assumption of there being a theoretical r*, which we argue is fallacious and misleading. As a result, Niehans' model struggled to describe key aspects of reality, and perhaps as a consequence, his important insight – that real capital is diverted to where it is most productive – has also been largely disregarded.

Consequently, when putting forward our model, we are building on aspects of the work of Branson and that of Niehans. From Branson, we take the key insight that a difference in rates of return on capital across countries should cause an exchange rate movement, hence a trade imbalance, and a transfer of stocks of capital between countries, which causes rates of return on capital to converge and trade imbalances to eventually reverse themselves. From Niehans, we take the idea that this process should be considered in terms of real variables, not in terms of stocks of money and bonds. However, unlike Niehans, we are not constrained to supposing that financial markets will directly equalize interest rates across countries, and thus our models do a much better job of describing reality.

In advancing our real capital stocks/ MPK modeling approach, our aims are therefore two-fold.

Our primary aim is to make a contribution to international economic theory. Specifically, we are seeking to set aside the pervasive idea that if capital is "perfectly mobile," financial markets should be expected to almost instantaneously equalize interest rates across countries to some world interest rate r*. We submit that this false hypothesis has impeded our progress in understanding international economics for the past 60 years. Instead, we believe that different countries, or regions, should be regarded as having their own, local rates of return on capital, which are related to local MPKs, offset by appropriate risk premiums. In this context, we submit that persistent trade imbalances can best be understood as being the result of economic forces diverting real capital to where it can be expected to be the most productive. We might contrast that with the approach of Obstfeld and Rogoff (1999), who have advanced the view that trade imbalances should be regarded as a mechanism by which consumers move consumption from one time period to another--the so-called *intertemporal approach.* Once the world interest rate r* is set aside, we argue that it is more coherent to regard consumers as moving consumption from one period to another by adding to, or subtracting from, the stock of real capital, and, by contrast, to regard trade imbalances as resulting from the optimal deployment of this capital. Our modeling approach also offers an explanation of why exchange rates may deviate from Purchasing Power Parity (PPP) values for prolonged periods of time (the so-called PPP Puzzle; see Obstfeld and Rogoff, 2000), the explanation being that one of the reasons why deviations from the PPP value occur is that exchange rates reflect asset values, and similar assets in different locations can be persistently valued differently because there can be persistent differences in the rates of return they offer.

Our secondary aim is to make a contribution to the debate about the current Trump Administration's concerns about the U.S. trade deficit and its tariff policies. Specifically, we hope to demonstrate that, (a) in a freely floating currency regime, countries' trade deficits and surpluses can largely be understood as being driven by market forces diverting capital to where the risk-adjusted returns on capital are highest, rather than necessarily being the result of unfair trading practices, and (b) while the U.S. trade deficit does damage the U.S. manufacturing sector, it probably does not damage the U.S. economy as a whole.

## 3. Theoretical Modeling to Demonstrate the MPK/Capital Stock Approach

In this section, we develop a series of models to demonstrate how economic forces might be expected to divert real capital from where it is relatively abundant and its MPK is relatively low to where it is relatively scarce and its MPK is expected to be higher.

International trade takes place for two reasons. The first is to realize the gains from comparative advantage in production. If trade is balanced, so that no country has a trade deficit or surplus, this is the only reason why trade takes place. The second reason is to make net transfers of capital (or "resources") from one country to another. This requires a trade imbalance between countries.

In our modeling approach, we are focusing only on the latter of these two motivations. It is possible to think of the capital transfer process as being superimposed on top of the "trade for comparative advantage" process. (In reality, it is of course not possible to distinguish individual transactions as being the result of one or the other motivation). However, for simplicity, we assume that the countries in our models have no comparative advantage. That allows us to focus solely on trade occurring to transfer capital between countries since our aim is to explain the causes and consequences of trade imbalances.

### Trade Frictions and Financial Market Frictions/Imperfections

In reality, there are frictions in goods markets as well as in financial markets. Consequently, goods and services cannot be moved between countries without cost, and thus net transfers of capital between countries cannot occur without cost either. Looking first at frictions in goods markets, the movement of goods between countries is subject to **trade frictions**, which include transport costs, costs of regulatory compliance, costs of adoption to local tastes and language, and most topically, tariffs. Different goods have different trade costs. Consequently, a small trade imbalance might be achieved by transferring only those goods that have small trade costs between countries. However, the demand for every type of good is limited, so a larger trade imbalance requires that goods with progressively higher trade costs be transferred between countries. Consequently, a progressively larger deviation of the exchange rate from PPP is necessary to cause a larger trade imbalance. This also means that the faster capital is transferred between countries, the higher are the costs of transferring that capital. That, in turn, means there must be a trade-off when it comes to transferring real capital between countries – although such a transfer allows that capital to earn a higher return, if it occurs too quickly, the losses involved in making the transfer will exceed the benefits of making the transfer.

Turning to financial markets, we identify three principal "frictions," all of which might be regarded as resulting from agents not having the perfect foresight assumed in theoretical models that eliminates all risk. The first friction is a reluctance to hold foreign assets because of perceived additional risk or, alternatively, a preference to hold foreign assets because of perceived safe haven status. The second

financial friction is that limited foresight impedes agents' ability to correctly value assets and bid exchange rates to optimum values. The third is that, in reality, some agents hold risk-free or risk-reduced assets and forgo some return to avoid risk.

We first describe a hypothetical model in which there are no trade frictions and in which agents have perfect foresight. We then go on to develop a model in which there are realistic trade frictions but in which agents still have perfect foresight. These models yield outcomes that provide significant insight regarding the U.S. trade deficit. However, we find it is necessary to introduce financial frictions to yield modeling outcomes that make full sense of the U.S. trade deficit in terms of its persistence, its causes, and its likely consequences.

### 3.1. A Super-simple Model with No Trade Frictions

We first present the simplest possible model that makes use of this MPK/capital stock approach and show that even this simple model can provide insights regarding some of the issues raised by the Trump tariff debate.

Consider a super-simplified model comprising two countries--country A, approximating the U.S., and country B, approximating Japan plus Germany. Assume that both economies are at full employment at all times. We assume that there is no economic growth.

Assume that country A initially has a capital stock that is 2.5 times its output Y, whereas country B initially has a capital stock that is 3.5 times the same output Y. Assume that, as a consequence, the rate of return on real capital (MPK) in country A is significantly higher than it is in country B. It follows that the owners of capital in country B can gain by transferring some of the capital stock of country B to country A, where its MPK is higher, provided the cost of transferring this real capital is sufficiently small.

In reality, the net transfer of real (or physical) capital (e.g., plant, equipment, and housing) between countries is a complex process that involves financial markets as well as goods markets and requires considerable time and cost. For example, agents wishing to acquire U.S. assets might push up the price of the dollar. The resulting price changes might result in real capital being transferred from Japan to the U.S. in the form of the export of autos from Japan to the U.S. As a result of auto imports coming in from Japan, U.S. auto workers will lose their jobs. However, the displacement of U.S. auto workers will allow, say, construction companies to hire more workers and build more productive facilities and housing, adding to the U.S. capital stock. This process incurs the cost of transporting the autos from Japan to the U.S. and the cost of displacing and retraining workers in the U.S. However, for illustrative purposes, consider a hypothetical scenario in which real capital (e.g., plant, equipment, and housing) can be transported between countries and recommissioned immediately, without cost, and at an unlimited rate.

Suppose that, in this hypothetical scenario, agents in country B choose to transfer some of their real capital from country B to country A because returns on capital are higher in country A and that they do so until MPKs are equalized across the two countries. After the transfer takes place, residents of country B will receive a return on the real capital that they own in country A, and they will spend this income on goods produced in country A, which are transported back to country B at no cost. Thus, in the first period, country A will have a very large trade deficit, whereas in subsequent periods, it will have a

modest trade surplus, which will continue indefinitely. Who will benefit from these transfers, and who will lose?

We assume that the output and MPK of each country can be modeled as being given by standard Cobb-Douglas production functions so that

$Y_{A,B} = (AL)_{A,B}^{(1-\alpha)} K^{\alpha}_{A,B}$, and $MPK_{A,B} = (dY/dK)_{A,B}$

where AL denotes effective labor and K denotes capital.

We assume that α, real capital's share of income, is 0.175 and hence that the share of labor (and other factors of production) of income is 0.825.

We initially set Y=1 for both countries, $K_A = 2.5$, and $K_B = 3.5$.

The amount of capital that needs to be transferred between the two countries to equalize MPK can be calculated as being 0.607 times initial GDP. The following table summarizes the changes that result from the transfer of capital between the two countries:

| | Initial values | Values after the transfer of capital | % change |
|---|---|---|---|
| Country A | | | |
| Output | 1 | 1.039 | +3.9% |
| Capital Stock | 2.5 | 3.107 | |
| MPK | 7% | 5.85% | |
| Income to Capital | 0.175 | 0.147 | -16.4% |
| Income to Labor | 0.825 | 0.857 | +3.9% |
| Total Income | 1 | 1.004 | +0.4% |
| Country B | | | |
| Output | 1 | 0.967 | -3.3% |
| Capital Stock | 3.5 | 2.893 | |
| MPK | 5% | 5.85% | |
| Income to Capital | 0.175 | 0.205 | +17% |
| Income to Labor | 0.825 | 0.797 | -3.3% |
| Total Income | 1 | 1.002 | +0.2% |

Proponents of tariffs in the U.S. argue that the accumulation of foreign capital in the U.S. impoverishes U.S. citizens, but our very simple model suggests that this is not likely to be the case. It is true that, after the capital transfer, a fraction of country A's output belongs to agents in country B and that it is transferred back to country B as a stream of goods. However, the output of country A is increased by slightly more than this amount so that the residents of country A are very slightly better off than before, rather than being impoverished.

Returning to a more realistic world in which the transfer of capital is gradual and involves manufactured goods, the Trump administration is particularly concerned that the workers in manufacturing who are displaced by import penetration are disadvantaged. This is undeniably true. However, this very simple model predicts that, in country A, the additional capital transferred will drive up the marginal product of labor and hence wages but that it will reduce the marginal product of capital. That suggests that although some workers in manufacturing will be disadvantaged, wage earners as a whole will gain.

In this model, the principal "winners" from this capital transfer are the owners of capital in country B. Labor in country A also gains. By contrast, the losers are the owners of capital in country A and labor in country B. We should point out that Niehans (1984, page 114-116) reaches similar conclusions regarding the winners and losers from the net transfer of real capital between countries.

We might also adapt the super-simple model to address the proposition of Stephen Miran (2024) that foreigners have purchased U.S. assets primarily for their "safe haven" status (rather than buying U.S. real assets for their superior yield) and thus that they have purchased primarily risk-free U.S. assets such as U.S. government bonds. Miran's hypothesis is arguably backed up by empirical data: Obstfeld (2025b) shows that, although foreigners made net transfers to the U.S. amounting to some 0.7 times GDP, the U.S. still has positive net foreign income investment because foreigners hold a significant quantity of low-return assets such as government bonds while U.S. foreign investment has been earning high returns.

We can attempt to reflect that in the model by assuming that agents in country B transferred the same amount of capital as described above but then chose to exchange their real assets for risk-free assets whose real yield is 0% instead of holding real assets. Because foreigners earn no income from their foreign investment, there is then the same large trade deficit for country A in period 1, but instead of there being a surplus in subsequent periods, there is no trade imbalance, as there are no earnings to repatriate.

In this case, the results of the simple model are as follows:

| | Initial values | Values after transfer of capital | Change % |
|---|---|---|---|
| Country A | | | |
| Output<br>Income | 1<br>1 | 1.039<br>1.039 | +3.9%<br>+3.9% |
| Country B | | | |
| Output<br>Income | 1<br>1 | 0.967<br>0.967 | -3.3%<br>-3.3% |

Country A benefits considerably if foreigners hold low-return or zero-return assets. That should not be surprising as country B is now giving country A an interest-free loan of part of its real capital stock.

Clearly, this is merely a theoretical model that yields indicative results. However, we suggest that it does make a useful contribution to one aspect of the debate regarding the U.S. deficit. That is that we should not regard the accumulation of U.S. assets as impoverishing the U.S., as the additional capital that the U.S. accumulates probably adds to U.S. total output by at least as much as foreigners gain in income from such assets.

**The Impact of Tariffs in This Super-simplified Model**

With regard to the debate regarding the impact of tariffs, we might use this super-simplified model to address two questions. These are, first, whether tariffs can stop this trade imbalance and hence capital transfers and, second, whether tariffs imposed by a country importing capital will result in a net gain to that country.

In our model, the same capital asset in country A initially earns a 7% yield, and in country B, it earns a 5% yield. From the perspective of an agent in country B, any asset located in country A is more valuable than the same asset located in country B because it initially offers 40% more yield (7%/5%) if this difference in yields were to continue indefinitely. Hence, the owners of capital in country B are motivated to move their capital from country A to country B. They do so until yields are equalized, at which point there is no incentive to move additional assets.

However, suppose country A were to impose a tariff on real capital assets being moved in from country B. If the tariff rate was 40% or more, then there would be no incentive to move any capital between the countries. The payment of the tariff would exceed the benefit of the additional yield. We therefore conclude that a sufficiently high tariff would stop the transfer of capital between the two countries.

Suppose, however, that country A were to impose a 20% tariff on imported capital. Now the agents in country B would still be incentivized to move some capital between the two countries but only to the point where the tariff is offset by a continued difference in yields. As a first-order approximation, suppose that only half the amount of capital is transferred between the countries as a result, which is equivalent to approximately 0.3 x GDP. If country A were to levy a 20% tariff, country A would make a one-time gain of

$$20\% \times 0.3 = 6\% \text{ of GDP} .$$

The group that loses in these circumstances are the owners of capital in country B, who give up some of their gain to the government of country A.

We are reluctant to draw conclusions from this super-simplified model about the impact of U.S. tariffs in reality, but it does suggest that there is potentially some benefit to be gained by the U.S. by levying tariffs on imports when it has a large trade deficit. However, we have set aside comparative advantage in this model. Standard trade theory suggests that tariffs will reduce the volume of "conventional" trade and reduce the gains from comparative advantage. This loss of the gains from comparative advantage may well exceed any benefits to be gained by taxing the capital transfer inherent in a trade deficit.

### 3.2. Models that Include the Impacts of Trade Frictions

#### An Overview of the Mechanism of Such Models

In reality, real capital assets cannot be transferred between countries without cost, and indeed, the cost of moving most existing capital assets between countries is prohibitive. Instead, capital is transferred between countries by there being a trade imbalance, the supply of goods from abroad allowing a country to divert resources to the production of additional capital goods, if its saving rate remains the same.

The purpose of these models is to demonstrate the long-run interaction between Country A and Country B, which have different saving rates. Country B has the higher saving rate, meaning that real capital is initially relatively abundant and the return on real capital is relatively low in this country. Country A has the lower saving rate, meaning that real capital is relatively scarce and the return on real capital is relatively high in this country. (In Models 1-4, countries A and B are intended to correspond very loosely to the U.S. and "Japan plus Germany," respectively, over the last 50 years or so.) Prior to the start of the model, it is assumed that significant capital transfers between the two countries were legally prohibited, which is equivalent to assuming that foreign exchange controls were in place, preventing

residents of both countries from owning foreign assets. At the start of the model, these restrictions are lifted, and a process of capital transfer between the two countries begins.

The issue we seek to explore in these models is the effects on trade imbalances and exchange rates of differences in MPK and hence on rates of return on capital assets, which are influenced by capital stocks and hence saving rates. We submit that these are the primary explanations of G7 countries (in particular the U.S.) having persistent trade imbalances. We are not attempting to model short-term influences on trade imbalances and exchange rates such as changes in the terms of trade, economic shocks and fluctuations, commodity price increases, and changes in the production or consumption of oil in the U.S. (With the exception of this last influence, a good description of these short-term impacts on the U.S. trade balance is given by Obstfeld, 2025b.) We believe these short-term impacts could be modeled as being superimposed on top of the effects we are describing, but to most transparently demonstrate the effects of MPK, etc., we exclude them from the modeling process.

Consequently, in our models, we suppose that neither country has any comparative advantage in the production of any good. As a result, there is no "conventional" trade in the models. Goods flow in only one direction in order to transfer resources from one country to the other.

We assume that, prior to the start of the model, each economy can be represented by a separate Solow model on a steady growth path. Each country is assumed to have the same underlying steady growth rate so that, in a "capital autarky" condition, the higher saving rate of country B would cause its capital stock/GDP ratio to be persistently higher than that of country A and its interest rate to be persistently lower. However, when the prohibition on owning foreign assets is lifted, the Solow models are modified to allow for the effects of the transfer of capital between the two countries.

We assume that none of the existing capital stock of either country (buildings, infrastructure, factories, etc.) can be economically moved between countries. Consequently, the sizes of the capital stocks and the levels of the real interest rates in the two countries cannot adjust to new levels instantaneously. However, capital can be transferred from country B to country A by the establishment of a trade imbalance so that domestic investment can be less than domestic saving in country B and that domestic investment can be greater than domestic saving in country A. Consequently, interest rates and the depths of capital stocks in the two countries can converge.

In the models we present, the saving rate is an exogenous variable. This is (1) for simplicity, (2) because interest rates change only slowly in these long-run models, and (3) because countries' saving rates are heavily influenced by government deficits, which are a matter of political choice and hence exogenous to the model.[2]

**Model 1: A Model with Trade Frictions but No Financial Market Imperfections**

As already discussed, we assume that the criteria of there being no financial frictions includes agents having perfect foresight. With perfect foresight, there is no risk, and hence no distinction between risk-free assets and risky assets, as all assets are risk-free. There is a single interest rate, this being the rate of return on real capital. There is also no incentive to diversify, so that while investors in country B will

[2] In reality, however, saving rates will be endogenous, being influenced by (among other things) consumers' rate of time preference.

acquire assets in country A because they are higher yielding, investors in country A will not acquire any assets in country B.

We set out the full mathematical details of the model in the Appendix, but the key elements are as follows.

We assume the following parameters:

The output Y of each country is initially the same. Output is calculated according to the relationship

$Y= (AL)^{(1-\alpha)} K^{\alpha}$,

where AL denotes effective labor and K denotes capital.

Effective labor (AL) in both countries is assumed to grow at a constant rate of 3% per annum in all models.

The starting capital stock of country B is 3.5 times output, while the starting capital stock of country A is 2.5 times output.

The net (of depreciation) saving rate of country B is 10.5%, while that of country A is 7.5%, and they are assumed to remain constant. (These values would keep the capital stock/output ratios constant in an autarky condition.)

In both countries, α, real capital's share of output, is 0.175.[3] Consequently, the starting real interest rates $r_A$ (country A) and $r_B$ (country B) are 7% and 5%, respectively, which is where they would remain in an autarky condition.

Agents are assumed to have perfect foresight and to bid up the current exchange rate over the expected future exchange rate in the next period by the difference in the interest rates of the two countries. The UIP equation will apply so, to a linear approximation,

$$(Q_{(t)} - Q_{(t+1)}) = (r_{A(t)} - r_{B(t)})$$

Trade Balance

The trade surplus $S_t$ in period t of country B is assumed to be a linear function of the deviation of the exchange rate from PPP, the size of the output in country B, the real exchange rate $Q_t$ (which equals the amount of any good or real asset situated in country B required to purchase 1 unit of the same good or asset located in country A), and an elasticity E (defined as the change in the ratio of the trade imbalance to GDP that is caused by a percentage change in the real exchange rate $Q_t$). Hence,

$$S_t = E(Q_t - 1)\, Y_{B(t)}$$

When Q =1, the exchange rate will be at the PPP value, and the trade imbalance will be zero.

[3] This value of α may seem small compared to "profit's typical share of GDP," but profits include the results of monopoly power, branding, control of natural resources, etc. We are attempting to focus on stocks of tangible real capital. Similarly, the rates of return on real capital may appear relatively low for industrial capital, but we believe they are in the right ballpark if the returns on housing and commercial property are included.

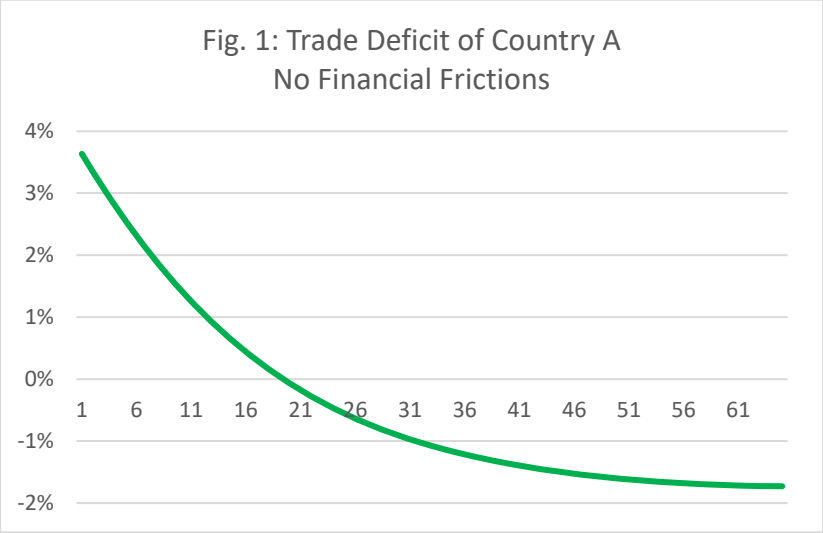
Capital Accumulation

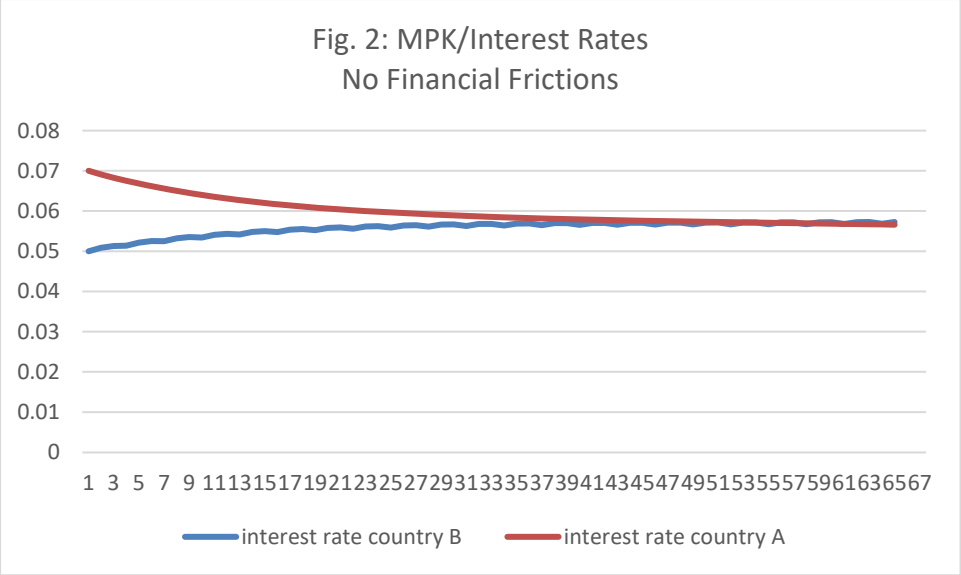
Agents in asset markets cause the real exchange rate to diverge from PPP because real assets located in country A are initially valued more highly than the same assets located in country B because of their higher expected future returns, hence initially Q is greater than 1. This causes country B to initially have a trade surplus, which means that it is transferring real capital to country A and that the residents of country B are accumulating ownership rights to a growing stock of real capital located in country A. The earnings on this stock of capital are initially also re-invested in country A. However, as time passes and the stock of capital in country A grows, the real exchange rate gradually falls until the trade balance reverses itself because eventually only a part of these foreign earnings is re-invested in country A and the remainder is returned to country B.

The mathematical details of the capital accumulation process, and the solution of these equations are given in the Appendix.

Results

With a value of E of 0.2, the model gives the following results:






Discussion

Model 1 is an idealized model that delivers a result that might be expected from generalized, basic economic theory. Market forces cause a transfer of capital from where it is scarce to where it is more abundant so that rates of return on capital are eventually equalized across countries. However, frictions in goods markets mean that this transfer of capital between counties happens only gradually. In this idealized model where agents have perfect foresight, the rate of capital transfer is optimized such that the sum of the gains from improved MPK less the losses due to frictional trade costs is optimized. Model 1 goes a long way toward explaining why interest rates are not rapidly equalized across countries and why countries can have persistent trade imbalances. If long-run interest rates are determined by MPK, they adjust only slowly because capital stocks and hence MPK adjust only slowly. (The "interest rate" in this model, MPK, is the rate of return on real capital and hence more closely corresponds in reality to the rate of return earned on the full spectrum of assets, including commercial and domestic property, industrial equipment, etc., as opposed to just the risk-free interest rate.) This model predicts that, in the long run, interest rates, which will equal MPK when there are no risk premiums, only gradually equalize and converge. We might contrast this with the Mundell-Fleming model, which supposes that in the absence of financial frictions, interest rates are instantly and permanently equalized across countries.

In this model, interest rates equalize only gradually because the rate of capital transfer between the two countries is inhibited by the costs caused by trade frictions. The linear relationship between the exchange rate and the trade imbalance assumed in the model implies that trade costs increase quadratically with trade volumes. This is because, as the trade imbalance increases, goods with increasingly large trade costs are transferred between the two countries. That is a reasonable reflection of reality – for example, Japan might achieve a modest trade surplus with the U.S. by exporting goods with relatively low trade costs such as televisions and electronic components. However, the U.S. has a limited capacity to absorb such goods, and a larger trade imbalance requires the transfer of goods with higher fractional trade costs such as steel, other basic materials, motor vehicles, etc., between the two countries. This in turn partly explains why trade deficits can be so persistent: because trade deficits are generally small compared to capital stocks, they must persist for a long time in order to have an appreciable impact on capital stocks and differences in MPK.

Model 1 is very closely related to Tobin's "Q" model. Tobin and Brainard (1977) put forward this model as a partial explanation of why the market value of a company's stock might deviate from the book value of its assets. According to Tobin, if real capital could be transferred instantaneously and without cost between companies, then with perfect competition, all companies would earn the same rate of return on capital, and they would all have a market value equal to the book value of their assets. If any shock caused the rate of return earned in any industry to exceed that in other industries, additional real assets would instantly be redeployed to that industry from other industries, causing rates of return to once again be equalized. However, in reality, the transfer of real capital into an industry involves real costs and delays. Tobin's model supposes that these costs increase quadratically with the rate of capital transfer. As a consequence, if a shock causes the rate of return on capital in a given industry to rise, real capital is transferred into that industry at only a limited rate. That results in this industry earning a rate of return on capital that is above the market rate for a prolonged period of time and in its rate of return returning only gradually to the market rate, even if there is perfect competition and perfect foresight after the shock. It also results in assets within the industry being valued more highly than similar assets outside the industry.

The analogy concerns similar effects arising from the real costs of transferring capital. In our Model 1, the frictional costs of transferring capital between countries prevents rates of return from rapidly equalizing across countries; in Tobin's model, they prevent rates of return from rapidly equalizing across industries. As a consequence, in our Model 1, assets located in the high interest rate country are initially valued more highly than identical assets located in the low interest rate country; in Tobin's model, assets installed in high-return industries have a higher value than similar assets installed in industries earning a lower return.

Our model also illustrates the concerns of those such as former United States Trade Representative Robert Lighthizer and American investor Warren Buffet. The accumulation of assets in country A by foreigners eventually causes the trade imbalance to reverse itself, as they predict it eventually will in the case of the U.S. However, because the trade imbalance in this model results in additional investment in country A, this foreign-owned capital does not impoverish the residents of country A, for the same reasons that are explained in the Super-simple model.

**A Comparison of the Outcomes of Model 1 with U.S. Trade Balance History**

As previously stated, our aims in this paper are to make the case that (a) trade deficits should be regarded as being the result of agents seeking to move their capital from where returns on capital are low to where it is high, (b) that we should regard returns on capital as being explained by MPK and hence capital stocks, and (c) that, over the long run, we should regard trade deficits as causing returns on capital to converge via their effects on capital stocks and hence MPK, rather than via their impacts on aggregate demand. To this end, we argue that our Model 1 provides a better basis for a general understanding of the long run behavior of the international economy than the Mundell-Fleming model.

We have also asserted that our Super-simplified Model, and our Model 1 provides a platform for understanding the causes and effects of the persistent U.S. trade deficit. However, if we are to suppose that country A is loosely equivalent to the U.S., there are still significant differences between actual long-run outcomes in the U.S. and the predictions of Model 1, which assumes perfect foresight and perfect competition. In particular,

Model 1 predicts much larger trade imbalances in the early years after exchange controls were lifted than were observed in reality in the U.S.

(a) Model 1 predicts that country A will initially have a trade deficit but that this will reverse itself after two decades or so and that it will then have a trade surplus as foreign investors repatriate their foreign earnings. Insofar as country A loosely corresponds to the U.S. and country B to Japan/Germany, this has not happened, and the U.S. continues to have substantial trade deficits, and Germany continues to have trade surpluses, some 50 years after exchange controls were lifted.

(b) As shown in Fig. 2 above, a model with trade frictions but perfect asset markets predicts that rates of return on real capital will nearly equalize over a small number of decades. Behind this is the result that capital stock/GDP ratios will converge. In reality, approximately 50 years after the general lifting of exchange controls, countries with high saving rates such as Japan and Germany still have significantly higher capital stock/GDP ratios than countries with lower saving rates such as the U.S. and the U.K., and apparently, these latter countries still have higher rates of return on real capital.

We acknowledge that, if our approach is to gain credibility, it is necessary to be able to explain the discrepancies between the predictions of our model and real-world outcomes, especially the longstanding U.S. trade deficit.

We believe that the discrepancies between actuality and the predictions of an idealized model predominantly arise because, in reality, agents do not have perfect foresight and because competition is not perfect.

Model 1 predicts that country A has high trade deficits in the first years after exchange controls are lifted because agents, with perfect foresight, recognize that this is consistent with a time path of trade deficits gradually declining, then reversing, over a time frame of decades and that rates of return on capital converge only gradually. However, in reality, agents in foreign exchange markets do not have such foresight. Instead, (a) it is possible that agents were influenced by the prevailing economic theory of the time that supposed that international financial markets would rapidly equalize interest rates across countries and so were inhibited from bidding up exchange rates because they thought that interest rate differences might not persist, (b) it is possible that agents were influenced by repeated warnings from economists that large "global (trade) imbalances" were "unsustainable," and (c) it is possible that agents were concerned that governments would intervene in foreign exchange markets or introduce tariffs or quotas if trade imbalances exceeded arbitrary levels because of the political difficulties large trade imbalances cause. These factors are likely to have inhibited agents from bidding up exchange rates to the levels predicted by a model that assumes perfect foresight and perfect competition, as a result of which trade imbalances have, in reality, been mostly restricted to more modest levels.

The reversal of the trade deficit happens in the model in part because of the large early trade deficits it predicts but mostly because the high rate of return earned by foreign capital in the model causes the stock of foreign owned capital in country A to grow relatively quickly. In the model with perfect foresight, there is no risk and therefore no risk premiums. All assets yield a return equal to MPK. Until the trade imbalance reverses itself, all the earnings of this foreign capital are re-invested in country A, so that the stock of foreign capital grows not only as a result of the trade deficit but also as a result of the re-investment of the earnings of this capital. When the point is reached at which the returns earned by this capital exceeds the rate at which residents of country B wish to add to the capital stock of country

A, the trade balance reverses itself, allowing first part, and eventually, all of these foreign earnings to be repatriated.

In the model, agents from country A own no assets in country B because, with perfect competition, there is no incentive for them to do so. They do not offer a higher return than domestic assets once expected exchange rate movements are taken into account. Thus, in the model, country B always has positive and growing net foreign earnings, as described above. Correspondingly, country A has negative foreign investment income – it is "paying interest" on the foreign-owned capital that has accumulated.

Returning to the U.S. trade deficit, our assumptions of agents only holding assets that yield MPK and perfect competition do not hold in the real world. Firstly, as discussed, the early trade deficits were not as large as our model with perfect foresight predicts. Secondly, as described at length by Obstfeld (2025b), despite the growth of its negative net international investment position to some 70% of GDP since the lifting of exchange controls, the U.S. nonetheless still has positive foreign investment income, averaging approximately 0.6% of GDP.

Obstfeld (2025b) explains this using two reasons. Firstly, foreign agents have bought not only high-yielding equities and property in the U.S. but have also bought significant quantities of assets that have near zero real returns, such as U.S. treasuries. This has depressed the average earnings of foreign-owned capital in the U.S. Secondly, agents in the US have accumulated a substantial quantity of foreign assets despite the U.S. net international position being significantly negative. U.S. investments abroad have been predominantly a mixture of foreign direct investment and equity investments, which have delivered relatively high returns. This is probably partly because competition is not perfect, as a result of which some U.S. corporations' operations abroad have had a degree of brand and monopoly power.

Other factors that are likely to have contributed to the U.S. trade deficit not yet reversing and expected U.S. returns on capital still not converging with Germany and Japan are (a) that the U.S. saving rate has declined in recent decades, driven by a growing federal deficit, and (b) that underlying U.S. economic growth has been higher than in these countries in recent years.

The assumption of agents having perfect foresight can be set aside, and these various effects can be incorporated into the model. We demonstrate some of these issues in a number of alternative models:

**Model 2: Incorporating Positive U.S. Foreign Investment Income**

If we continue to suppose country A is a loose proxy for the U.S., we can adjust the model to demonstrate the effect of the net foreign earnings of country A being positive instead of negative.

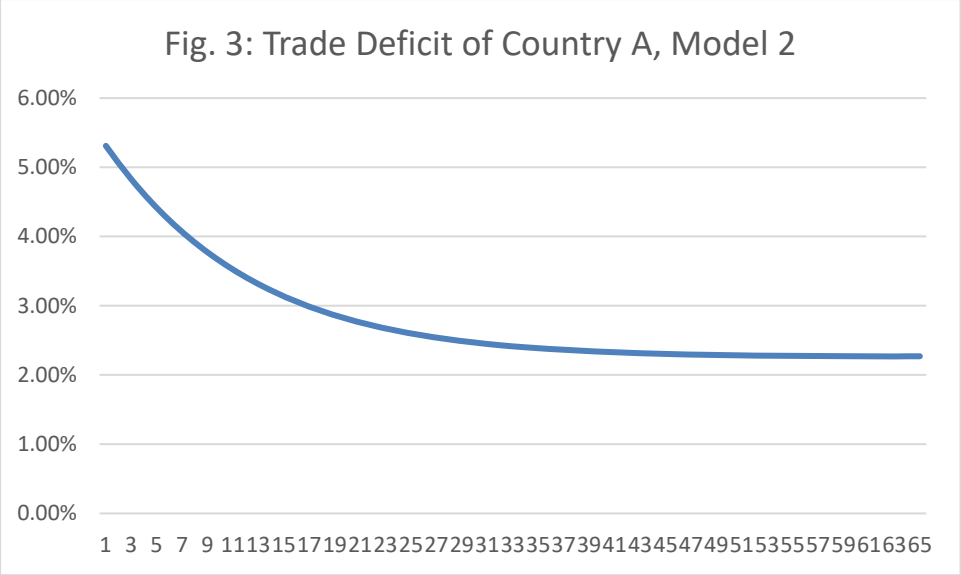
In Model 1, we assume that

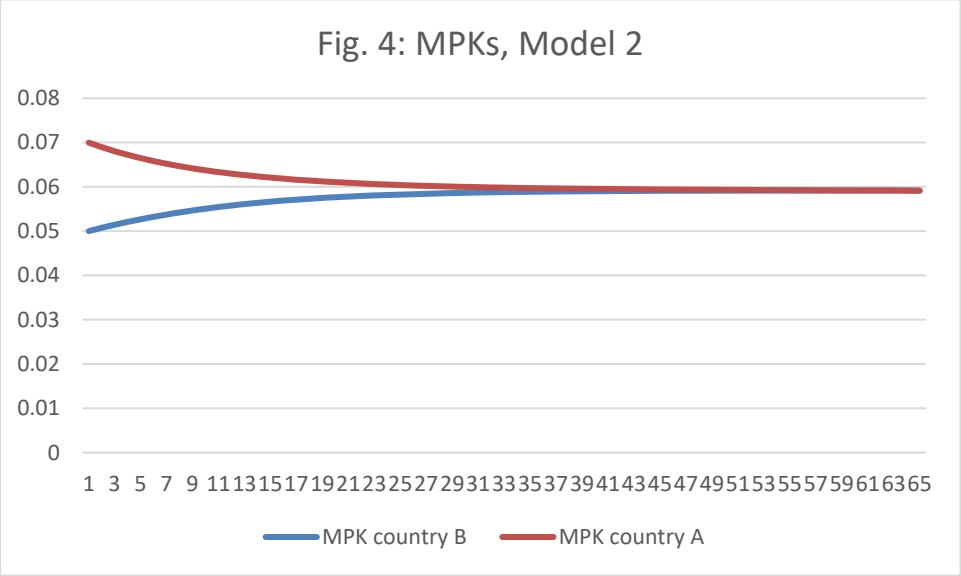
Growth in foreign owned capital in country A = trade deficit + MPK rate of interest on accumulated capital

In Model 2, we replace this by

Growth in foreign owned capital in country A = trade deficit – 0.6% x GDP country A

This yields the following results:



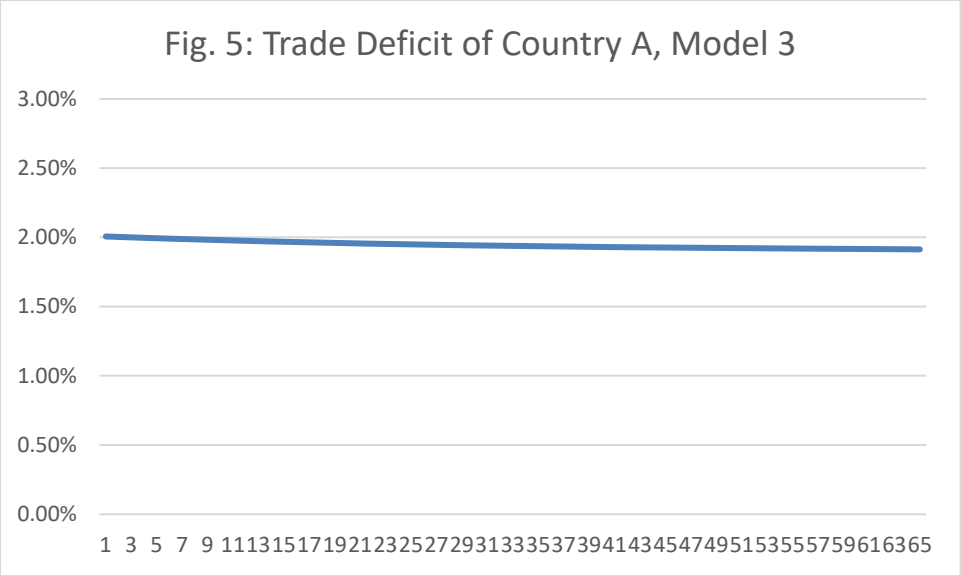



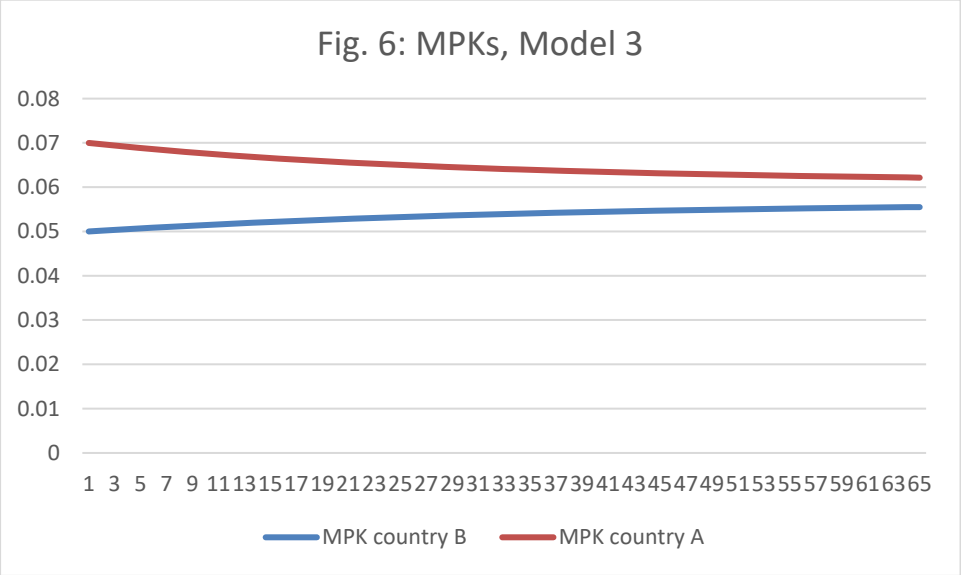

In terms of yielding results that cause the model to more closely resemble the historical experience of the U.S., this makes a significant improvement. The trade deficit does not reverse itself but continues indefinitely. However, differences in MPK and in capital stock/output ratios still converge more quickly than has been observed in reality.

**Model 3: Incorporating Positive U.S. Foreign Investment Income and Imperfect Foresight in the Foreign Exchange Market**

As discussed above, in reality, agents in the foreign exchange market do not have perfect foresight. We might suppose that, instead, they are not prepared to bid the exchange rate beyond levels that result in some arbitrary level of trade deficit in the medium term.

If we override the part of our model that supposes that the UIP equation holds and instead arbitrarily limit the average long-run trade imbalance to 2% of output, in addition to assuming an arbitrary U.S. net foreign income position as before, the model yields the following results:



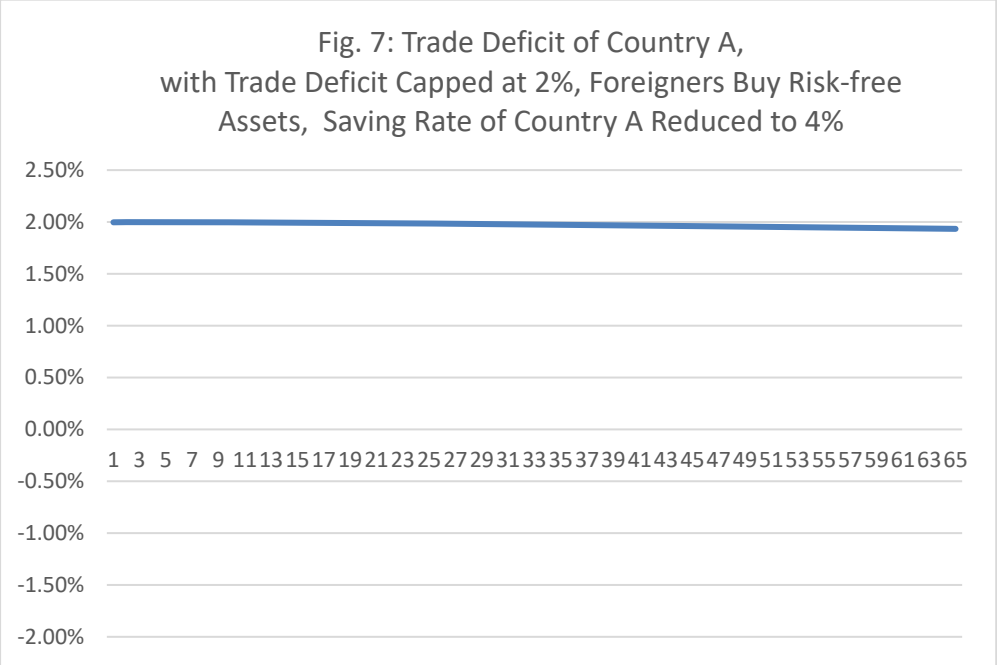



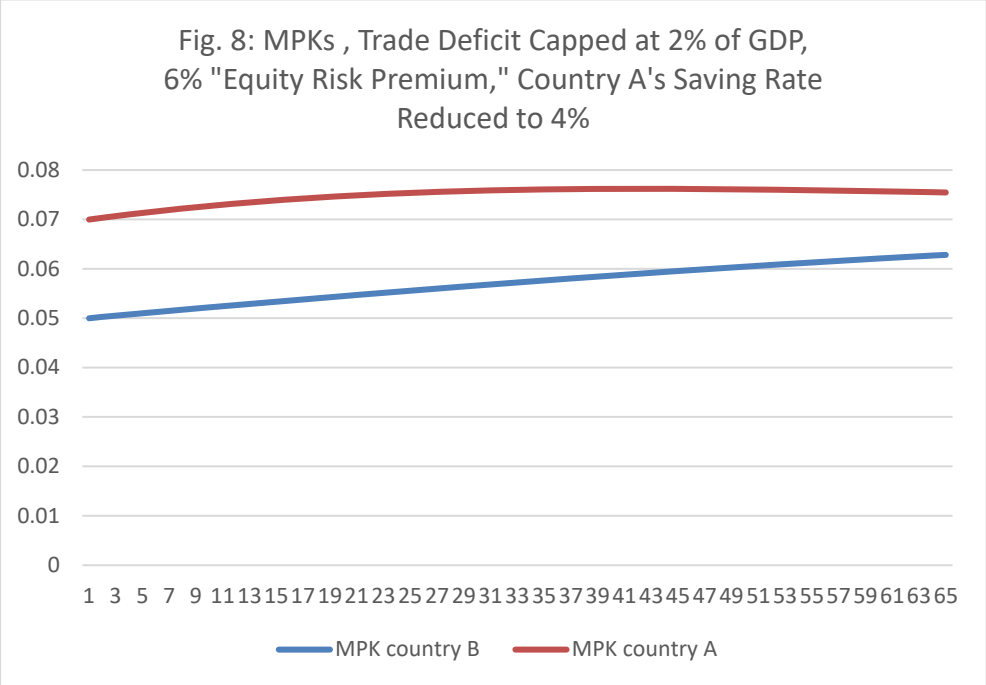

It can be seen that, qualitatively, the results of the model now correspond more closely to the historical experience of the U.S. in that (a) the early trade deficits are more realistic, (b) the trade deficit does not reverse itself, and (c) MPK in country A remains above that of its trading partners.

**Model 4: A Mixture of Parameters and Financial Market Imperfections to Give Outcomes That More Closely Correspond to the Experience of the U.S.**

In Model 4, we assume (a) that foreigners hold exclusively risk-free assets, which yield 6 percentage points less than MPK, (b) that the trade deficit of country A is capped at 2%, and (c) that country A's net (of depreciation) saving rate is reduced from 7.5% to 4%.

This gives the following results:




This third change has further pushed back the convergence of MPK's and capital stock/output ratios.

Discussion

We believe that the idealized Model 1 demonstrates our principal argument, that being that differences in MPK drive trade imbalances, which explains the persistence of such trade imbalances. We believe that the model fits the main stylized facts, these being the persistent U.S. and U.K. trade deficits and the persistent surpluses of Germany and Japan. The purpose of Models 2, 3, and 4 is to demonstrate that such an approach has the potential to even more accurately explain real world data, if its idealized assumptions are relaxed in favor of more realistic ones.

These latter models also suggest that a change in the U.S. net foreign investment position could relatively quickly cause the U.S. trade deficit to shrink and eventually reverse itself. If foreigners sold their holdings of U.S. treasuries and instead bought U.S. equities, companies, and property, their investment income might increase, shifting the path of parameters back closer to those shown in Model 1.

## 4. Understanding Real World Events and Implications for Policy

### 4.1. Implications for Trump Administration Concerns Regarding the U.S. Trade Deficit

In terms of the underlying cause of the U.S. trade deficit, an MPK modeling approach supports both the idea that the cause of the U.S. trade deficit is the relatively low level of U.S. saving and the fact that better investment opportunities are available in the U.S than in its trading partner countries. In the context of MPK, the relatively low level of saving in the U.S. keeps its MPK high. To put it another way, the low level of U.S. saving means that good investment opportunities are not used up so quickly, as a result of which investment returns in the U.S. remain high. The high investment returns result in a strong U.S. dollar and hence a U.S. trade deficit. Indeed, probably because of the large federal government deficits, U.S. saving is so low that the additional capital inflow from the rest of the world is only maintaining the U.S. capital stock/GDP ratio at its current level rather than causing it to increase. However, this does not negate the argument we are making regarding the impact of the trade deficit on the U.S. capital stock – the trade deficit causes the capital stock to be higher than it would otherwise be, given its level of saving. It is true, as some argue, that the U.S. would be wealthier in the future if it had a higher level of saving and did not rely on foreign capital to partly finance its investment. However, if the root cause of the low level of U.S. saving is the large federal government deficit, then the size of the federal government deficits should be regarded as the root cause of why the U.S. will not be as wealthy in the future as it might otherwise be; the trade deficit should more reasonably be regarded as a consequence of that low level of saving and the Federal government deficit.

### 4.2. Implications Regarding the Use of an "Industrial Policy" to Reduce Trade Deficits

The current U.K. Labour government expresses similar regret to the Trump Administration regarding the U.K. trade deficit in goods and the decline in U.K. manufacturing, even though it expresses this regret somewhat less forcefully and less emotionally. Rather than using tariffs, it is attempting to bolster the U.K. manufacturing sector via an "industrial strategy," which involves various mechanisms to subsidize chosen manufacturing sectors.

However, our methodology implies that the long-term cause of the decline of U.K. manufacturing has been the U.K.'s persistent trade deficit, which in turn has been caused by the U.K.'s persistent low level

of saving, consequent low level of investment, and consequent low level of the capital stock/GDP ratio. A tentative conclusion is that an industrial strategy that promotes one sector over another is unlikely to alter the overall size of the trade deficit as long as the low level of saving persists because the low level of saving is the root cause of the trade deficit. Our methodology suggests that, just as in the U.S., cutting the U.K. government deficit and hence increasing aggregate saving is more likely to reduce the trade deficit than an "industrial strategy."

### 4.3. Implications Regarding a Single Currency Area Such as the Eurozone

Although the models we have presented are framed in terms of countries having different currencies, the same processes should apply in a single currency area although the real exchange rate will then be "sticky" and adjust via changes in local price levels. Thus, we might regard events after the formation of the Euro as being to some extent reflected in the modeling processes we have described. The introduction of the Euro took away the foreign currency risk premium associated with investing in higher risk countries such as Spain, Portugal and Greece. German and French banks lent to these countries to finance additional investment, particularly in property. Additional demand caused price and wage levels to increase in these countries relative to Germany, and they developed large trade deficits vis-à-vis other Eurozone countries, especially Germany. Indeed, it is arguable that this was a rationale diversion of real capital to where it was expected to be most productive.

However, the financial crisis showed up a weakness of a single currency regime. When their property bubbles burst, Spain, Portugal and Greece were no longer the best places to which to divert capital. If they had had their own currencies, these would have devalued, and the flow of capital would have been diverted elsewhere. However, in the current single currency regime, they were unable to rapidly achieve a real devaluation and had to endure a period of disinflation to bring it about. They were also unable to refinance their banking systems. Consequently, it might perhaps be concluded that a convergence in inflation rates is an insufficient criterion for countries to successfully form a single currency area, and some criteria regarding convergence in MPK and high elasticities of trade balances to price levels might also be important.

## 5. Summary

The main point we wanted to make in this paper is that the existing models and descriptions of the transfer of capital between countries that are provided in international economics are inadequate. Commonly used models such as those of Mundell and Fleming (Mundell, 1963, and Fleming, 1962) and Dornbusch (Dornbusch, 1976) fail to explain the causes of, or the consequences of, persistent trade imbalances, and the common assumption that there is a world interest rate, r* at which all countries can theoretically lend or borrow is extremely misleading. Instead, we argue that the world should be seen as consisting of a number of regions, each of which has a particular rate of return on capital, which is a function of the local MPK.

We believe that such a modeling approach would take much of the heat out of the tariff debate and provide some light. Firstly, it demonstrates that the U.S. trade deficit might be regarded as the consequence of rational market forces diverting capital to where investment returns are highest, as opposed to being the result of the unfair trading practices of the U.S.'s trading partners. Secondly, it

also demonstrates that, while the U.S. trade deficit damages the U.S. manufacturing sector, it probably does not damage the U.S. economy as a whole and may well be beneficial to it. Thus, it provides a starting point for evaluating the likely impact of tariffs on the U.S.'s trade deficit and on the revenue that might be raised and for evaluating whether the benefits of tariffs are significant compared with the costs of tariffs (viz., the potential disruption of trade, the loss of the benefits of specialization and comparative advantage, and the hindrance of the efficient allocation of capital).

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## Appendix: Mathematical Details of Model 1

Consider a modeling framework for evaluating the long-run behavior of a world with two countries--country A and country B. The countries are assumed to use the same technology and produce the same range of goods with the same relative productivity so there is no comparative advantage. We assume that country B has a higher saving rate than country A and initially has a significantly higher capital stock/GDP ratio and consequently a lower real interest rate $r_B$ than the interest rate $r_A$ in country A. We assume that initially the two economies are the same size.

We assume that, prior to the start of the model, net capital transfers between the two countries were legally prohibited. We assume that, if this had continued, the long-run behavior of each economy could be represented by a separate Solow model on a steady growth path. The two countries are assumed to have the same underlying growth rate and thus, in a "capital autarky" condition, the higher saving rate of country B would cause its capital stock to GDP ratio to be persistently higher than that of country A and its interest rate to be persistently lower.

However, we assume that, at the beginning of the model, any legal restrictions preventing net transfers of capital between the two countries are lifted. Net transfers of capital can then occur between the two countries.

We assume that the existing capital stock of each country (buildings, infrastructure, factories, etc.) cannot economically be moved between countries. Consequently, the capital stocks and real interest rates of each country cannot change instantaneously. However, capital can be transferred from country B to country A by the establishment of a trade imbalance so that investment in country B can be less than domestic saving, and investment in country A investment can be greater than domestic saving. Consequently, the interest rates and the depths of the capital stocks in the two countries can converge. However, trade costs and imperfections in capital markets may, when included in the model, impede the net transfer of capital between countries.

The mechanism by which capital is transferred between the two countries is via a change in the real exchange rate. Initially, because agents prefer to hold the higher yielding assets in country A, the price of assets in country A (and hence the price of all goods in country A) rises above those in country B. In other words, the real exchange rate moves away from PPP. That, in turn, causes a trade imbalance between the countries, representing a net transfer of capital from country B to country A.

Output and Interest Rates

Output and interest rates are given as in a standard Solow model. Hence, in any time period t, the outputs of country A, $Y_{A(t)}$, country B, $Y_{B(t)}$, are given by

$$Y_{A(t)} = (AL_{A(t)})^{(1-\alpha)} (K_{A(t)})^{\alpha} \text{ and } Y_{B(t)} = (AL_{B(t)})^{(1-\alpha)} (K_{B(t)})^{\alpha} \qquad \text{(A1), (A2)}$$

where $AL_{At}$ and $AL_{Bt}$ are technologically enhanced labor in countries A and B in time period t, and

$K_{A(t)}$ and $K_{B(t)}$ are the quantities of capital in countries A and B in period t,

and $\alpha$ is capital's share of national income, presumed to be constant.

$Y_A$ , $Y_B$ , $K_A$ , $K_B$ are all real variables.

We assume that both countries have the same fixed rate of underlying growth, which we have chosen as 3%, so that:

$$AL_{A(t+1)} = 1.03\ AL_{A(t)} \text{ and } AL_{B(t+1)} = 1.03\ AL_{B(t)} \qquad \text{(A3, A4)}$$

The interest rates $r_{A(t)}$ and $r_{B(t)}$ in countries A and B, respectively, in period t are given by dY/dK. Hence,

$$r_{A(t)} = \alpha.\ Y_{A(t)} / K_{A(t)} \text{ and } r_{B(t)} = \alpha.\ Y_{B(t)} / K_{B(t)} \qquad \text{(A5), (A6).}$$

The capital stock of country B is wholly owned by the residents of country B throughout. However, the capital stock of country A must be considered in two parts—namely,

$K_{AA(t)}$, the capital stock in country A owned by residents of country A in time period t, and

$K_{AB(t)}$, the capital stock in country A owned by residents of country B in time period t.

Thus,

$$K_{A(t)} = K_{AB(t)} + K_{AA(t)} \qquad \text{(A7)}$$

At the start of the model, $K_{AB(1)} = 0$, but this changes as time progresses.

Real Exchange Rate

Identical assets located in the two countries do not have the same value. Because capital is scarcer in country A, a real asset there will earn a higher return than an identical asset located in country B. Consequently, initially, all assets (including stocks of consumption goods) located in country A have a higher value than identical assets located in country B because of their location.

The real exchange rate Q is the quantity of any asset/good located in country B that can be exchanged for 1 unit of the same asset/good located in country A. Therefore, initially Q is greater than 1.

With trade frictions but with perfect capital markets (perfect foresight, no risk premiums), the model functions as follows:

Agents are assumed to have perfect foresight and to bid $Q_{(t)}$, the exchange rate, above the future exchange rate in the next period by the difference in interest rates so that the uncovered interest parity (UIP) equation applies. Thus, to a linear approximation,

$$(Q_{(t)} - Q_{(t+1)}) = (r_{A(t)} - r_{Bt)}) \qquad \text{(A8)}$$

Re-arranging yields:

$$Q_{(t+1)} = Q_t - r_{A(t)} + r_{B(t)} \qquad \text{(A9)}$$

Trade Balance

The trade surplus $S_{(t)}$ in period t of country B is assumed to be a linear function of the deviation of the exchange rate from PPP, the size of output in country B, the real exchange rate $Q_t$, and an elasticity E, presumed to be constant. (E is the percentage of GDP by which the trade surplus changes for a percentage change in the real exchange rate Q.) Hence,

$$S_{(t)} = E.\ (Q_{(t)} - 1)\ .\ Y_{B(t)} \qquad \text{(A10)}$$

$S_{(t)}$ is the capital transferred out of country B in period t.

However, the capital that arrives in country A is less than this because of trade costs. Hence, capital that arrives in country B in period t because of this trade imbalance is $S_{(t)} / Q_{(t)}$.

The micro-foundation underlying this result is that it becomes profitable to export all goods from country B to country A whose trade costs (transfer costs between countries) are less than the difference in prices resulting from the exchange rate. These cease to be produced in country A, and additional production for export takes place in country B. The value of goods arriving in country A is less than the value of goods exported from country B, partly because of the trade costs and partly because they are sold at a reduced price in country A.

Incomes

The residents of country B accumulate assets in country A. Consequently, $I_{A(t)}$ and $I_{B(t)}$, the incomes of residents of countries A and B, respectively, in time period t are no longer given just by the outputs of the two countries but have to be adjusted by interest income and changes in the value of $K_{AB(t)}$, the stock of capital in country A owned by residents of country B.

The income of residents of country A is reduced by the interest on this capital. Hence,

$$I_{A(t)} = Y_{A(t)} - r_{A(t)} \text{ x } K_{AB(t)} \qquad \text{(A11)}$$

The income of residents of country B is adjusted by (a) the interest on this capital and also by (b) any gains/losses on this capital as a result of the change in the exchange rate. Both of these adjustments have to be multiplied by the real exchange rate because, from the perspective of residents of country B, goods and assets located in country A have a different value to identical goods and assets located in their own country. Hence,

$$I_{B(t)} = Y_{B(t)} + (r_{A(t)} \text{ x } K_{AB(t)}) \text{ x } Q_{(t)} - (Q_{(t)} - Q_{(t-1)}) \text{ x } K_{AB(t)} \text{ x } Q_{(t)} \qquad \text{(A12)}$$

Capital Accumulation

The saving rates of the two countries A and B are $s_A$ and $s_B$, respectively, which are assumed to be constant.

All of the saving of country A is invested in country A and thus is added to $K_{AA,}$.

Hence, the change in $K_{AA}$ in period t, $\Delta K_{AA(t)}$ is given by

$$\Delta K_{AA(t)} = s_A \text{ x } I_{A(t)} \text{ and hence} \qquad \text{(A13)}$$

$$K_{AA(t+1)} = K_{AA(t)} + \Delta K_{AA(t)} = K_{AA(t)} + s_A \text{ x } I_{A(t)} \qquad \text{(A14)}$$

where $I_{A(t)}$ is the income of the residents of country A, which is different to the output of country A, because some of country A's capital stock is owned by residents of country B, as explained above.

The change in the quantity of foreign-owned capital in country A in period t, $\Delta K_{AB(t)}$, is given by the interest on the existing stock of capital plus the additional capital brought into the country as the result of the trade imbalance. Hence,

$$\Delta K_{AB(t)} = r_{A(t)} \text{ x } K_{AB(t)} + S_{(t)} / Q_{(t)} \text{ and thus} \qquad \text{(A15)}$$

$$K_{AB(t+1)} = K_{AB(t)} + \Delta K_{AB(t)} = K_{AB(t)} + r_{A(t)} \times K_{AB(t)} + S_{(t)} / Q_{(t)} \quad \text{(A16)}$$

The additions to the capital stock in country B, $\Delta K_{B(t),}$ are given by the saving of country B less the amount that residents of country B invest in country A. From the perspective of residents of country B, the investments they make in country B are worth Q times their value in country A. Hence,

$$\Delta K_{B(t)} = s_B \times I_{B(t)} - (\Delta K_{AB(t)}) \times Q_{(t)} \quad \text{(A17)}$$

Solution of Equations

The above may look complicated, but all the above equations are doing is calculating the next period's value given the current period's values.

The constants of the model and the starting values for Y and K are all selected. The only unknown variable in the model is the appropriate starting exchange rate Q.

We have chosen values to give a model that corresponds very approximately to country B being Germany plus Japan, country A being the US, and supposing that there is no Rest of the World.

To give the outcome described in Figures 1 and 2, the constants and initial values of the variables were selected as follows:

The initial outputs of both countries are normalized to 1, so $Y_{A(1)} = 1$ and $Y_{B(1)} = 1$.

The initial capital stocks of the countries are chosen to be $K_{A(1)} = 3.5$ and $K_{B(1)} = 2.5$, chosen to correspond loosely to the capital stocks of the Germany/Japan and the US.

$\alpha = 0.175$, selected to yield an after-tax return on real capital of 5% in country A and 7% in B

$s_A = 10.5\%$ and $s_B = 7.5\%$, selected to yield constant interest rates with growth of 3% per annum if no net transfers of capital occur between the two countries.

Using these values, initial values of AL in both countries were calculated.

From that point, there is only one free variable—namely, the real exchange rate Q. For any given starting value of Q in the first period, the values of all of the variables in the second period can be calculated, including the value of Q itself in the second period. It then follows that the values of all of the variables including Q can be calculated in the third period, and so on. This is done easily using a spreadsheet.

There is only one starting value of Q that gives outcomes in terms of interest rates, capital stock ratios, etc. that converge to steady values. That value of Q is the path that agents with perfect foresight would foresee. (This is conceptually the same as the "saddle path" of the Dornbusch model (Dornbusch, 1976)). This path of Q results in returns from investing in either country being equal. Any value off the path would result in it being more profitable to invest in one country than the other, and it is assumed with perfect foresight arbitrage will force the exchange rate back to the "saddle path" value.

That value of Q is determined by informed trial and error, readjusting the value depending upon the observed long-run values of the variables until a value is found that causes them to converge.

Once this value of Q is established, so are the paths of all of the other variables.