US-China Rivalry: The Macro Policy Choices*

Rod TYERS

Business School
University of Western Australia
Research School of Economics
Centre for Applied Macroeconomic Analysis (CAMA)
Australian National University

Yixiao ZHOU

School of Economics and Finance
Curtin Business School
Curtin University

May 2019

Key words:
Trade policy, macroeconomic policy, general equilibrium analysis, numerical theory, China

JEL Codes:
F13, F41, F47

Author best contact details:
Rod Tyers
Winthrop Professor of Economics
UWA Business School
Crawley, WA 6009
Australia
rod.tyers@uwa.edu.au

* Thanks are due to Harry Bloch, Jane Golley and Warwick McKibbin for related discussions and suggestions and for comments at seminars at the UWA, Curtin University and the Australian Treasury.

US-China Rivalry: The Macro Policy Choices

Abstract

Stylized representations of recent US and Chinese tax reforms, tariffs against imports and alternative Chinese monetary targeting are examined using a calibrated global macro model that embodies both trade and financial interdependencies. For both countries, unilateral capital tax relief and bilateral tariffs are shown to be "beggar thy neighbor" in consequence with tariffs most advantageous for the US if revenue finances consumption tax relief. China is nonetheless a net loser when these policies are implemented unilaterally by the US, irrespective of its policy response, though a currency float is shown to cushion the effects on its GDP in the short run. Equilibria in normal form non-cooperative tariff games exhibit spill-overs that are substantial but insufficient to deter dominant strategies. The US imposes tariffs while China liberalizes, sustaining fiscal balance via consumption tax relief in the US and expenditure restraint in China.

1. Introduction

The dispute between China and the US over tariffs and exchange rate policy has been amongst the most notable of the large country economic conflicts in recent years.[1] While the trade dispute originated in 2018, accusations by the US government that China has protected its economy via "currency manipulation" go back decades. McKinnon (2006), notes the use of US broader bargaining power to place pressure on Japan in the 1980s, and subsequently on China, to appreciate their currencies against the US$.[2] The expectation that rapid economic expansion in China might deliver an appreciating currency stems in part from the Balassa-Samuelson hypothesis, which predicts that economies with rapidly expanding tradable sectors would experience strong wage growth, higher prices of little traded services and therefore real appreciations. This pattern was not borne out in the case of China because of the offsetting effects of trade reforms in the lead-up to its accession to the WTO and very high saving rates during its subsequent growth surge.[3]

[1] Other prominent trade conflicts underlie the recent renegotiation of North America Free Trade Area (NAFTA), European retaliation against surviving US steel and aluminium tariffs and a US threat to impose a 25% duty on motor vehicle imports from the EU, pending the outcome of continuing negotiations.

[2] This pressure was formalized under the US *Exchange Rates and International Economic Policy Coordination Act of 1988*, then directed at Japan. The stated intention by the Japanese government to accede to this pressure then precipitated a property boom and a bust from which the Japanese economy took decades to recover (Bayoumi 2001, McKinnon and Ohno 2001, Tyers 2012).

[3] See the analysis of both real and nominal exchange rate trends and policies in Tyers and Zhang (2011, 2014).

Following the failures of post-Uruguay Rounds of multinational negotiations, China's rapid development during the 2000s and the publication of its "Made in China 2025" plan (State Council, 2015), concern in the US refocused toward the race to dominate the global technological frontier. The intention of subsequent US policy developments has therefore been to secure US firms' market access and, at the same time, their intellectual property, as well as to combat special assistance rendered to state owned and otherwise favored Chinese firms (Office of the US Trade Representative 2018). One of the more superficial concerns to emerge has been with China's bilateral trade surplus. While bilateral imbalances have no particular economic significance they are seen by some as one indicator that the gains from trade are being manipulated to the advantage of one partner. Yet the China-US bilateral imbalance is significantly enhanced by China's role as an assembly point for wider Asian component manufacture, via recently emerging global value chains, leading to a mismatch between trade value and Chinese value added content.[4]

The imposed tariffs have been the most recently controversial of these and they impact economic performance in standard ways. First, they modify the domestic terms of trade to favor home firms, causing domestic consumers to shift expenditure, triggering entry and scale expansion at the expense of imports. This demand switch also appreciates the real exchange rate, tending to partially offset the inflationary force that stems from the higher post-tariff prices (Johnson 1953; Bagwelland Staiger, 1999; Ossa, 2011). Second, trade diversion occurs when unilateral protection restricts imports from one region but price incentives remain the same in others (Bouët and Laborde 2017, Dong and Walley 2012). Two key patterns emerge. First, the larger scale of the US economy is frequently dominant in that its new protection yields an "optimum tariff" effect that is only sometimes overcome by the negative effects of Chinese retaliation and associated contractions in the rest of the world. Second, China is virtually always the largest *proportional* loser from the conflict, suggesting that it has the most to gain from negotiating a resolution to the conflict.

In this paper we offer a broader examination of the macro and trade policy alternatives facing the US and China, which include rates of taxation on capital and other sources of income, the distribution of additional tariff revenue between spending and tax relief and, for China at least,

[4] See the now extensive literature from Athukorala (2011) to Koopman et al. (2014).

the option of a currency float and therefore a significant depreciation. To this end we apply stylized policy shocks to a six-region global macro model that captures international flows of claims over financial instruments as well as final and intermediate goods, along with their dependence on direct and indirect tax rates. Each region has three different households, with capital owners managing global portfolios of variably differentiated regional assets, and central banks that mostly target inflation, thus "anchoring" expectations over consumer prices. Two types of solutions are obtained, one under short run assumptions, with varying unemployment levels and fiscal deficits but fixed capital use, and another in which time is allowed for financial flows to redistribute productive capacity across countries, for labor markets to adjust and for fiscal balance to be retained via changes in tax rates or government expenditure.

At either length of run trade distortions alter the relativities between consumer, producer and GDP prices, wage rates and capital returns. Since all regions are characterized as "large", unilateral increases in protection by any one region can raise domestic "welfare" at the expense of other regions, though such protection can shrink output domestically and globally. We offer several policy scenarios to reflect alternative trajectories of the policy conflict, depending on the actions taken by the US and China. These include an assessment of the spill-overs from reforms affecting capital income tax rates in both economies, the effects of unilateral protection by the US against Chinese imports, bilateral liberalization and retaliatory protection by China, and a variety of fiscal responses to the associated changes in tariff revenue. And finally, we embed policy alternatives in normal form game structures in search of equilibrium outcomes.

Several conclusions emerge. First, income tax rates do yield significant spill-over effects at a length of run over which production capacity can adjust. But those effects are not strong enough to deter dominant strategies on both sides to reduce capital income tax rates, sustaining fiscal balance by raising tax rates on skill income. Second, while the unilateral imposition of tariffs by the US against China is not beneficial to its own economy in the short run, with time for capacity adjustment it is welfare improving. It raises real wages and real GDP but reduces these globally. These gains are not sustained for China when US tariffs are imposed, while they are for the US, albeit with some offset when China retaliates. Normal form tariff games yield equilibria in which the US imposes tariffs and China liberalizes.

Importantly, the experimental results described are carried out with a calibrated numerical model and so should be seen as helping to flesh out an economic narrative. Nonetheless, the results are more than illustrative, by virtue of the model's construction on data that is representative of the global economy. Section 2 of the paper offers some further background on the China-US economic rivalry while Section 3 takes the reader through the essential components of the model used. Section 5 presents results and Section 6 concludes.

2. Background

As its hegemonic power declines, and the cost of responsible leadership by the US over the global "rules based order" rises it is politically inclined to adopt more strategic economic policies.[5] These include both policies on corporate taxation as well as tariffs on trade. As these policies have emerged the government of China, the second largest and soon to be the largest global economy, has responded strategically with tax changes and tariffs of its own. A further option, previously resisted by the Chinese economy, is exchange rate flexibility.

2.1 Corporate taxation:

The fear of a global "race to the bottom" on the taxation of mobile capital income,[6] saw some justification in early 2018 with the passing of the Trump Administration's tax reform bill. This offered considerable concessions on the taxation of capital income, one stated objective of which was the return to the US of foreign activity by US multinational corporations. While the implications of the change of tax law are many and complex, for our purpose a crude approximation has it implying a reduction in the power of the effective tax rate on capital income of five per cent.

In the case of China, according to Ministry of Finance (2019), existing preferential policies for small and low-profit enterprises are to be applied to a wider range of companies. Previously, companies with annual taxable income below RMB 1 million (US$147,290) per year enjoyed a preferential corporate income tax (CIT) rate of 20 percent on half their income, with the other

[5] The substance of the "rules based order" is detailed by Chatham House (2015).
[6] Key contributions to this substantial literature are by Tiebout (1956), Oats (1972), Bretchger and Hettich (2002) and Fuest et al. (2003), which embody debate about the role of migration between taxing regions. In our modelling results to follow the pure race to the bottom result of Oats emerges because migration is not allowed.

half tax-free. Such companies can now enjoy the same preferential CIT rate of 20 percent but will only be taxed on 25 per cent of their income, with the remaining 75 percent tax-free. In addition, companies with taxable income from RMB 1 to 3 million (US$147,290 to 441,870) now enjoy the preferential 20 percent CIT rate on half their income, with the other half tax-free. According to the government, the preferential CIT rates now apply to 95 per cent of corporate taxpayers and lower the total tax burden for qualified enterprises by five to 10 per cent. We characterize this change of tax policy as also being an approximate five per cent reduction in the power of income tax on capital income.

2.2 Tariffs on trade

The recent China-US tariff conflict stems primarily from the implicit threat to returns from US R&D perceived as emerging from China's drive to upgrade the sophistication of its manufacturing sector, as embodied in "Made in China 2025" (State Council, 2015). Related to this is the set of hangovers from the Uruguay Round of trade negotiations and the conditions under which China originally acceded to the WTO, which grant concessions over trade, investment and intellectual property protection in both goods and services sectors and which are seen to unfairly advantage the now more modern Chinese economy. In addition, there are the much discussed downsides from widely beneficial globalization, primarily in the form of poor labor market performance by the low-skilled and hence income inequality, which the surge of Chinese growth in the 2000s exacerbated. The global richest one per cent captured 27 per cent of the total income growth since 1980, two times more than the bottom half of adults, who together captured 12 per cent (Alvaredo et al., 2017). Clearly there are factors affecting low-skill performance that go beyond increased global competition between Chinese and other low-skill workers, including labor-saving technical change, the rise of the intangible capital market, and a trend toward industrial oligopolization.[7]

The associated change in the global pattern of international trade that has seen outsourcing of stages of production and the rise of "value chains" has tended to cause a mismatch between the

[7] There is a long literature on the roles of Asian finance and trade in labour market performance in advanced economies, with recent contributions including Pierce and Schott (2012), Autor et al. (2013), Arora et al. (2015), Acemoglu et al. (2016) and Tyers (2015b, 2016). Labor-saving technical change is addressed by an equally large literature, from which Acemoglu and Restrepo (2017) is a recent example. Intangible capital is examined by Koh et al. (2016) and oligopolization by Moazed and Johnson (2014) and Ezrachi and Stucke (2016).

balances of trade and value added content that give the superficial impression of unjust behavior. The consequences of trade conflicts that lead to tariffs on imports are therefore less obvious than prior to the development of these value chains. In analyzing these, we therefore distinguish carefully between intermediate inputs and final goods in production and in the matrix of trade flows.

At the same time catch-up by the transitional economies is seeing a convergence between the patterns of their exports and those of the advanced economies. The mix of China's exports across manufacturing classes has converged rapidly on that of exports from the US, Europe and Japan, so that now these regions and China export both light (labor intensive) and heavy manufacturing. The share of light manufactures in China's exports has fallen in recent decades as it approaches that in the exports of the advanced economies. The major emerging difference is the rise in the share of services in US exports, to about a third today, while China's exports of services remain below a tenth. Since traded services tend to be intensive in skill, the convergence of China's trade pattern lags in this respect due to temporary differences in skill endowment, combined with strategic interventions that protect Chinese services.[8] While this suggests some residual scope for Heckscher-Ohlin-Samuelson forces to drive trade between the US and China, the broad pattern of manufacturing trade is approaching the intra-industry structure that exists between the advanced regions. In our modelling, therefore, we separate intermediates from final goods but do not account for the residual effects of the remaining differences in factor intensities and endowments across tradable industries.

2.3 Chinese exchange rate management

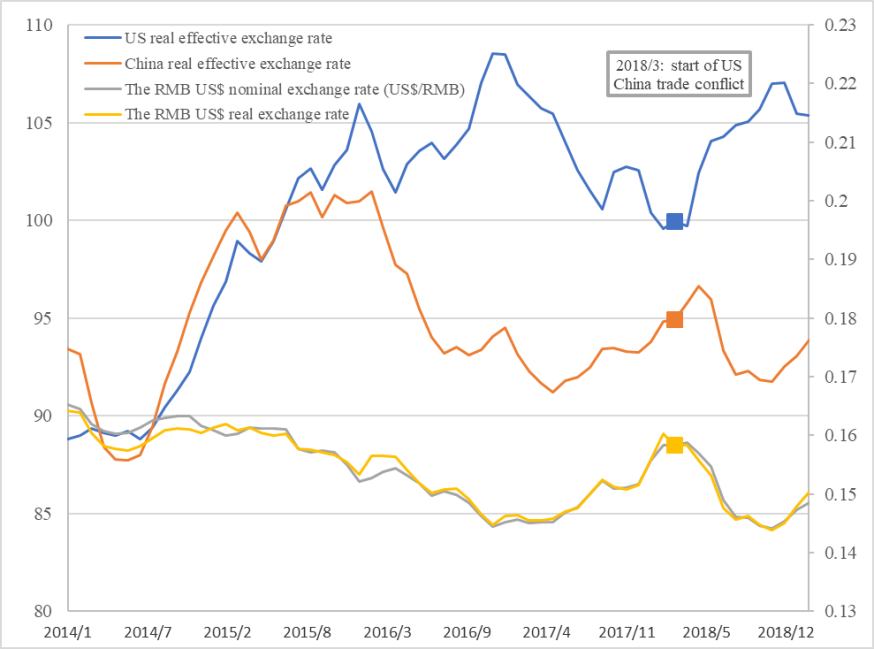
Although China's rigid, though informal, peg against the US$ was relaxed in 2005, the rate has been closely regulated since. China's special relative openness to trade is one reason for this but there has also long been sensitivity to the accusations of "currency manipulation".[9] While the bilateral real and nominal exchange rates have both been stable in recent years, as Figure 1

[8] High levels of protection of services, including banking and utilities, have been found elsewhere to reduce overall productivity growth. The liberalization of these sectors in the 1990s in many advanced economies spurred subsequent growth (Nicoletti and Scarpeta 2003, Griffiths and Harrison 2004, OECD 2007).

[9] The American literature critical of China's macroeconomic policies is also extensive. Bernanke (2005, 2011) offers the outline and Krugman (2010) declares that "China is making all of us poorer". The US macroeconomic position is put in more detail by, amongst others, Lardy (2006, 2012) and Bergsten et al. (2008). Similar advocacy of policy-induced "balance" in China's growth can be found, still more formally, in Blanchard and Giavazzi (2006), while it is also recognized that some of the US reaction is mercantilist (Ito 2009).

attests, changes in the direction of China's trade have seen its real effective exchange rate depreciate relative to that of the US since mid-2015. Since the tariff conflict began in 2018 there has been a depreciating trend in the RMB against the US$ and in the corresponding real rate. The question arises, then, as to the potential for exchange rate flexibility to assist China to ride out the terms of trade shocks that are due to US tariff imposition.

Figure 1: Real and Nominal Exchange Rate Movements



Source: Federal Reserve Bank of St. Louis FRED Database. US real effective exchange rate is from "Real Effective Exchange Rates Based on Manufacturing Consumer Price Index for US, Index 2015=100, monthly, not seasonally adjusted". China real effective exchange rate is from "Real Effective Exchange Rates Based on Manufacturing Consumer Price Index for China, Index 2015=100, Monthly, Not Seasonally Adjusted". The RMB US$ nominal exchange rate (US$/RMB) is the "China / U.S. Foreign Exchange Rate, U.S. Dollar to One RMB, Monthly, Not Seasonally Adjusted". The RMB US$ real exchange rate is calculated as the product of the RMB US$ nominal exchange rate and the ratio of consumer price index in China (Index 2005=100) and consumer price index in the U.S. (Index 2005-100).

3. Essential Elements of the Modelling

To provide an ex-ante assessment of the potential impacts of the current economic conflict, we employ a multi-region general-equilibrium model to simulate prospective combinations of tax concessions and increased bilateral tariffs with macro policy adjustments. Much of the structure of this model is conventional and consigned to an appendix. Here we describe those elements of it that are essential to the analysis of the macro dimensions of a trade conflict. These include

production from both primary factors and intermediate inputs, endogenous consumption, saving decisions and associated financial and trade flows that are sensitive to tax instruments, as well as central banks and money stocks that allow us, most particularly, to represent China's choice of monetary target.

Six regions are identified, namely the US, the EU, Japan, China, Australia and the Rest of the World.[10] The EU is modeled as the full 28 and it is assumed that this collective has a single inflation targeting central bank. In each region there are three households, each with factor-specific income (from low skill labor, skilled labor and physical capital) and each with different reduced form consumption behavior that depends on the regional real interest rate and the levels of current and expected future real disposable income.

Production and intermediates

Each region supplies a single product that is differentiated from the products of the other regions and this product is both consumed directly and used as an intermediate input at home and abroad. Regional production depends on the three primary factors: low-skill labor, skilled labor and physical capital, and the use of tradable intermediate goods. Amongst the three primary factors, low-skill labor is a partially unemployed variable factor while skilled labor and physical capital are fully employed.

The production technology has output depending on "relative" factor and input use, so that the gross output volume of region i, y_i, is a Cobb-Douglas composite of real value added, v_i, and of intermediates, q_i.

$$(1) \qquad \frac{y_i}{y_i^0} = \left(\frac{A_i^Y}{A_i^{Y0}}\right)\left(\frac{v_i}{v_i^0}\right)^{\beta_i^V}\left(\frac{q_i}{q_i^0}\right)^{\left(1-\beta_i^V\right)}, \forall i, i \in (regions),$$

where A^Y is total (factor and input) productivity. Value added, in turn, has Cobb-Douglas dependence on domestic primary factors, raw labor, L, skill, S^K and physical capital, K.

$$(2) \qquad \frac{v_i}{v_i^0} = \left(\frac{A_i^V}{A_i^{V0}}\right)\left(\frac{L_i}{L_i^0}\right)^{\beta_i^L}\left(\frac{S_i^K}{S_i^{K0}}\right)^{\beta_i^S}\left(\frac{K_i}{K_i^0}\right)^{\beta_i^K}, \sum_f \beta_i^f = 1, \forall i, f \in (factors).$$

[10] The model is a developmental blend of the two developed for Tyers (2015a b, 2016), Tyers and Zhou (2017) and Zhou and Tyers (2017).

To allow for inter-regional substitution in intermediate demand across regional sources, domestically employed intermediate inputs, *q*, are a CES composite of products acquired from all regions:

$$(3) \qquad q_i = \left(\sum_j \alpha_{ij}^Q q_{ij}^{-\theta_i^Q} \right)^{-\frac{1}{\theta_i^Q}}, \ \forall i \ ,$$

where q_{ij} is the quantity of region *j*'s product that is absorbed by production in region *i*.

The composite prices of value added and intermediate inputs from (1) are related via:

$$(4) \qquad \frac{P_i^V}{P_i^P} = \beta_i^V \frac{y_i}{v_i}, \quad \frac{P_i^Q}{P_i^P} = \left(1 - \beta_i^V\right) \frac{y_i}{q_i}, \ \forall i \quad .$$

Here P_i^P is the producer price level – the factory gate price of region *i*'s product, P_i^V is the price of value added and P_i^Q is the price of a composite of home and imported intermediate inputs. The real production wages of unskilled and skilled workers and the capital rental rate depend conventionally on the corresponding marginal products.

The gross volume of output, *y*, is distinguished from real GDP, which is that portion of output that meets final demand, thus excluding intermediate use, and which equates to real value added, *v* in (1). The complete set of demands facing country *i*'s industries, which must sum to equate with (1), takes the form:

$$(5) \qquad y_i = \frac{I_i + G_i}{P_i^P} + \sum_j c_{ji} + \sum_j q_{ji} \ ,$$

which is a real version of the standard expenditure identity (on the homogeneous domestic output of region *i*) with intermediate demand included. *I* and *G* are nominal gross investment and nominal government spending on goods and services (net of transfers), c_{ji} is the volume of final consumption of region *i*'s product in region *j*, and q_{ji} is the volume of region *i*'s product that is absorbed as intermediate inputs by production in region *j*. Net trade is embodied in the second and third terms and real GDP omits the final term. Equating this with (1) determines producer price levels, P^P, in each region. Producer cost minimization at these prices then determines all the unit factor rewards.

Income and consumption

Disposable income, for each household, is net of separate taxes on primary factor income and gross of transfers, taking the form:

$$(6) \qquad \begin{aligned} Y_{hi}^{D} = s_{hi}^{L}\left[\left(1-t_i^{L}\right)W_i L_i + \alpha_i W_i^{o}\left(F_i - L_i\right)\right] + s_{hi}^{S}\left(1-t_i^{S}\right)W_i^{S} S_i^{K} \\ + s_{hi}^{K}\left(1-t_i^{K}\right)K_i\left(P_i^{P}\, MP_i^{K} - P_i^{K}\,\delta_i\right) + T_{hi}^{R}\,, \quad \forall h \end{aligned},$$

where s_{hi}^{f} is the ownership share of household *h* in region *i* of factor *f*. $[\, s_{hi}^{f}\,]$ is a unit diagonal matrix in this analysis since households are defined by their source of factor income.[11] K_i is the regional capital stock, F_i is the labor force, W_i is the nominal low-skill wage rate, W_i^{S} is the corresponding skilled wage and t_i^{f} is the direct tax rate on income to factor *f*. P_i^{K} is the price of capital goods in region *i* and δ_i is the corresponding depreciation rate. $T_h^{R} = t_h^{R} N_h Y$ is a direct transfer to the household from government revenue, with t_h^{R} the transfer rate to household *h* per unit of group population, N_h, and per unit of nominal GDP.[12]

For each household, *h*, in region *i*, consumption expenditure, C_{hi}, is a nominal sum but real consumption behaviour is motivated by current and expected future real, per capita, disposable incomes and the real interest rate. Real consumption, (lower case) c_{hi}, depends negatively on the after-tax real return on savings (the home bond yield, *r*) and positively on both current and expected future real disposable income per capita for that household:

$$(7) \qquad c_{hi} = \frac{C_{hi}}{P_i^{C}} = N_i^{h} A_{hi}^{C} \left(\frac{r_i}{\tau_i^{h}}\right)^{-\varepsilon_{hi}^{CR}} \left(\frac{Y_{hi}^{D}}{N_i^{h} P_i^{C}}\right)^{\varepsilon_{hi}^{CY}} \left(\frac{Y_{hi}^{De}}{N_i^{h} P_i^{C}\left[1+\pi_{hi}^{Ce}\right]}\right)^{\varepsilon_{hi}^{CY}},$$

where the tax rate on interest income, τ^{h}, is household specific, set as the tax rate on the household's dominant source of direct factor income. The expected inflation rate of the consumer price level is π^{Ce}. The elasticities in this expression vary by household, ensuring different consumption responses.

[11] Mixed sources of factor income are included in earlier single country studies by Tyers and Zhou (2017) and Zhou and Tyers (2018). At the global level empirical evidence is not sufficient to construct factor income matrices for all represented regions.

[12] The expression (6) is more complex if the households have multiple sources of factor income and labor force participation rates of low skill workers are unequal across households or if participation rates of skilled workers are unequal across households.

Consumption driven trade and pricing

To capture the home household's substitution between home and foreign products, real aggregate consumption in region *i* is a CES composite of region *i*'s consumption of products from all regions:

$$(8) \qquad c_i = \left(\sum_j \alpha_{ij}^C c_{ij}^{-\theta_i^C} \right)^{-\frac{1}{\theta_i^C}}$$

The home household then chooses its mix of consumed products to minimize consumption expenditure in a way that accounts for home consumption and trade taxes, foreign export taxes, differing foreign product prices and exchange rates:

$$(9) \qquad C_i = P_i^C c_i = P_i^P \tau_i^C c_{ii} + \sum_{j \neq i} \tau_i^C \tau_i^M \tau_j^X c_{ij} P_j^P \frac{E_j}{E_i} \ ,$$

where τ_i^C is the power of region *i*'s consumption tax, τ_i^M is the power of its average import tariff on consumption goods, τ_j^X is the power of the average export tax in the region of origin, *j*, and E_i and E_j are the nominal exchange rates of regions *i* and *j* relative to the US $, measured as US$ per unit of home currency.[13] Optimum consumption is consistent with an elasticity of substitution between home and foreign products of $\sigma_i^C = 1/\left(1+\theta_i^C\right)$. Given these consumption volumes, the composite price of all consumption, or the consumer price level, emerges as:

$$(10) \qquad P_i^C = \tau_i^C \left[\left(\alpha_{ii}^C\right)^{\sigma_i^C} \left(P_i^P\right)^{1-\sigma_i^C} + \tau_i^M \sum_{j \neq i} \left(\alpha_{ij}^C\right)^{\sigma_i^C} \left\{ \frac{P_j^P E_j}{E_i} \right\}^{1-\sigma_i^C} \right]^{\frac{1}{1-\sigma_i^C}} .$$

Intermediate input demand driven trade and pricing

To capture region *i*'s home firms' substitution between intermediate inputs sourced from home and abroad, real aggregate input use, q_i, is a CES composite of intermediate demands for products from all regions (3). Home firms then choose their mix of intermediate products to

[13] The US$ is the numeraire in the model, so $E_{US}=1$.

minimise expenditure on such intermediates, V_i^Q , in a way that accounts for home indirect tax rates, foreign export taxes and differing foreign product prices and exchange rates:

$$(11) \qquad V_i^Q = P_i^Q q_i = P_i^P y_i - P_i^V v_i = P_i^P q_{ii} + \sum_{j \neq i} \tau_i^M \tau_j^X q_{ij} P_j^P \frac{E_j}{E_i} ,$$

Where the composite price of intermediate inputs is P^Q. Consumption taxes are not levied on intermediate input use. Optimum intermediate use is consistent with an elasticity of substitution between home and foreign products of $\sigma_i^Q = 1/\left(1+\theta_i^Q\right)$. The corresponding derived demands are then:

$$(12) \qquad q_{ii} = \left(\alpha_{ii}^Q\right)^{\sigma_i^Q} \frac{V_i^Q}{P_i^Q} \left[\frac{P_i^P}{P_i^Q}\right]^{-\sigma_i^Q} , \quad q_{ij} = \left(\alpha_{ij}^Q\right)^{\sigma_i^Q} \frac{V_i^Q}{P_i^Q} \left[\frac{\tau_i^M P_j^P \left(E_j/E_i\right)}{P_i^Q}\right]^{-\sigma_i^Q} , i \neq j \ .$$

Given these volumes, the composite price of all intermediates in region *i*, $\hat{P}_i^Q$, emerges from the combination of (3) and (11) as:

$$(13) \qquad P_i^Q = \frac{1}{A_i^Q} \left[\left(\alpha_{ii}^Q\right)^{\sigma_i^Q} \left(P_i^P\right)^{1-\sigma_i^Q} + \tau_i^M \sum_{j \neq i} \left(\alpha_{ij}^Q\right)^{\sigma_i^Q} \left\{\frac{P_j^P E_j}{E_i}\right\}^{1-\sigma_i^Q} \right]^{\frac{1}{1-\sigma_i^Q}} .$$

International finance

The global financial capital market is central to effective modelling of the global economy. Here it is assumed that the financial products of each region are differentiated and that portfolio managers assign new net saving across regions so as to maximise expected portfolio returns given this differentiation. Although there is a tendency for financial flows to move the global economy toward uncovered interest parity, in the length of run considered asset differentiation leaves this process incomplete. Expected rates of return generally depart from regional bond yields, the latter reflecting short run equilibria in regional financial markets, as between savers, indebted governments and investors. We offer some detail on this behaviour below since it is strongly influenced by capital income tax rates, which feature prominently in our analysis.

Each region's financial market is represented as the market for domestic long maturity assets. These behave like equity, in the sense that income from them is assumed to be taxed after depreciation, even though they include government debt issued to a level that depends on fiscal policy as well as both debt and equity issued by domestic investors. Purchasers of these assets are assumed to respond to changes in an expected rate of return on installed domestic capital, r^{ce}, which is net of depreciation and capital tax and adjusted for sovereign risk. This rate of return has a number of components. First, since only the after-depreciation component of capital income is taxed, nominal capital income after tax for region *i* is:

$$(14) \qquad Y_i^{KN} = \left(1 - t_i^K\right) K_i \left(P_i^P MP_i^K - P_i^K \delta_i\right),$$

where P^P, first defined earlier, is the producer price of the regional product and P^K is the price of capital goods.[14] The ad-valorem tax rate, t^K, is here defined as the rate applied to income from financial assets, including both debt and equity, and δ is the depreciation rate of physical capital. The marginal physical product of capital, $MP^K = MP^K(K)$, is a declining function of the regional capital stock, derived from (1) and (2). The regional real rate of return net of both tax and depreciation is then:[15]

$$(15) \qquad r_i^C = \frac{Y_i^{KN}}{P_i^K K_i} - \delta_i = \left(1 - t_i^K\right)\left(\frac{P_i^P MP_i^K\left(K\right)}{P_i^K} - \delta_i\right) - \delta_i \ .$$

To obtain the expected future value of this rate, it first adjusted by a sovereign risk factor and then embedded in an uncovered interest parity condition, here operating in real terms:

$$(16) \qquad r_i^{ce} = r_i^c \left(\frac{\varphi_i^0}{\varphi_i}\right) + \hat{e}_i^e \ ,$$

where $\hat{e}^e$ is the exogenous, expected proportional change in the *real* exchange rate and the interest premium factor, φ , permits consideration of the effects of changes in the fiscal balance on sovereign risk. A deteriorating fiscal balance causes investment to be less attractive. For this

[14] In this single product model the product and capital goods prices are separated by a single parameter: $P^K = \gamma P^P$. This allows shocks to represent the relative cheapening of capital goods over time as their information technology content rises.

[15] This is a real rate of return because it depends on the real volumes, MP^K and *K*, adjusted only by the ratio of P^P and P^K. It is therefore impervious to common inflation. Note also that the additional depreciation term arises because of the assumption that depreciation is generally deductible from capital income for tax purposes.

reason, a further adjustment is made using an interest premium factor, φ_i, that is defined relative to the US ($\varphi_{US} = 1$). This permits consideration of the effects of changes in sovereign risk in association with the fiscal balance. Increments to regional sovereign risk, relative to the US, cause investments in regions with increasing fiscal deficits to be less attractive.

$$(17) \qquad \varphi_i = \varphi_i^0 \left[\left(\frac{G_i}{T_i} \Big/ \frac{G_{US}}{T_{US}} \right) \right]^{\phi_i}, \quad \forall i \neq "US",$$

where ϕ is a positive elasticity indicating sensitivity to sovereign risk, *G* is government expenditure net of transfers, *T* is gross government revenue also net of transfers, and the zero superscripts indicate initial values.

The domestic demand for investment financing then depends on the ratio of the expected real rate of return on installed capital, r^{ce}, which is defined as after capital income tax, and the after tax real long bond yield that clears the domestic financial market, *r*. Since the numerator indicates the market value of domestic assets and the denominator the cost of financing their replacement, this is in the tradition of Tobin's Q. Accordingly, since firms do not incur tax when issuing stock or bonds, no taxation is applied in the denominator.

$$(18) \qquad \frac{I_i^D / P_i^K}{I_i^0 / P_i^{K0}} = \left[\left(\frac{r_i^{ce}}{r_i} \right) \Big/ \left(\frac{r_i^{ce0}}{r_i^0} \right) \right]^{\varepsilon_i^I},$$

where ε^I is a positive elasticity and the zero superscripts indicate initial values. Since investment demand, I^D, is defined as nominal, it is adjusted by the capital goods price. The yield ratio deviates from unity not only because income from new investments is taxed after depreciation, but also due to the regional differentiation of assets. In part, this differentiation reflects the fact that, at short to medium lengths of run, the economy is not in a financial steady state.

This investment demand is then matched in each region by a supply of saving that incorporates contributions from all regional households. Here the modelling incorporates explicit portfolios of assets from all regions. Data on regional saving and investment is first combined with that on international financial flows to construct an initial matrix to allocate total domestic saving in

each region to investment across all the regions. From this is derived a corresponding matrix of initial shares of region *i*'s net (private and government) saving that are allocated to the local savings supply that finances investment in region *j*, i_{ij}^{S0}. When the model is shocked, the new shares are calculated so as to favour investment in regions, *j*, whose real yields are boosted by the shock. Since these are portfolio investments, the real rate of return available in each region is assumed to be the domestic market clearing yield, *r*.

Region *i*'s portfolio manager allocates the proportion i_{ij}^{S} of its annual (private plus government) saving to new investments in regions j, such that $\sum_j i_{ij}^{S} = 1$.[16] Because the newly issued equity is differentiated across regions based on un-modelled and unobserved region-specific properties, their services are combined via a constant elasticity of substitution (CES) function specific to each regional portfolio manager. Thus, region i's household portfolio management problem is to choose the shares, i_{ij}^{S}, of its private saving net of any government deficit, $S_i^D = S_i^P + T^D + T^I - G$, which are to be allocated to the assets of region j so as to maximise a CES composite representing the value of the services yielded by these assets:

$$(19) \qquad \max_{i_{ij}^S} U_i^F = S_i^D \left[\sum_j \alpha_{ij} (i_{ij}^S)^{-\rho_i} \right]^{-\frac{1}{\rho_i}} \text{ such that } \sum_j i_{ij}^S = 1.$$

Here α_{ij} is a parameter that indicates the benefit to flow from region *i*'s investment in region *j*. The CES parameter, ρ_i, reflects the preparedness of region *i*'s household to substitute between the assets it holds. To induce rebalancing in response to changes in rates of return the α_{ij} are made dependent on ratios of after-tax yields in destination regions, *j*, and the home region, *i*, via:[17]

[16] The manager does not re-optimise over total holdings every year. This is because the model is deterministic and risk is incorporated only via exogenous premia. The motivations for continuous short run rebalancing, other than the arrival of new saving, are therefore not represented.

[17] Note that region *i*'s market bond yield, r_i, is determined concurrently and indicates the replacement cost of capital in region *i* and therefore the opportunity cost for region *i*'s household of investment in region *j*.

$$\alpha_{ij} = \beta_{ij}\left[\frac{r_j\left(1-t_j^K\right)}{r_i\left(1-t_i^K\right)}\right]^{\lambda_i} \quad \forall i, j, \quad \lambda_i > 0 \quad \forall i \ . \tag{20}$$

Here, t_i^K is the rate of capital income tax rate in region *i*. This relationship indicates the responsiveness of portfolio preferences to yields, via the (return chasing) elasticity λ_i. The allocation problem, thus augmented, is:

$$\max_{i_{ij}^S} U_i^F = S_i^D\left[\sum_j \beta_{ij}\left[\frac{r_j\left(1-t_j^K\right)}{r_i\left(1-t_i^K\right)}\right]^{\lambda_i}(i_{ij}^S)^{-\rho_i}\right]^{-\frac{1}{\rho_i}} \text{ such that } \sum_j i_{ij}^S = 1. \tag{21}$$

Solving for the first order conditions we have, for region i's investments in regions *j* and *k*:

$$\frac{i_{ij}^S}{i_{ik}^S} = \left(\frac{\beta_{ij}}{\beta_{ik}}\right)^{\frac{1}{1+\rho_i}}\left[\frac{r_j\left(1-t_j^K\right)}{r_k\left(1-t_k^K\right)}\right]^{\frac{\lambda_i}{1+\rho_i}} \ . \tag{22}$$

This reveals that region i's elasticity of substitution between the bonds of different regions is $\sigma_i^I = \lambda_i/(1+\rho_i) > 0$, which has two elements. The return-chasing behaviour of region *i*'s household (λ_i) and the imperfect substitutability of regional bonds, and therefore the sluggishness of portfolio rebalancing (ρ_i). For the purposes of this analysis the values of σ_i^I are seen as indicating the extent of each region's integration with global financial markets.

The optimal share of the net domestic saving of region *i* that is allocated to assets in region *j* then follows from (22) and the normalisation condition, that $\sum_k i_{ik}^S = 1$.

$$i_{ij}^S = \frac{1}{\sum_k\left(\frac{\beta_{ik}}{\beta_{ij}}\right)^{\frac{\sigma_i^I}{\lambda_i}}\left[\frac{r_j\left(1-t_j^K\right)}{r_i\left(1-t_i^K\right)}\right]^{\sigma_i^I}} \ . \tag{23}$$

Regional money

This has two main sources of demand the first being the conventional "cash in advance" constraint applying across the whole of GDP and the second is its contribution to the liquid share

of the collective private portfolio, where it is held in combination with regionally differentiated long maturity bonds (claims over physical capital and government debt across the regions). The latter accounts for the observed dominance of financial transactions over money demand in recent decades.[18] Since portfolios are dominated by long maturity assets, the opportunity cost of holding money is the long bond yield, which is modelled as emerging from equilibrium in a thus weakly segmented global market for loanable funds. Central banks derive monetary expansions in regionally specific proportions from conventional monetary policy and from UMP, with reliance on the market segmentation theory of the yield curve (Johnson et al. 2010) to ensure that conventional monetary policy has no direct impact on the market for long term bonds. Short rates are therefore not modelled explicitly, rather the monetary base in each region is determined as endogenous to the target of monetary policy and an exogenous parameter determines the share of any change in the monetary base that takes the form of long asset balance sheet expansion. UMP expansions raise home long maturity asset prices and lower long yields, causing imperfect spill-overs across regions due to global arbitrage that is only partially constrained by asset differentiation.

More formally, the three determinants of the demand for real money balances are first, the cash-in-advance constraint, which applies across all components of regional gross (including intermediate) output and so is represented by y_i. Second, portfolio demand is driven by the real purchasing power of financial wealth. And, third, the opportunity cost of holding home money is set at the nominal after-tax yield on home long term bonds.[19] Real money balances are measured in terms of purchasing power over home products at the GDP price, P^Y.

$$(24) \qquad m_i^D = a_i^{MD} \left(y_i\right)^{\varepsilon_i^{MY}} \left(w_i^F\right)^{\varepsilon_i^{MW}} \left(\frac{r_i\left(1+\pi_i^e\right)}{\tau_i^K}\right)^{-\varepsilon_i^{MR}} = \frac{M_i^S}{P_i^Y} = \frac{\mu_i M_i^B}{P_i^Y}.$$

Real financial wealth is w_i^F, τ_i^K is the power of the capital income tax rate in region *i* and π_i^e is the expected inflation rate of the consumer price level, P^C, defined as a CES aggregate of home

[18] The inclusion of financial wealth as a driver of real money demand follows Ragot (2014) and Mena and Tirelli (2017), who incorporate Baumol (1952) – Tobin (1956) behaviour.

[19] Short rates, at least as they have a role in conventional monetary policy, are here embedded in the determination of the monetary base. While housing investment can be sensitive to short rates in economies where most mortgage contracts have variable rates, the assumption that investment financing depends on the long maturity market is a simplifying abstraction in this global analysis.

and imported consumer prices. Real financial wealth or assets, w^F, is represented as the present value of an infinite stream of real dividends that are equal to after-tax returns on the capital stock, at the expected real rate of return on installed capital, r^{ce}, discounted at the current real financing rate, r. A price adjustment is also made for relative inflation or deflation of capital goods prices, which raise or lower the purchasing power of financial wealth over home products.[20]

$$(25) \qquad w_i^F = \frac{r_i^{ce}\left(1-t_i^K\right)\left(P_i^K / P_i^Y\right)K}{r_i} \ .$$

Regional financial market clearance requires that the home financial market in each region clears separately and this implies global financial market clearance. For region i, the nominal value of domestic investment, I_i^D, represents the sum total of all domestic long bond issues. This is then equated with demand for those bonds from home and foreign (net private and government) savings, along with demands for home long bonds that arise from the "quantitative easing" components of monetary expansions by both home and foreign central banks.

Global financial balance

Financial balance then requires that total investment spending in region i, in i's local currency, is equated with the total supply of financing directed from all represented regions:

$$(26) \qquad I_i^D = \sum_j \left(\left[i_{ji}^S S_j^D + \theta_{ji}^{QE} s_j^{QE} \Delta M_j^B \right] \frac{E_j}{E_i} \right), \quad \forall i \ ,$$

Where i_{ji}^S is the endogenous share of region j's domestic total (private and government) saving, S_j^D, that is directed to assets in region i. E_i is the nominal exchange rate of region i relative to the US$. The "quantitative easing" share of the current period's expansion of the monetary base

[20] On the supply side of the money market, the proportion of expansions that occur via the purchase of long maturity assets (UMP) is parameterised. Conventional expansions directly affect the money supply while UMP expansions affect both it and the long end of the yield curve. UMP expansions raise home long maturity asset prices and lower long yields, causing imperfect spill-overs due to global arbitrage that is only partially constrained by asset differentiation. By contrast, conventional monetary policy involves trade in short term instruments which has no direct, immediate impact on the market for long term bonds, which are major components of the global portfolio. Short rates are therefore not modelled explicitly, rather the monetary base in each region is determined as endogenous to the target of monetary policy and an exogenous parameter determines the share of any change in the monetary base that takes the form of long asset balance sheet expansion.

by region *j*'s central bank, s_j^{QE}, and the share of this expansion that takes the form of acquisitions of region *i*'s long bonds, θ_{ji}^{QE}, both determine central bank demand. These flows are originally in foreign currency and are therefore converted at the appropriate cross rates. The regional real bond yields (interest rates, r_j) emerge from this equality. Their convergence across regions is larger the larger are the elasticities of asset substitution, σ_j^I.[21]

The balance of payments condition requires that the sum of net inflows of payments on the current account and net inflows on the capital and financial accounts, measured in a single (home) currency is zero:

$$(27) \qquad X_i - M_i + \sum_{j \neq i} \left(\left[i_{ji}^S S_j^D + \theta_{ji}^{QE} s_j^{QE} \Delta M_j^B \right] \frac{E_j}{E_i} \right) - \sum_{j \neq i} \left(i_{ij}^S S_i^D + \theta_{ij}^{QE} s_i^{QE} \Delta M_i^B \right) = 0, \quad \forall i \neq "US"$$

The first terms are nominal values of exports and imports (formulated in the appendix) while the second two terms are financial inflows and outflows. The first parenthesised term represents acquisitions of region *i*'s home-issued long bonds by foreign savers and by foreign central banks, the latter associated, as above, with the "quantitative easing" component of the current period's expansions of the monetary bases across regions. These net saving and central bank flows are originally in foreign currency and so are converted at the appropriate cross rates. The second parenthesised term represents acquisitions of foreign-issued long bonds by region *i*'s home savers and its own central bank. A balance of payments in the US is implied by balance in all the other regions. These equations determine the nominal exchange rates. Since these are defined relative to the US$, that for the US is always unity $\left(E_{US} = 1\right)$, though nominal and real effective exchange rates are also calculated.

Economic welfare

In calculating an aggregate welfare measure we add the real purchasing power of disposable income to that of government expenditure on goods and services, the latter signifying the supply of public goods. The public goods are then considered to be available on an equal per capita

[21] This elasticity is central to the characterization in the model of the global financial market in which economies have varying degrees of integration. Emphasis is given to this parameter by Tyers and Zhou (2019b). The representation of global financial markets is described in full in the accompanying appendix.

bases to all three households, irrespective of income. For household *h* in region *i*, economic welfare is then:

$$(28) \qquad W_{hi}^{E} = \left[Y_{hi}^{D} + \left(N_i^h / \sum_{h}^{H} N_i^h \right) G_i^X \right] / P_i^C, \quad \forall\, h \in (Lh, Sh, Kh).$$

Expectations

These are formed over regional consumer prices. All economies are modelled in zero growth steady states and, generally, central banks set monetary policies to adjust monetary bases so that there are no changes to consumer price indices. All households anticipate no change in consumer price levels.

Calibration

The model database is built on national accounts, international trade and financial data for the global economy in 2016. The relative sizes of the four major economic regions, the US, the EU, Japan and China indicate that China's economy (even measured without PPP adjustment) is not the smallest of them and it matches the largest in investment, exports[22] and saving. The structures of the regional economies differ in important ways. The US has a high consumption share of GDP, China a low one. Necessarily, then, the US has a low saving share while China has a high one. Some regions are more dependent on indirect taxes than others, which makes a difference to the proportion of GDP made up of factor cost and hence the size of the household budget and the gap between producer and GDP prices. The EU and China are relatively dependent on indirect taxes, for example. Since these taxes fall most heavily on consumption, changes in saving behaviour have strong implications for fiscal deficits and, indirectly, for interest premia, which are endogenous to the scale of fiscal deficits relative to GDP levels. Investment is larger in some than in others, being extraordinarily high in China. And then, of course there are the fiscal deficits that are largest in the EU and Japan, and the current account surpluses or capital-financial account deficits in Japan and China, at least partly funding the substantial deficit in the US. Other elements of the model database and analytical structure are available in an accompanying appendix.

[22] EU exports, for this comparison, are net of intra-EU trade.

4. Strategic Effects of Trade and Tax Policy Changes

While the tariffs imposed by the US on imports from China represent the first blows in the current trade battle, the global spill-overs due to the prior implementation of the 2018 US tax reforms turn out to be of magnitude similar to the tariffs. The anticipated potential for a global "race to the bottom" is evident from the simulation results, which are presented in the next sub-section. Yet the macroeconomics of the subsequent tariff changes are counterintuitive and require some elaboration. In particular, we highlight in the sub-section to follow the dependence in this model of protection effects on the targets of monetary policy and on fiscal policy as it drives fiscal balance and the mix of taxes that support government revenue. In further sub-sections we detail the effects of US unilateral protection, the Chinese response and the strategic interaction between the US and China over trade and bilateral tariffs.

Throughout, experiments are conducted at two lengths of run. In the short run employment is flexible and capital stocks are fixed. Nominal government spending on goods and services is fixed and so fiscal deficits are endogenous. In the long run fiscal balance is retained and the capital stock (or capacity) can adjust around the world so as to restore the initial values of the expected rate of return on installed capital net of depreciation and tax, so employment is fixed but capital use is variable. Initial differences across regions in the expected net rate of return on installed capital are assumed to be associated with risk considerations not endogenous in the model. Following a policy shock the model solves for an equilibrium in which these differences are restored by capital stock adjustments that are consistent in direction with changes in real investment.

4.1 Reduced Capital Taxation as Strategy

Since changes in tax rates progress slowly through most countries' policy formation processes, they are here considered only under long run conditions, which means they drive changes in expected rates of return that are eventually arbitraged by the redistribution investment and capital accumulation across regions. Spill-overs are therefore significant and, even though these policy changes are not in any way directed at individual partner countries, we wonder if there is a strategic game over capital taxation between China and the US. To observe this we simulate the bilateral effects of capital tax reforms in both countries, in combination with alternative fiscal responses to reduced capital taxation and, in China the choice to continue to peg or to float its

exchange rate. Central to these long run simulations is that labor markets clear in all regions to the same extent as in 2016 and that fiscal deficits are retained at the same level as in 2016. In each case the reductions in the power of capital income tax are five per cent in both China and the US and four possible policy objectives are explored: aggregate welfare (approximately the purchasing power of national income at home consumer prices), real GDP, low income household welfare and capital owner welfare. The results for aggregate welfare and real GDP are presented in Table 2 and for sectional welfare in Table 3.

Table 2:
Long Run Normal Form Capital Tax Games on Aggregate Welfare and Real GDP[a]

Criterion: [China, US] Welfare, % change				US Actions							
				None		Cut TauK with fiscal option					
						Reduce spending		Raise consn tax		Raise skill tax	
Chinese actions				China	US	China	US	China	US	China	US
	None		Peg	0.000	0.000	-0.061	0.742	-1.129	-1.222	-0.283	0.829
			Float	0.000	0.000	-0.075	0.767	-1.250	-0.801	-0.315	0.894
	Cut TauK	Reduce spending	Peg	1.881	0.037	1.815	0.779	0.739	-1.178	1.591	0.865
			Float	1.851	0.086	1.771	0.854	0.581	-0.692	1.527	0.981
		Raise consn tax	Peg	-1.174	0.092	-1.294	0.838	-3.000	-1.080	-1.623	0.926
			Float	-1.139	-0.501	-1.271	0.253	-3.076	-1.553	-1.632	0.370
		Raise skill tax	Peg	2.463	-0.011	2.406	0.730	1.439	-1.254	2.200	0.815
			Float	2.462	-0.009	2.386	0.756	1.237	-0.828	2.151	0.882

Criterion: [China, US] GDP, % change				US Actions							
				None		Cut TauK with fiscal option					
						Reduce spending		Raise consn tax		Raise skill tax	
Chinese actions				China	US	China	US	China	US	China	US
	None		Peg	0.000	0.000	-0.112	0.678	-1.860	-0.686	-0.400	0.723
			Float	0.000	0.000	-0.025	0.687	-0.635	-0.500	-0.161	0.747
	Cut TauK	Reduce spending	Peg	1.975	0.014	1.858	0.692	0.089	-0.667	1.566	0.737
			Float	2.154	0.032	2.126	0.719	1.508	-0.451	1.988	0.779
		Raise consn tax	Peg	1.545	0.034	1.418	0.713	-0.427	-0.623	1.113	0.759
			Float	-0.621	-0.185	-0.690	0.498	-1.817	-0.834	-0.926	0.555
		Raise skill tax	Peg	0.352	-0.022	2.420	0.674	0.747	-0.701	2.145	0.718
			Float	0.085	-0.047	2.509	0.684	1.921	-0.512	2.378	0.743

a Spending changes refer to government spending on goods and services only, seen as the provision of public goods that have constant per capita impact across all households.
Source: Simulations of the model described in the text.

Both aggregate welfare and real GDP maximization yield a single dominant strategy for the US, which is to reduce capital tax while sustaining fiscal balance via an increase in the taxation of skilled wage income. Irrespective of China's actions, for the US to reduce government spending

on goods and services comes a close second but this sacrifices the provision of public goods as per (28). For China the dominant strategy in the welfare game is the same as for the US, while retaining its US$ peg. This changes if the objective is to maximize real GDP, however. While it remains optimal for China to reduce capital taxation, in the absence of tax reform in the US it is optimal to reduce government spending for fiscal balance and to float the exchange rate. Once the US cuts capital tax China's best response is raise tax rates on skill income and to float its currency.

Table 3:
Long Run Normal Form Capital Tax Games on Low-skill and Capital-Owner Welfare[a]

Criterion: [China, US] Low income welfare, % change (Rawlsian game)				**US Actions**							
				None		Cut TauK with fiscal option					
						Reduce spending		Raise consn tax		Raise skill tax	
Chinese actions				China	US	China	US	China	US	China	US
	None		Peg	0.000	0.000	-0.056	-0.947	-1.027	-1.799	-0.264	0.664
			Float	0.000	0.000	-0.078	-0.923	-1.271	-1.432	-0.321	0.716
	Cut TauK	Reduce spending	Peg	-1.084	0.036	-1.142	-0.911	-2.084	-1.761	-1.346	0.693
			Float	-1.132	0.086	-1.214	-0.837	-2.386	-1.337	-1.453	0.783
		Raise consn tax	Peg	-2.895	0.093	-2.987	-0.853	-4.318	-1.674	-3.256	0.741
			Float	-2.445	-0.502	-2.560	-1.428	-4.122	-2.087	-2.872	0.307
		Raise skill tax	Peg	0.352	-0.022	1.896	-0.959	1.574	-1.827	1.795	0.653
			Float	0.085	-0.047	1.849	-0.934	0.996	-1.456	1.674	0.706

Criterion: [China, US] capital owner welfare, % change				**US Actions**							
				None		Cut TauK with fiscal option					
						Reduce spending		Raise consn tax		Raise skill tax	
Chinese actions				China	US	China	US	China	US	China	US
	None		Peg	0.000	0.000	-0.068	4.289	-1.266	0.812	-0.307	4.616
			Float	0.000	0.000	-0.070	4.314	-1.223	1.310	-0.307	4.681
	Cut TauK	Reduce spending	Peg	6.064	0.037	5.987	4.327	4.728	0.863	5.736	4.653
			Float	6.059	0.086	5.981	4.404	4.766	1.439	5.730	4.768
		Raise consn tax	Peg	1.323	0.092	1.166	4.387	-1.050	0.979	0.754	4.713
			Float	0.797	-0.500	0.641	3.784	-1.494	0.419	0.214	4.157
		Raise skill tax	Peg	7.056	-0.010	6.897	4.277	5.815	0.773	6.675	4.603
			Float	6.959	-0.009	6.887	4.304	5.746	1.278	6.652	4.670

a Spending changes refer to government spending on goods and services only, seen as the provision of public goods that have constant per capita impact across all households.
Source: Simulations of the model described in the text.

If we imagine a more socialistic government with Rawlsian criteria the game is only slightly different, as indicated in Table 3. Then China has a dominant strategy to increase taxes on the skilled while retaining its US$ peg. Not surprisingly, when the criterion is the welfare of capital-owning households, the dominant strategies and the equilibrium are exactly the same. There is, in effect, an alliance between the very wealthy and the working class, which parallels the political patterns under "populist" democratic regimes, including that of the US.

4.2 Macro Tariff Stories

To aid intuition about the effects of tariff changes in this model it is useful to examine their effects in general terms before observing experimental outcomes. Tariff changes act through their effects on revenue and on the price levels represented in the model. The consumer price, P^C , is the weighted average of the home producer price and the domestic currency price of foreign goods, which is boosted by the power of the tariff, $\tau_M = (1+t_M)$, where t_M is the average ad valorem tariff rate on imports. Of course, P^C is further boosted by the power of the consumption tax, $\tau_C = (1+t_C)$, where again, t_C is the ad valorem rate. While it is more complex in the model due to its constant elasticity of substitution (CES) price index and the separation of intermediates from final goods, we can usefully simplify Equation (10) to:

$$(29) \qquad P^C = \tau_C \left[\alpha_H P^P + (1-\alpha_H)\left(\frac{\tau^M P^*}{E} \right) \right],$$

where α_H is the home product share of consumption, P^* is the landed foreign currency price of foreign goods and E is the nominal exchange rate expressed as the purchasing power of the home currency over others.

An increase in the home tariff on imports raises the second term in the square parentheses. This is the expected rise in the home prices of foreign goods, relative to the home producer price of home goods, P^P. It induces the desired substitution in consumption toward home goods. Because the protagonist's central bank targets consumer price inflation and we are making comparative static shocks, we equate inflation to price level targeting. The (short) policy rate is adjusted so as to change the money supply to keep P^C constant in local dollars per unit of

volume. With the second term rising, a monetary tightening is required to sustain the equality in (29) and this causes the nominal producer price level, P^P, to fall.

Of course, this primary effect is opposed in the model (and in reality) by a real (and, with price level targeting, therefore also a nominal) exchange rate appreciation ($E\uparrow$) and a rise in the share of the home product that is consumed ($\alpha_H \uparrow$), but these do not reverse the direction of price effects. This is counterintuitive because we expect that the protection is implemented to create a price incentive to raise home production, arising from a switch in domestic demand as home consumers substitute away from imports toward home products. Indeed, this switch does occur, but the producer price level would only rise if the protagonist's monetary policy were to break the P^C inflation anchor and implement a surprise expansion, and this could only be effective in the short run.[23]

The effect of protection in other regions on free trading, inflation targeting economies is also evident from (29). Then the second term in parentheses still rises, because their currencies depreciate. So inflation targeters have contracting producer price levels as do the protecting economies. In the case of China, where we initially assume some information inefficiency, so that consumer price expectations are set at zero while the nominal exchange rate is the principal target of monetary policy, the second term in parentheses falls only slightly. This is because the increase in protection abroad raises global supply and reduces international trading prices, causing a decline in P^*, as represented in (29). But China's *real* exchange rate must depreciate in response to the foreign protection, since that protection switches demand away from Chinese goods toward those that are protected. Its fixed nominal exchange rate then requires a deflation of all its price levels, including its consumer price, P^C, and for the above reason to a lesser extent, its nominal producer price, P^P. For China, then, both sides of (29) decline in response to US unilateral protection. Importantly, for China this undesirable development can be avoided by floating its currency, though as we shall see the advantage this confers is limited to effects on real GDP and not welfare defined more generally.

[23] In the case of US unilateral protection against China alone, in the short run P^C inflation of a per cent or so would be sufficient to prevent real GDP decline. But even this would affect the credibility of the anchor and could prove difficult in any case due to the very low policy rates prevailing in advanced economies.

In the short run nominal wages are rigid in all regions, as is the level of capital use and government spending on goods and services, while nominal government spending is fixed and tax revenue is endogenous at fixed rates, so that fiscal balance is not sustained. Following the implementation of the tariff, firms face no change in unit labor costs but a cut to revenue and so they reduce employment. Output therefore falls, as does welfare more generally. In free trading partner economies producer prices also deflate, with consequences that are similar as to direction. The long run is different in three ways. First, nominal wages are flexible and unemployment rates remain constant. Second, expected rates of return on investment net of depreciation and capital income tax are sustained while regional capital stocks adjust and, third, all regions retain their initial nominal fiscal imbalances, allowing adjustment via either nominal government expenditure on goods and services (public good provision) or tax rates. As it turns out, whether there is a net gain or loss in the long run depends on which of these does adjust.

4.3 Unilateral Tariff Imposition by the US

Since the US appears, at least superficially, to have been the progenitor in recent trade disputes, as well as to have unilaterally altered its capital income taxation regime, we devote some initial attention to the consequences of actions of this type in the absence of retaliation. The simulations and the policy changes represented in them are detailed in Table 1.[24] In the short run no changes are possible in nominal wages, capital use or in rates of taxation, so new tariffs yield revenue that moderates fiscal deficits. Long run cases, however, all require conserved fiscal balance and the adjustments in expenditure and tax rates required for this are noted in the table. In the case of US capital income tax reform, which is here combined with a new bilateral tariff, the adjustment is borne by government expenditure on goods and services, or public good provision.

[24] The reduction in capital income taxation and the tariff rate imposed are crude simplifications. This is because the tax reform in which the capital tax reductions are embedded is complex and the tariffs are thus far applied over a limited number of products with presumed enforcement imperfections.

Table 4: US Unilateral Changes in Capital Tax and Tariffs against China: Simulated US Effects[a]

% changes	Short run	Long run					
		Govt exp (public goods) adjust	Consn tax adjusts	Labor income tax adjusts	Skill income tax adjusts	Capital income tax adjusts	With capital tax reform[b]
Shock to power of import tariff vs China	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Endogenous fiscal effects							
Government expenditure on goods	0.00	0.96	0.00	0.00	0.00	0.00	-6.02
Power of consumption tax rate	0.00	0.00	-0.31	0.00	0.00	0.00	0.00
Power of tax rate on low-skill wage income	0.00	0.00	0.00	-0..68	0.00	0.00	0.00
Power of tax rate on skilled wage income	0.00	0.00	0.00	0.00	-0.26	0.00	0.00
Power of tax rate on capital income	0.00	0.00	0.00	0.00	0.00	-0.67	-5.00
Change in fiscal position, %GDP	0.11	0.00	0.00	0.00	0.00	0.00	0.00

a Six simulations are represented, one with employment adjustment and fixed capital use (short run), a further four with capacity adjustment, constant unemployment rates and constant fiscal balance with adjustment of expenditure or tax rates (long run), and a final simulation with an additional exogenous shock to the capital income tax rate, to represent recent tax reform. In all cases China is assumed to maintain its *de facto* US$ peg.
b The final simulation allows capacity to adjust but combines the tariff change with a reduction in the power of the tax rate on capital income or 5%, to represent recent tax reform, allowing government expenditure to adjust to retain fiscal balance.
Source: Simulations of the model described in the text.

US effects

The domestic effects on economic performance, for each of the shocks indicated in Table 4, are summarized in Table 5. Nominal producer price levels fall in most cases as the tariffs widen the wedge between them and targeted consumer prices. In the short run, when unit labor costs are fixed, contracting producer prices reduce employment and output. Associated inflationary pressure then demands a monetary contraction to defend the consumer price level. Saving falls and the long maturity bond yield rises, so the yield curve shifts upward.[25] The government's fiscal position is improved slightly by the additional tariff revenue and the current account deficit is modestly reduced. But the shock not only contracts GDP but is net welfare reducing in the short run, with the largest losers being capital owners, as the change in real financial assets indicates.

The long run analyses allow switches in the tax mix. In most cases the widening of the wedge between consumer and producer prices sees contractionary producer price deflation. One such case is that in which the tariff revenue allows consumption tax relief.[26] To preserve fiscal balance, the additional tariff revenue causes the power of the consumption tax rate, τ_C , to fall. Returning to (29), just as in the short run, the home price of foreign products rises relative to that of home products, P^P, which is the desired effect of the protection. In the long run, however, the fall in τ_C, and with P^C fixed by monetary policy, creates room for a *rise* in P^P. Domestic wholesale prices of both home and foreign goods rise relative to final consumer prices, with the foreign product prices rising by more. Nonetheless, the rise in P^P increases the net rate of return on domestic investment and so leads to a domestic capital expansion in the long run that occurs at the expense of foreign economies, appreciating the real and nominal exchange rates.

The clearing labor market ensures that the protection-induced rise in home product prices also leads to rises in nominal factor incomes in the US. But with a constrained consumer price level this implies rising purchasing power of disposable income over final goods and hence rising welfare. It does not imply rising real output or real GDP, however. While *nominal* GDP does

[25] This rise is aided by monetary contractions outside the US, where UMP implies reduced demand for long assets by central banks, combined with the partial integration of global capital markets.
[26] In the US this would require lower indirect tax rates at the state level, or further federal tax reform.

Table 5: US Unilateral Changes in Capital Tax and Tariffs against China: Simulated US Effects[a]

	Short run, govt exp constant, capital stocks & nominal wages constant	*Long run* retaining fiscal balance					
		Fiscal balance is retained in US by adjustment below, non-US adjustment via government expenditure on goods					5% rise in US tariff and 5% fall in US capital tax power[b]
		Govt exp on goods	Consn tax	Labor income tax	Skill income tax	Capital income tax	
Producer price level, %	-0.13	-0.09	0.18	-0.14	-0.15	-0.14	-0.11
Long bond yield, %	0.23	0.89	0.43	0.90	0.80	0.33	-3.27
Nominal effective exchange rate, %	0.25	0.35	0.16	0.34	0.32	0.36	0.47
Real effective exchange rate, %	0.70	0.73	0.47	0.72	0.67	0.76	1.03
Change in fiscal position, %GDP	0.11	0.00	0.00	0.00	0.00	0.00	0.00
Change in employment, millions	-0.20	0.00	0.00	0.00	0.00	0.00	0.00
Physical capital stock, %	0.0	-0.30	0.20	-0.30	-0.31	-0.05	1.54
Money supply, %	-0.41	-1.08	-0.28	-1.09	-1.01	-0.77	1.24
Change in current account, % GDP	0.20	0.18	0.15	0.17	0.19	0.15	-0.05
Real financial assets, %	-0.60	-1.19	-0.33	-1.21	-1.12	-0.40	4.88
Real consumption low-skill wage, %	0.00	-0.30	0.20	-0.30	-0.31	-0.20	0.42
Gini coefficient, %	-0.12	-0.06	0.01	-0.47	0.00	0.28	2.40
Real GDP, %	-0.05	-0.11	0.07	-0.11	-0.12	-0.02	0.57
Aggregate welfare[c], %	-0.13	-0.10	0.17	-0.09	-0.11	0.001	0.65

a Six simulations are represented, one with employment adjustment and fixed capital use (short run), a further four with capacity adjustment, constant unemployment rates and constant fiscal balance with adjustment of expenditure or tax rates (long run), and a final simulation with an additional exogenous shock to the capital income tax rate, to represent recent tax reform. In all cases China is assumed to maintain its *de facto* US$ peg.

b The final simulation reduces the overall tax rate on capital income by 5% as well as imposing the tariff. It allows capacity to adjust but imposes no change in tariffs but a reduction in the power of the tax rate on capital income by 5%, to represent recent tax reform, holding the fiscal position fixed but contracting government expenditure on goods and services to achieve this.

c Aggregate welfare is the real purchasing power of disposable income at domestic consumer prices.

Source: Simulations of the model described in the text.

rise in the US, the GDP price level, P^Y, inflates by a proportion that deviates from the rise in P^P due to the change in overall indirect tax revenue. Thus, real output actually falls. This counterintuitive result arises because the new trade distortions reduce global demand, and the re-establishment of the original expected rates of return across regions requires that capital stocks are lower, even in the US. Its home industry's larger share of domestic demand notwithstanding, the US real appreciation sees a decline in exports.

In most of the long run cases examined, the unilateral tariffs are net welfare improving for the US. These improvements might be thought of as due to the "optimal tariff" effects of protection by a large country. But their achievement does depend on the kind of tax relief applied following the receipt of tariff revenue. A reduced consumption tax rate ensures rising welfare while real GDP declines. A reduced tax rate on labor income worsens the capital contraction and the monetary contraction needed to sustain the P^C target. But there is a net improvement in real worker household incomes and in overall welfare. Application of the tariff revenue to reducing capital income taxation causes the most considerable "beggar thy neighbor" effects of the pure tariff cases, expanding the US capital stock in the long run at the expense of the rest of the world. Despite substantial global losses the rise in the US capital stock is sufficient to generate an expansion of its real GDP.

From the final columns of Tables 4 and 5 it is clear that the combination of the unilateral tariffs with more general capital income tax reform yields larger "beggar thy neighbor" gains to the US. This is because the policy changes attract considerably more investment and capital growth to the US economy, at the expense of the rest of the world. It is because of the inflow of global saving to investments in the US that US asset prices are driven up and the US long bond yield declines. In all other cases, and in all other regions, monetary contractions (short maturity yield rises) are required to maintain targets and sustain zero inflation anchors and there is a contraction in the supply of saving to meet investment demand, thus shifting yield curves upward.

Effects on China

In partner regions the effects of the new US tariffs are negative across the board, irrespective of the choice of US tax mix adjustments, and they are worst when, in the long run, US tariff revenue accommodates capital income tax relief. The effects on China follow this pattern, as

summarized in Table 6. The short run results are negative and dominated for China by substantial worker displacement. Importantly, they depend on its choice of monetary target. As indicated in the previous section, a response to the US tariffs can be the floating of its currency. Allowing a depreciation would reduce substantially the monetary contraction required and hence the associated decline in nominal producer prices. It would therefore cut by half the labor displacement effect of the US tariffs and the associated reduction in real Chinese GDP.

Clearly, this option would be preferred by a real GDP oriented government, yet its effects on economic welfare (the real purchasing power of disposable income at domestic consumer prices) would be negative. This is because the exchange rate target yields a consumer price deflation, partially offsetting the decline in purchasing power, which is eliminated with the transition from exchange rate to inflation targeting. In the long run cases this GDP protecting response is preserved.[27] This is because of the long run requirement that there be no change in expected net rates of return on capital across regions. Just as lower capital tax rates mean that marginal products of capital must decline and hence capital stocks rise, higher producer prices also boost expected rates of return and are similarly expansionary in the long run by virtue of their effects on capital growth.

4.4 China-US Tariff Games

In the short run we allow the US the choice of whether or not to raise the power of its existing protection against Chinese goods by five per cent and China chooses between making no change, liberalizing (reducing the equivalent power if its tariffs and non-tariff barriers against US imports by five per cent) and imposing an increase in the power of its tariffs against US goods, each option augmented by the alternatives of retaining or relaxing its US$ peg.[28] The payoff matrices

[27] There are two alternative modelling assumptions that are relevant to this conclusion. Since the market for capital goods is not depicted in the model as separate from those for intermediates or final products we can either assume that capital goods prices are fixed at today's levels or that any product price inflation or deflation applies also to capital goods prices. We have opted for the former assumption on the grounds that decisions about long run investments will be made at capital goods prices that are near those at present, while future output prices will depend on policy shocks.

[28] Liberalizing by China in response to trade pressure from the US will not necessarily take the form of tariff reductions. We use this approximation in the absence of ready mechanisms to account for relief from the cost of unwanted joint ventures and vulnerability to the theft of intellectual property.

Table 6: US Unilateral Protection against China: Simulated Effects on China[a]

	Short run		Long run			
			Tariff with US capital income tax adjustment		US capital income tax reform with tariff[b]	
	US$ peg	Float	US$ peg	Float	US$ peg	Float
Producer price level, %	-1.19	-0.33	-0.76	-0.25	-0.89	-0.27
Consumer price level, %	-1.03	0.00	-0.75	0.00	-0.90	0.00
Long bond yield, %	0.28	-0.08	1.31	0.71	1.81	1.07
Nominal effective exchange rate, %	0.30	-1.25	0.40	-1.09	0.52	-1.26
Real effective exchange rate, %	-0.77	-1.70	-0.15	-1.38	-0.09	-1.57
Change in fiscal position, %GDP	0.11	-0.30	0.00	0.00	0.00	0.00
Change in employment, millions	-16.82	-7.06	0.00	0.00	0.00	0.00
Physical capital stock, %	0.0	0.0	-1.58	-0.85	-3.51	-0.90
Money supply, %	-2.87	-1.21	-2.83	-1.65	-3.51	-2.08
Change in current account, % GDP	-0.25	-0.02	-0.40	-0.08	-0.32	0.05
Real financial assets, %	-2.39	-0.95	-2.15	-1.12	-2.72	-1.48
Real consumption low-skill wage, %	1.04	0.00	-0.84	-0.85	-0.91	-0.92
Gini coefficient change, %	-0.58	-0.23	0.00	0.00	-0.003	0.002
Real GDP, %	-0.88	-0.37	-0.83	-0.44	-0.93	-0.47
Aggregate welfare[c], %	-0.40	-0.79	-0.86	-0.86	-0.94	-0.79

a Six simulations are represented, one with employment adjustment and fixed capital use (short run), a further four with capacity adjustment, constant unemployment rates and constant fiscal balance with adjustment of expenditure or tax rates (long run), and a final simulation with an additional exogenous shock to the capital income tax rate, to represent recent tax reform.

b The final simulation allows capacity to adjust but imposes both the tariff and a reduction in the power of the US tax rate on capital income of 5%, to represent recent US tax reform. Fiscal balance is retained by reducing government expenditure on goods and services.

c Aggregate welfare is the real purchasing power of disposable income at domestic consumer prices.

Source: Simulations of the model described in the text.

for four normal form games are provided in Table 7. The objectives are aggregate economic welfare, real GDP, low-income welfare and capital-owner welfare. In each case rising Interestingly, the games on low-skill and capital-owner welfare both yield US protection and Chinese liberalization, though they differ as to the retention of the US$ peg. When real GDP is the objective we see again that a Chinese float limits the losses from US protection, but with unilateral protection by China the peg is preferred. The equilibria in all three games where Chinese liberalization is preferred yield net welfare and real GDP gains to both countries while the equilibrium with Chinese protection disadvantages the US.

The corresponding long run games are detailed in Tables 8 and 9. These also show dominant strategies for the US, which are to impose tariffs against China, in most cases with revenue providing consumption tax relief.[29] The strength of consumption tax relief derives from the effects on producer prices under consumer price targeting, as discussed in Section 4.2. Reduced consumption tax rates raise producer relative to consumer prices, allowing a small producer price inflation that raises investment returns. When aggregate welfare or real GDP are the objectives (Table 8), this effect on investment incentives turns out to be stronger than the alternative of capital tax relief, irrespective of China's response, though Chinese tariff retaliation does reduce US net gains substantially.

US tariffs cause net losses for China, no matter how it responds. Although, like the US, it would enjoy net gains from unilateral tariff imposition, once the US is protecting its dominant strategy is to liberalize and to sustain fiscal balance by cutting spending, rather than by raising consumption or capital tax rates. As indicated earlier, this response is best combined with a currency float if the objective is real GDP since this avoids the production effects of a domestic deflation. Under welfare criteria, however, a retained peg with the then necessary deflation of consumer prices actually raises welfare. When the objectives are Rawlsian (Table 9), the constancy of per capita public goods weighs more heavily and so, even while the Chinese best response is still to liberalize, the preferred means to sustain fiscal balance is to raise capital income taxes. When capital-owner interests dominate the game's equilibrium changes more

[29] This is not straightforward in practice since the US has no federal consumption tax. Such taxation is implemented, variably, by states.

Table 7:
Short Run Normal Form Tariff Games[a]

Criterion: [China, US] Welfare, % change			US Actions			
			None		Tariffs	
Chinese actions			China	US	China	US
	None	Peg	0.000	0.000	-0.399	-0.132
		Float	0.000	0.000	-0.597	-0.090
	Liberalise	Peg	0.284	0.050	-0.114	-0.083
		Float	0.176	0.074	-0.425	-0.018
	Protect	Peg	-0.266	-0.045	-0.667	-0.175
		Float	-0.169	-0.066	-0.762	-0.155

Criterion: [China, US] Real GDP, % change			US Actions			
			None		Tariffs	
Chinese actions			China	US	China	US
	None	Peg	0.000	0.000	-0.876	-0.046
		Float	0.000	0.000	-0.366	-0.034
	Liberalise	Peg	-0.186	0.015	-1.056	-0.031
		Float	0.114	0.022	-0.255	-0.012
	Protect	Peg	0.162	-0.013	-0.720	-0.059
		Float	-0.109	-0.020	-0.473	-0.053

Criterion: [China, US] Low-sill welfare, % change			US Actions			
			None		Tariffs	
			China	US	China	US
Chinese actions	None	Peg	0.000	0.000	0.156	-0.031
		Float	0.000	0.000	-0.373	-0.007
	Liberalise	Peg	0.399	0.030	0.556	-0.002
		Float	0.099	0.044	-0.276	0.036
	Protect	Peg	-0.366	-0.027	-0.211	-0.058
		Float	-0.096	-0.039	-0.466	-0.045

Criterion: [China, US] Capital owner welfare, % change			US Actions			
			None		Tariffs	
			China	US	China	US
Chinese actions	None	Peg	0.000	0.000	-1.045	-0.190
		Float	0.000	0.000	-0.856	-0.140
	Liberalise	Peg	0.149	0.060	-0.893	-0.132
		Float	0.268	0.089	-0.595	-0.053
	Protect	Peg	-0.150	-0.053	-1.197	-0.242
		Float	-0.256	-0.080	-1.106	-0.217

a Here US protection implies a five per cent increase in the power of US tariffs only against Chinese goods. Chinese protection implies the same against US goods and Chinese liberalization implies a reduction in the equivalent power of Chinese tariffs and non-tariff barriers against US goods by five per cent.
Source: Simulations of the model described in the text.

substantially. Not surprisingly, the US then prefers to use tariff revenue to finance capital income tax relief while China still adopts liberalization, while retaining its US$ peg.

Table 8:
Long Run Normal Form Tariff Games on Aggregate Welfare and Real GDP[a]

Criterion: [China, US] Welfare, % change				US Actions							
				None		Protect with fiscal option					
						Increase spending		Reduce consn tax		Reduce capital tax	
Chinese actions				China	US	China	US	China	US	China	US
	None		Peg	0.000	0.000	-0.787	-0.096	-0.646	0.167	-0.793	0.001
			Float	0.000	0.000	-0.854	0.011	-0.675	0.247	-0.862	0.123
	Liberalise	Reduce spending	Peg	0.030	0.072	-0.759	-0.025	-0.608	0.256	-0.765	0.079
			Float	-0.009	0.146	-0.867	0.156	-0.666	0.424	-0.876	0.283
		Increase consn tax	Peg	-0.305	0.078	-1.445	-0.012	-1.196	0.270	-1.456	0.093
			Float	-0.300	0.092	-1.429	0.048	-1.181	0.306	-1.441	0.162
		Increase capital tax	Peg	-0.170	0.067	-1.169	-0.034	-0.963	0.245	-1.177	0.068
			Float	-0.168	0.137	-1.176	0.138	-0.942	0.405	-1.186	0.263
	Protect	Increase spending	Peg	-0.047	-0.064	-0.832	-0.159	-0.700	0.087	-0.838	-0.068
			Float	-0.007	-0.133	-0.857	-0.120	-0.700	0.086	-0.864	-0.022
		Reduce consn tax	Peg	0.247	-0.070	-0.892	-0.158	-0.676	0.087	-0.903	-0.066
			Float	0.242	-0.086	-0.885	-0.126	-0.674	0.092	-0.896	-0.029
		Reduce capital tax	Peg	0.129	-0.060	-0.868	-0.160	-0.686	0.088	-0.877	-0.069
			Float	0.132	-0.125	-0.873	-0.121	-0.686	0.087	-0.882	-0.023

Criterion: [China, US] Real GDP, % change				US Actions							
				None		Protect with fiscal option					
						Increase spending		Reduce consn tax		Reduce capital tax	
Chinese actions				China	US	China	US	China	US	China	US
	None		Peg	0.000	0.000	-0.815	-0.110	-0.582	0.073	-0.826	-0.020
			Float	0.000	0.000	-0.440	-0.071	-0.347	0.109	-0.442	0.031
	Liberalise	Reduce spending	Peg	-0.191	0.072	-1.005	-0.083	-0.756	0.112	-1.016	0.012
			Float	0.082	0.146	-0.361	-0.018	-0.256	0.186	-0.363	0.098
		Increase consn tax	Peg	-0.305	0.078	-1.102	-0.079	-0.837	0.118	-1.114	0.018
			Float	-0.300	0.092	-0.878	-0.057	-0.724	0.134	-0.883	0.047
		Increase capital tax	Peg	-0.403	0.025	-1.437	-0.087	-1.132	0.108	-1.452	0.008
			Float	-0.108	0.051	-0.730	-0.024	-0.584	0.178	-0.735	0.090
	Protect	Increase spending	Peg	0.166	-0.024	-0.651	-0.133	-0.432	0.038	-0.661	-0.049
			Float	-0.080	-0.049	-0.517	-0.119	-0.435	0.038	-0.519	-0.030
		Reduce consn tax	Peg	0.208	-0.026	-0.660	-0.133	-0.428	0.038	-0.671	-0.049
			Float	0.148	-0.032	-0.543	-0.121	-0.412	0.040	-0.548	-0.033
		Reduce capital tax	Peg	0.352	-0.022	-0.689	-0.134	-0.416	0.038	-0.702	-0.050
			Float	0.085	-0.047	-0.536	-0.120	-0.419	0.038	-0.540	-0.031

a Spending changes refer to government spending on goods and services only, seen as the provision of public goods that have constant per capita impact across all households.
Source: Simulations of the model described in the text.

Table 9:
Long Run Normal Form Tariff Games on Low-Skill and Capital-Owner Welfare[a]

Criterion: [China, US] Low skill welfare, % change				US Actions							
				None		Protect with fiscal option					
						Increase spending		Reduce consn tax		Reduce capital tax	
Chinese actions				China	US	China	US	China	US	China	US
	None		Peg	0.000	0.000	-0.757	0.030	-0.629	0.148	-0.762	-0.098
			Float	0.000	0.000	-0.862	0.138	-0.681	0.218	-0.871	-0.004
	Liberalise	Reduce spending	Peg	-0.055	0.071	-0.813	0.101	-0.676	0.226	-0.819	-0.037
			Float	-0.122	0.146	-0.987	0.283	-0.783	0.375	-0.996	0.122
		Increase consn tax	Peg	-0.260	0.077	-1.234	0.114	-1.036	0.239	-1.243	-0.026
			Float	-0.265	0.091	-1.262	0.174	-1.043	0.271	-1.272	0.028
		Increase capital tax	E tgt	0.076	0.066	-0.548	0.091	-0.449	0.217	-0.551	-0.045
			PC tgt	-0.012	0.137	-0.772	0.265	-0.596	0.358	-0.780	0.106
	Protect	Increase spending	Peg	0.026	-0.063	-0.729	-0.033	-0.609	0.077	-0.734	-0.153
			Float	0.092	-0.132	-0.768	0.006	-0.608	0.076	-0.776	-0.118
		Reduce consn tax	Peg	0.207	-0.069	-0.766	-0.032	-0.594	0.077	-0.775	-0.152
			Float	0.213	-0.085	-0.782	0.000	-0.595	0.081	-0.791	-0.123
		Reduce capital tax	Peg	-0.085	-0.060	-0.706	-0.034	-0.618	0.078	-0.710	-0.154
			Float	-0.002	-0.125	-0.757	0.005	-0.617	0.077	-0.764	-0.119

Criterion: (China, US] Capital owner welfare, % change				US Actions							
				None		Protect with fiscal option					
						Increase spending		Reduce consn tax		Reduce capital tax	
Chinese actions				China	US	China	US	China	US	China	US
	None		Peg	0.000	0.000	-0.828	-0.261	-0.669	0.192	-0.834	0.309
			Float	0.000	0.000	-0.842	-0.156	-0.667	0.285	-0.849	0.489
	Liberalise	Reduce spending	Peg	0.146	0.072	-0.685	0.101	-0.516	0.295	-0.692	0.420
			Float	0.143	0.146	-0.705	-0.012	-0.507	0.490	-0.713	0.721
		Increase consn tax	Peg	-0.367	0.078	-1.729	-0.178	-1.412	0.311	-1.744	0.441
			Float	-0.347	0.092	-1.655	-0.118	-1.368	0.353	-1.668	0.543
		Increase capital tax	E tgt	-0.523	0.067	-2.048	-0.199	-1.693	0.283	-2.064	0.404
			PC tgt	-0.396	0.137	-1.753	-0.029	-1.437	0.468	-1.768	0.692
	Protect	Increase spending	Peg	-0.147	-0.064	-0.971	-0.325	-0.823	0.101	-0.977	0.210
			Float	-0.141	-0.133	-0.977	-0.287	-0.823	0.099	-0.984	0.277
		Reduce consn tax	Peg	0.301	-0.070	-1.063	-0.323	-0.787	0.100	-1.076	0.212
			Float	0.280	-0.086	-1.025	-0.292	-0.781	0.106	-1.037	0.267
		Reduce capital tax	Peg	0.434	-0.061	-1.090	-0.325	-0.776	0.101	-1.106	0.209
			Float	0.328	-0.126	-1.031	-0.288	-0.777	0.100	-1.044	0.276

a Spending changes refer to government spending on goods and services only, seen as the provision of public goods that have constant per capita impact across all households.
Source: Simulations of the model described in the text.

2. Conclusion

In this paper we examine stylized representations of recent US and Chinese tax reforms, tariffs against imports and alternative Chinese monetary targeting using a calibrated global macro model that embodies both trade and financial interdependencies. For both countries, unilateral capital tax relief is shown to be "beggar thy neighbor" in long run consequence, with an effective alliance between low-skill workers and capital owners ensuring that the burden of sustaining

fiscal balance falls on skilled, professional households. In the case of tariffs there is most advantage in the US if fiscal balance is sustained by having revenue finance consumption tax relief, while in China this depends on whether the objective is the maximization of GDP or economic welfare more broadly defined. China is nonetheless a net loser from unilateral US protection, whether the policy criterion is aggregate welfare, real GDP or the welfare of low-skill workers or capital owners, irrespective of its policy response. A Chinese currency float is shown to cushion the effects on its GDP in the short run but the retention of its peg is strongest under welfare criteria.

Equilibria in normal form non-cooperative tariff games exhibit spill-overs that are substantial but that are most often insufficient to deter dominant strategies. The results suggest that the US suffers short run losses from the imposition of tariffs against Chinese imports but it gains when the resulting changes in investment incentives are allowed to bring about regional capacity adjustments. In this long run a welfare or GDP maximizing US uses tariff revenue to offer consumption tax relief, which in the US context suggests wider cuts to indirect taxation other than import tariffs. Only if capital owners dominate the US decision process is it optimal for the US to redirect tariff revenue to capital income tax relief. In response China's best strategy is to minimize its losses by reducing tariffs and maintaining long run fiscal balance by reducing government expenditure on goods and services, rather than by raising consumption or capital income tax rates.

Importantly, at a length of run over which investment incentives allow capacity adjustment, the tax and tariff policies of the US deliver for both low-skill workers and for capital owners, with the net gains to capital owners proportionally larger in both cases. Though we recognize that "it was ever thus", the point to emerge is that US tariffs and tax reform might benefit US workers but it will not reduce inequality.

A particular complement offered by this approach is to observe the effects of protection on financial markets. Even unilateral protection in the US alone requires a tightening of monetary policies and a contraction in global investment and saving, causing short and long bond yields to rise. Such changes should facilitate continued "normalization" in the US and the return in Europe and Japan to conventional monetary policy, though trade conflicts represent a "bad exit" from the recent global malaise of low rates, low inflation and low growth.

References

Acemoglu, D., D. Autor, D. Dorn, G. Hanson and B. Price (2016), "Import competition and the great US employment sag of the 2000s," *Journal of Labor Economics*, 34(S1):141-198, Part 2, January.

Acemoglu, D. and P. Restrepo (2017), "Robots and jobs: Evidence from U.S. labor markets," *NBER Working Paper*, No. 23285, online available at http://www.nber.org/papers/w23285

Alvarado, F., L. Chancel, T. Piketty, E. Saez and Gabriel Zucman (2017), "The Elephant Curve of Global Inequality and Growth," *World Wealth and Income Database (WID) Working Paper Series*, 2017/20, online available at https://eml.berkeley.edu/~saez/ACPSZ2018WIDWP.pdf.

Arora, V., R. Tyers and Y. Zhang (2015), "Reconstructing the savings glut: the global implications of Asian excess saving," *International Journal of Economics and Finance*, Vol. 7, No. 7, pp.19-42, July.

Athukorala, P. (2011), "Production networks and trade patterns in East Asia: regionalization or globalization?" *Asian Economic Papers*, MIT Press, 10(1): 65-95, January.

Autor D.H., D. Dorn and G. Hanson (2013), "The China syndrome: local labour market effects of import competition in the US," *American Economic Review*, Vol. 103, No. 6, pp.2121-68, October.

Bagwell, K. and R.W. Staiger (1999), "An economic theory of GATT," *American Economic Review*, Vol. 89, No. 1, pp. 215-248.

Bayoumi, T. (2001), "The morning after: Explaining the slowdown in Japanese growth in the 1990," *Journal of International Economics*, 53 (2), 241–259.

Bergsten, C.F., C. Freeman, N.R. Lardy and D.J. Mitchell (2008), *China's Rise: Challenges and Opportunities*, Washington DC: Peterson Institute for International Economics.

Bernanke, B.S. (2005), "*Remarks by the Governor*," Sandridge Lecture, Virginia Association of Economists, Richmond Virginia, March, Federal Reserve Board.

_____ (2011), "*Global imbalances: links to economic and financial stability*," speech given at the Banque de France Financial Stability Review Launch Event, Paris, France February 18.

Blanchard, O. and F. Giavazzi (2006), "Rebalancing growth in China: a three-handed approach," *China and the World Economy*, Institute of World Economics and Politics, Chinese Academy of Social Sciences, 14(4): 1-20.

Bouët, A. and D. Laborde (2017), "US trade wars with emerging countries in the 21st Century: Make America and its partners lose again," *IFPRI Discussion Paper*, No. 01669, online available at http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/131368/filename/131579.pdf

Bretchger, L. and F. Hettich (2002), "Globalization, capital mobility and tax competition: theory and evidence for OECD countries," *European Journal of Political Economy*, 18(4): 695-716.

Chatham House (2015), "*Challenges to the rules based international order*," The London Conference, Royal Institute for International Affairs.

Congressional Budget Office (2017), *An Update to the Budget and Economic Outlook: 2017 to 2027*, US Government, Washington DC, June.

Dong, Y. and J. Whalley (2012), "Gains and losses from potential bilateral US-China trade retaliation," *Economic Modelling*, Vol. 29, pp. 2225-2236.

Ezrachi, A. and M.E. Stucke (2016), *Virtual Competition: The Promise and Perils of the Algorithm-Driven Economy*, Cambridge MA: Harvard University Press.

Fuest, C., B. Huber and J. Mintz (2003), "Capital mobility and tax competition: A survey," *Foundations and trends in Microeconomics*, Vol. 1, No. 1, pp.1-62.

Griffiths, R and R. Harrison (2004), "The link between product market reform and macro-economic performance," *European Commission Economic Papers*, No. 209.

Ito, H. (2009), "US current account debate with Japan then, and China now," *Journal of Asian Economics*, 20: 294-313.

Johnson, H.G. (1953), "Optimum tariffs and retaliation," *The Review of Economic Studies*, 21(2): 142-153.

Johnson, R.C. (2014), "Five facts about value-added exports and implications for macroeconomics and trade research," *Journal of Economic Perspectives*, 28(2): 119-142.

Koh, D., R. Santaeulalia and Y. Zheng (2016), "Labour share decline and intellectual property products capital," *Barcelona Graduate School of Economics Working Paper*, No. 927, February.

Koopman, R., Z. Wang and S.-J. Wei (2014), "Tracing value-added and double counting in gross exports," *American Economic Review*, 104(2): 459–494.

Krugman, P. (2010) "Capital export, elasticity pessimism and the *renminbi* (wonkish)," *New York Times* (blog), 16 March.

Lardy, N.R. (2006), 'Toward a consumption-driven growth path," *Policy Brief*, 06-6, Washington DC: Peterson Institute for International Economics.

Lardy, N.R. (2012), *Sustaining China's Growth after the Global Financial Crisis*, Washington DC: Peterson Institute for International Economics, January.

McKinnon, R. (2006), "China's exchange rate trap: Japan redux?" *American Economic Review*, 96(2): 427-431, May.

McKinnon, R. and K. Ohno, 2001. "The foreign exchange origins of Japan's economic slump and low interest liquidity trap," *The World Economy*, 24: 279-315, March.

Ministry of Finance of China (2019), *Notice on Implementing the Policy of Inclusive Tax Relief for Small and Micro Enterprises*, 17 January: https://www.china-briefing.com/news/china-extends-tax-relief-incentives-small-micro-businesses/.

Moazed, A. and N.L. Johnson (2016), *Modern Monopolies: What it Takes to Dominate the 21st Century Economy*, New York: St Martin's Press.

Nicoletti, G and S. Scarpetta (2003), "Regulation, Productivity and Growth", *World Bank Policy Research Working Paper*, No. 2944.

OECD (2007), *Going for Growth: Economic Policy Reforms*, OECD Publishing, Paris.

Office of the US Trade Representative (2018), *Findings of the investigation into China's acts, policies and practices related t technology transfer, intellectual property and innovation under Section 301 of the Trade Act of 1974*, Executive Office of the President, 22 March, Washington DC.

Ossa, R. (2011), "A 'new trade' theory of GATT/WTO negotiations," *Journal of Political Economy*, Vol. 119, No. 1, pp. 122-152.

Piketty, T. and G. Zucman (2014), "Capital is back: wealth-income ratios in rich countries 1700-2010," *The Quarterly Journal of Economics*: 1255-1310.

Pierce, J.R. and P.K. Schott (2012), "The surprisingly swift decline of U.S. manufacturing employment," *American Economic Review*, Vol. 106, No. 7, pp.1632-62.

State Council of the People's Republic of China (2015), *Made in China 2025*, in Chinese at: http://www.miit.gov.cn/n11293472/n11293877/n16553775/n16553792/16594486.html.

Tiebout, C. (1956), "A pure theory of local expenditures," *Journal of Political Economy*, 64(5): 400-415.

Tyers, R. (2012), "Japan's economic stagnation: causes and global implications," *The Economic Record*, 88(283): 459-607, December.

_____ (2015), "International effects of China's rise and transition: neoclassical and Keynesian perspectives," *Journal of Asian Economics*, Vol. 37, pp. 1-19, April.

_____ (2016), "China and Global Macroeconomic Interdependence," *The World Economy*, 39(11):1674-1702.

Tyers, R. and Y. Zhang (2011), "Appreciating the *renminbi*," *The World Economy*, 34(2): 265-297, February.

Tyers, R. and Y. Zhou (2017), "Automation and inequality with taxes and transfers," Discussion Paper in Economics No. DP 17.01, Business School, University of Western Australia, January, CAMA Working Paper 16/2017, Australian National University, https://cama.crawford.anu.edu.au/publication/cama-working-paper-series/9218/automation-and-inequality-taxes-and-transfers

_____ (2019a), "The US-China trade dispute: a macro perspective," Discussion Paper in Economics, Business School, University of Western Australia, January.

_____ (2019b), "Financial integration and the global effects of China's growth surge," Discussion Paper in Economics, Business School, University of Western Australia, January.

Zhou, Y. and R. Tyers (2018a), "Automation and inequality in China," *China Economic Review*, https://doi.org/10.1016/j.chieco.2018.07.008.