The Effects of Financial Decoupling of the U.S. and China: Simulations with a Global Financial CGE Model

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P.B. Dixon,
J.A. Giesecke,
J. Nassios,
and
M.T. Rimmer
Centre of Policy Studies,
Victoria University

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Address: Centre of Policy Studies, Victoria University, PO Box 14428, Melbourne, Victoria, 8001
home page: www.vu.edu.au/CoPS/ email: copsinfo@vu.edu.au Telephone +61 3 9919 1877

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The effects of financial decoupling of the U.S. and China: simulations with a global financial CGE model

By

P.B. Dixon, J.A. Giesecke, J. Nassios and M.R. Rimmer

Centre of Policy Studies, Victoria University

October 23, 2020

Abstract

We add a financial module to the GTAP model, built around an 18-region asset-liability matrix. We simulate financial decoupling between the U.S. and China. We find that the U.S. would gain by limiting its capital flows to China, leading to a redirection of finance to the domestic economy. This would stimulate investment in the U.S. with favorable effects on employment, capital stocks, real GDP, wealth and real wage rates. At the same time investment in China would decline with negative effects on the Chinese economy. Similarly, China would gain by limiting its capital flows to the U.S. and the U.S. would lose. In a tit-for-tat situation in which each country reduces it financial-asset holding in the other country by *x* per cent, the winner would be China. We conduct additional simulations to compare the effects of trade decoupling with those of financial decoupling.

JEL: C68; F17; F37; F51

Key words: Financial decoupling; U.S.-China economic relations; Trade decoupling; Financial module in GTAP; CGE simulations

Contents

Summary

(1) We have added a financial module to the GTAP model. This module is built around an 18-region *by* 18-region asset-liability table. Looking down a column of the table we see the value of the assets that a region holds in each of the 18 regions. Looking across a row of the table we see the value of liabilities of a region to each of the 18 regions. A 3-region version of this table is presented below:

Assets & liabilities at the start of 2015 ($US trillion)

	USA	China	RoW	Total
USA	26.59	3.00	24.26	53.85
China	1.14	31.95	7.70	40.79
RoW	19.97	7.62	134.16	161.74
Total	47.70	42.56	166.13	256.39

(2) The column total for a region in the asset-liability table is a measure of the region's wealth. The row total for a region is a measure of the value of capital located in the region. In the financial CGE model, the column totals (wealth) grow through time reflecting the region's savings. The row totals (capital) grow through time reflecting physical investment in the region. The internal components of the table are put in place by the decisions of asset optimizing agents who take account of movements in rates of return on alternative investments.

(3) We simulate the effects of financial decoupling between the U.S. and China by introducing penalties for U.S. holders of Chinese liabilities and Chinese holders of U.S. liabilities. In terms of the asset-liabilities table, we introduce negative shocks in the China-USA and USA-China cells.

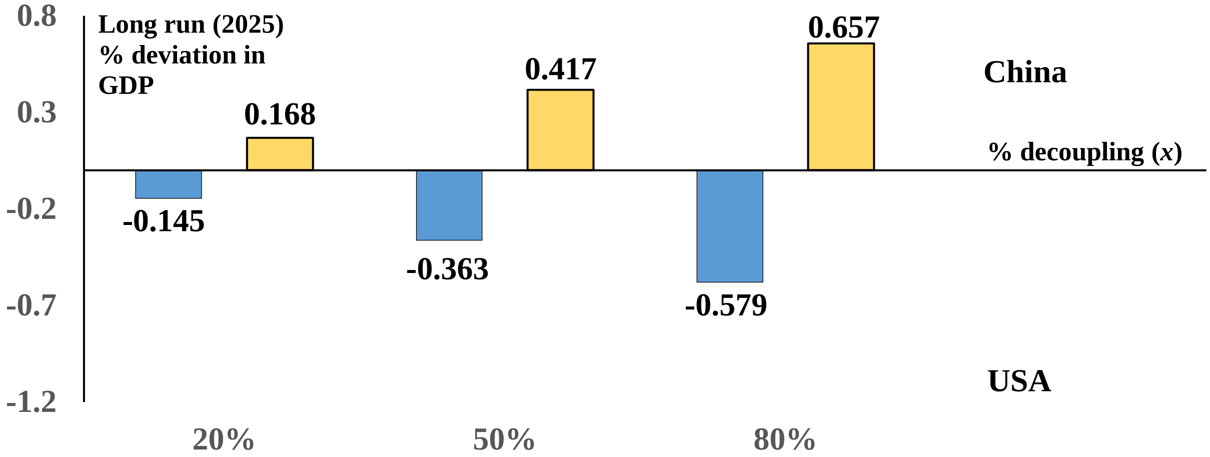
(4) Our simulations show that the U.S. would gain by limiting its capital flows to China, leading to a redirection of finance to the domestic economy. This would stimulate investment in the U.S. with favorable temporary effects on employment and favorable permanent effects on capital stocks, real GDP, wealth and real wage rates. At the same time investment in China would decline with negative effects on Chinese capital stocks, real GDP, wealth and real wage rates.

(5) Similarly, China would gain by limiting its capital flows to the U.S. and the U.S. would lose.

(6) In a tit-for-tat situation in which each country reduces it financial-asset holding in the other country by *x* per cent, the winner would be China. The primary reason is that the value of Chinese financial assets in the U.S. ($US3 trillion, table above) is considerably greater than the value of U.S. financial assets in China ($US1.14 trillion). A reinforcing mechanism is that initial gains for China are translated strongly into long-run gains through China's very high saving rate. A low saving rate for the U.S. means that this mechanism is weaker in the U.S.

(7) The long-run GDP effects of different percentage tit-for-tat decoupling are shown in the figure below.

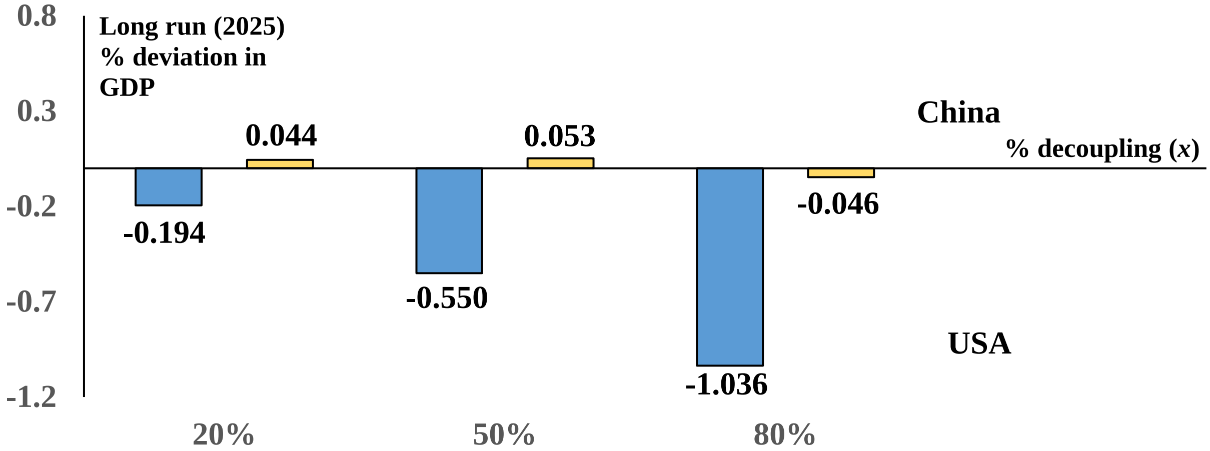
U.S. reduces its financial assets in China by x% and China reduces it financial assets in the U.S. by x%



(8) In discussions of decoupling, finance and technology transfer are often linked. We focus purely on financial flows. Technology transfer can be viewed separately as a matter of how to handle intellectual property issues, patents and training of foreign students.

(9) We conduct additional simulations to compare the effects for the U.S. and China of trade decoupling with financial decoupling. We find that trade decoupling adds to the negative GDP effects of financial decoupling for the U.S. and effectively eliminates the gains for China, see figure below.

U.S. and China reduce their financial assets in each other's countries by x% and also reduce their imports from each other by x%



1. Introduction

This paper reports simulation results on the effects of financial decoupling between the U.S. and China. In discussions of decoupling, finance and technology transfer are often linked. Here we focus purely on financial flows. We think that technology transfer can be viewed separately as a matter of how to handle intellectual property issues, patents and training of foreign students.

Reducing financial flows between the U.S. and China will change the ways in which the two countries allocate their wealth across global assets. This will change rates of capital creation in different parts of the world, with implications for growth in employment, capital stocks, GDP and wealth that differ across regions.

We analyze these issues with an enhanced version of the well-known GTAP model.

GTAP is a widely applied global CGE model, originally documented in Hertel (1997). Documentation of the current standard version is in Corong *et al.* (2017) and Aguiar *et al.* (2020). In the standard version, capital moves costlessly between industries within each region and wages either adjust fully to achieve exogenously given levels of employment or wages are exogenous and employment adjusts. In earlier research we added to the standard version industry-specific capital and sticky-wage adjustments, see Dixon *et al.* (2019). We now add to GTAP a financial module. We do this in an 18-region 57-commodity version of GTAP that includes our industry-specific capital and sticky-wage specifications.

Section 2 outlines the new financial module. Then section 3 describes our application to financial decoupling between the U.S. and China. Concluding remarks are in section 4.

The application in section 3 should be considered preliminary. We set it up as though the decoupling commences in 2015. In future research we plan to update the data to 2020. However, we anticipate that the update would not affect the general picture that emerges from our simulations. This is because the results depend mainly on U.S. financial assets in China as a share of U.S. wealth and Chinese financial assets in the U.S. as a share of Chinese wealth. Data for 2020 presented in Appendix 1 show that these shares have not changed dramatically since 2015.

The paper contains 6 other appendices. Appendices 2 to 6 deal with technical issues concerning: the behavioral specification for financial asset optimizers in each region (Appendix 2); the estimation of the start and end-year asset-liability table (Appendix 3); regional investment and rates of return (Appendix 4); an adding up problem with the asset-liability table leading to a potential structural singularity in solution (Appendix 5); and closures for the model (Appendix 6).

Appendix 7 presents simulation results on the macro effects on the U.S. and China of trade decoupling. We compare these results with those of financial decoupling.

2. The financial module

The financial module is built around the asset-liability matrix set out in Table 1. The (s,d) entry in this table is the value at the start of 2015 of liabilities issued by region *s* that are held by region d. For example, the table shows that U.S. financial liabilities (e.g. government

Table 1. Assets and liabilities at the start of 2015 ($US trillion)

	1 USA	2 China	3 Japan	4 Skorea	5 France	6 Germany	7 Brazil	8 India	9 Russia	10 Australia	11 RoAmer	12 RoAsia	13 RoEuro	14 Africa	15 RoW	16 UK	17 Canada	18 Mexico	Total
1 USA	26.59	3.00	2.06	0.28	2.16	2.52	0.21	0.13	0.33	0.42	0.37	2.94	11.17	0.29	0.05	0.43	0.76	0.14	**53.85**
2 China	1.14	31.95	0.66	0.09	0.68	0.80	0.07	0.04	0.10	0.13	0.12	0.93	3.55	0.09	0.02	0.14	0.24	0.05	**40.79**
3 Japan	1.09	0.41	13.00	0.04	0.31	0.37	0.03	0.02	0.05	0.06	0.05	0.43	1.62	0.04	0.01	0.06	0.11	0.02	**17.73**
4 Skorea	0.21	0.08	0.06	4.45	0.06	0.07	0.01	0.00	0.01	0.01	0.01	0.08	0.32	0.01	0.00	0.01	0.02	0.00	**5.43**
5 France	1.90	0.72	0.52	0.07	2.69	0.64	0.05	0.03	0.08	0.11	0.09	0.75	2.83	0.07	0.01	0.11	0.19	0.04	**10.91**
6 Germany	1.81	0.69	0.50	0.07	0.52	7.36	0.05	0.03	0.08	0.10	0.09	0.71	2.70	0.07	0.01	0.10	0.18	0.03	**15.10**
7 Brazil	0.33	0.13	0.09	0.01	0.09	0.11	5.15	0.01	0.01	0.02	0.02	0.13	0.49	0.01	0.00	0.02	0.03	0.01	**6.65**
8 India	0.18	0.07	0.05	0.01	0.05	0.06	0.01	5.40	0.01	0.01	0.01	0.07	0.27	0.01	0.00	0.01	0.02	0.00	**6.24**
9 Russia	0.21	0.08	0.06	0.01	0.06	0.07	0.01	0.00	3.38	0.01	0.01	0.08	0.31	0.01	0.00	0.01	0.02	0.00	**4.33**
10 Australia	0.50	0.19	0.14	0.02	0.15	0.17	0.01	0.01	0.02	2.68	0.02	0.20	0.75	0.02	0.00	0.03	0.05	0.01	**4.98**
11 RoAmer	0.36	0.14	0.10	0.01	0.10	0.12	0.01	0.01	0.02	0.02	5.85	0.14	0.54	0.01	0.00	0.02	0.04	0.01	**7.50**
12 RoAsia	2.20	0.84	0.61	0.08	0.63	0.74	0.06	0.04	0.10	0.12	0.11	12.96	3.29	0.09	0.02	0.13	0.22	0.04	**22.27**
13 RoEuro	9.76	3.72	2.69	0.36	2.81	3.29	0.28	0.16	0.43	0.55	0.48	3.83	1.62	0.38	0.07	0.56	0.99	0.19	**32.16**
14 Africa	0.30	0.12	0.08	0.01	0.09	0.10	0.01	0.01	0.01	0.02	0.01	0.12	0.45	4.57	0.00	0.02	0.03	0.01	**5.96**
15 RoW	0.05	0.02	0.01	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.08	0.00	0.50	0.00	0.01	0.00	**0.75**
16 UK	0.19	0.07	0.05	0.01	0.06	0.07	0.01	0.00	0.01	0.01	0.01	0.08	0.29	0.01	0.00	9.73	0.02	0.00	**10.61**
17 Canada	0.63	0.24	0.17	0.02	0.18	0.21	0.02	0.01	0.03	0.04	0.03	0.25	0.94	0.02	0.00	0.04	4.00	0.01	**6.85**
18 Mexico	0.25	0.09	0.07	0.01	0.07	0.08	0.01	0.00	0.01	0.01	0.01	0.10	0.37	0.01	0.00	0.01	0.03	3.14	**4.27**
Total	**47.70**	**42.56**	**20.92**	**5.55**	**10.74**	**16.80**	**5.98**	**5.90**	**4.67**	**4.32**	**7.30**	**23.82**	**31.59**	**5.71**	**0.70**	**11.43**	**6.97**	**3.71**	**256.39**

bonds or shares in U.S. companies) held by Chinese residents (including Hong Kong) were worth $US3.00 trillion at the start of 2015. Similarly, Chinese financial liabilities held by U.S. residents were worth $US1.14t.

The d^{th} diagonal entry in the table is the value of physical assets in region *d* held by residents of region *d*. Debts and liabilities between residents of region *d* are netted out.

The column totals in the table show values at the start of 2015 of wealth in each region. For example, U.S. wealth at the start of 2015 was $US47.70t made up of $US26.59t of domestic ownership of domestic capital *plus* foreign assets worth $US21.11t. These foreign assets consisted of $US1.14t of Chinese liabilities, $US1.09t of Japanese liabilities, $US0.21t of South Korean liabilities, etc.

The row totals show values at the start of 2015 of physical capital in each region. The value for region *s* is made up of ownership of domestic physical assets by residents of *s* (the diagonal entry) *plus* claims by foreigners on assets in *s*. For example, the table shows that at the start of 2015, physical assets in the U.S. were worth $US53.85t. Of this amount, $US26.59t was the value of U.S. physical assets owned by U.S. residents, while $US27.26t was the value of U.S. foreign liabilities. These foreign liabilities consisted of obligations (debts and equity) worth $US3.00t to China, $US2.06t to Japan, etc.

The difference between the column and row sums for a region is the region's net foreign assets. For the U.S., net foreign assets at the start of 2015 were -$US6.15t, that is the U.S. had net foreign liabilities of $US6.15t.

The row and column sums in Table 1 were derived from IMF data, see IMF (2018), and the GTAP database for 2014. The derivation of the shaded entries in the U.S./China block (north-west corner) of the table is described in Appendix 1. The rest of the table was derived by RAS. Given row and column totals, this technique fills in the entries in a matrix to be as close as possible to a plausible initial guess, see Bacharach (1970).[1] In summary, the shaded entries in Table 1 are genuine data, while the other entries are reasonable estimates. We judge that in its current form, with genuine U.S. and Chinese bilateral data, Table 1 adequately supports the applications presented in section 3.

In GTAP-Fin, the standard (real-side) GTAP model is linked with the asset-liability matrix through saving and investment behavior. The column totals (wealth) move in response to saving, which is determined in GTAP in relation to income. The column totals are also affected by changes in the prices of capital goods (capital gains and losses). The row totals (value of capital stocks) move in response to changes in prices of capital goods and investment in physical assets. In GTAP, creation of physical assets moves in response to expected rates of return on these assets. We assume that expected rates of return on financial assets reflect expected rates of return on underlying physical assets.

Given region *d's* wealth in year *t* (determined mainly by the region's accumulated saving from previous years), the allocation of this wealth between alternative assets (that is the allocation down *d's* column) is determined by a constrained optimization problem, see Appendix 2. The optimization problem in year *t* takes account of the allocation in year *t-1* (thus accounting for home bias and other existing bilateral links) and of changes between

[1] Details are in Appendix 3.

years *t-1* and *t* in expected rates of return on alternative assets. If, between years *t-1* and *t*, expected rates of return in region *s* increase relative to those in other regions, then on this account each region *d* allocates an increased proportion of its wealth towards assets in *s*.

Given wealth in each region (column totals) and expected rates of return on assets in each region, the decisions of the wealth allocators determine the row totals in the asset-liability table. But how can we be sure that movements in the row totals determined in this way are compatible with physical investment in each region? The equilibrating mechanism is the expected rate of return on physical assets.

One way to understand how this works is to adopt an initial guess for the expected rate of return on physical assets in each region. Because we link rates of return on physical and financial assets, this is sufficient to give us an initial guess of the expected rate of return relevant to every cell of the asset-liability table. Now we can determine the row sum for region *s* in two ways: (1) as an add-up of the allocations to *s* by the wealth optimizers in all regions *d*; and (2) as the value of physical assets in *s* determined by capital from the previous year and investment in the current year. If row sum (1) is greater than row sum (2), this means that asset allocators what to supply more funds to *s* than capital creators in *s* want to use. This disequilibrium is eliminated by a downward adjustment in the expected rate of return on physical assets in *s*. The downward adjustment reduces the asset allocation to *s*. At the same time, investment in *s* increases because more investment projects in *s* can generate the lower expected rate of return. Appendix 4 sets out this process with stylized algebra.

3. Financial decoupling between the U.S. and China

3.1. Setting up the simulations

In this section we report results from three simulations with GTAP-Fin. A simulation consists of two runs: a baseline or business-as-usual run, and a perturbation run. We adopt the same baseline run in all three simulations. This is generated under bland (pre-Covid) IMF assumptions concerning GDP and employment by region for the period 2015 to 2025. In the perturbation runs we introduce exogenous changes in U.S. asset holdings in China and Chinese asset holdings in the U.S. In terms of the asset-liability table, we shock the entries in the China row/USA column and in the USA row/China column. The effects of these shocks are calculated as differences between results in the perturbation run and those in the baseline run.

In the first simulation, the perturbation shock is a 50 per cent reduction in U.S. assets held in China phased in over three years, 2016, 2017 and 2018. In the second simulation, the perturbation shock is a 50 per cent reduction in Chinese assets held in the U.S., again phased in over these three years. The third simulation combines the shocks from the first two simulations.

The components of the asset-liability table are naturally endogenous (explained by the model). Thus, to shock the China-US and US-China entries we must change the closure (choice of endogenous and exogenous variables) so that these entries become exogenous. We do this via the equation:

$$R(s,d) = RK(s) * T(s,d) \qquad (3.1)$$

In this equation,

RK(s) is the expected rate of return on physical assets in region s;

R(s,d) is the rate of return expected by the asset-allocating agent in region *d* on assets purchased in region *s*; and

T(s,d) is a shift variable that allows us to introduce differences between rates of return anticipated by agents in region *d* on their investments in *s* and rates of return anticipated by other potential suppliers of funds to *s*.

Exogenous shifts in T(s,d) could be used in simulations of the effects of tax or other policies by *s* that either encourage or discourage funding by *d*. Alternatively, we can calculate the shift in T(s,d) required to achieve a given movement in *d's* funding of *s*. In this case, the movement in *d's* assets in *s* becomes exogenous and the movement in T(s,d) becomes endogenous. It is this closure change that we adopt in the three simulations.

In the perturbation run of simulation 1, T(China, USA) moves endogenously to achieve the exogenously imposed 50 per cent reduction in U.S. assets in China. All other components of T remain exogenous. In the perturbation run of simulation 2, T(USA, China) moves endogenously to achieve the exogenously imposed 50 per cent reduction in Chinese assets in the U.S. while all other components of T are exogenous. In the perturbation run of simulation 3, T(China, USA) and T(USA, China) are both endogenous while the other components of T are exogenous.

As explained in Appendix 2, by imposing the targets (the 50 per cent reductions) for the movements for U.S. assets in China and vice versa, we minimize the role in our simulations of the elasticity of substitution between alternative assets in the utility functions of the regional asset-allocating agents. This is advantageous because the value that we use for this parameter is a judgement, uninformed by convincing research.

While the computations were performed with the 18-region model, we report results for three regions: U.S., China and the other 16 regions aggregated as Rest of world (RoW). This keeps the presentation manageable, but it also seems reasonable in view of the data input to the model. The effects on a third country, say India, of a reduction in U.S. assets held in China depends on U.S. and Chinese bilateral financial positions with India. Table 1 presents a plausible guess of the U.S.-India and China-India positions, but not hard data. In these circumstances we can't be confident of identifying differences in the effects on India from those on other third countries. On the other hand, at the 3-region level (shown in Table 2) all of the entries are informed by hard data.

Table 2. Assets & liabilities at the start of 2015
3-region version of Table 1

	USA	China	RoW	Total
USA	26.59	3.00	24.26	53.85
China	1.14	31.95	7.70	40.79
RoW	19.97	7.62	134.16	161.74
Total	47.70	42.56	166.13	256.39

3.2. Results for asset and liability values

Table 3 shows results for end-of-year asset and liability values in the perturbation runs expressed as deviations from their baseline values.

3.2.1 Asset and liability values in simulation 1

In simulation 1, we phase in the 50 per cent reduction in U.S. asset holdings in China in three equal percentage installments: 20.63 per cent reduction in 2016 [see the (China,USA) entry in

Table 3. Effects of financial decoupling by U.S. and China on assets/liabilities, wealth and capital: percentage deviations from baseline*

	2016				2017				2018					2025			
	USA	China	RoW		USA	China	RoW		USA	China	RoW		…	USA	China	RoW	
Simulation 1. U.S. cuts assets held in China by 50%																	
				Capital				*Capital*				*Capital*					*Capital*
USA	0.50	-1.12	-0.21	0.08	0.92	-1.89	-0.34	0.19	1.26	-2.41	-0.44	0.28	…	1.34	-1.82	-0.38	0.36
China	-20.63	0.11	1.04	-0.28	-37.00	0.20	1.78	-0.51	-50.00	0.28	2.31	-0.67	…	-50.00	0.25	1.73	-0.58
RoW	0.68	-0.95	0.00	0.04	1.20	-1.62	-0.01	0.05	1.61	-2.08	-0.02	0.06	…	1.65	-1.53	-0.03	0.06
Wealth	0.05	-0.17	0.02		0.09	-0.28	0.03		0.13	-0.35	0.03		…	0.16	-0.22	0.00	
Simulation 2. China cuts assets held in the U.S. by 50%																	
USA	0.60	-20.63	1.37	-0.43	1.09	-37.00	2.53	-0.88	1.54	-50.00	3.57	-1.30	…	2.12	-50.00	4.75	-2.00
China	-3.35	1.59	-2.61	0.73	-5.95	2.88	-4.61	1.43	-8.07	3.84	-6.23	1.99	…	-8.77	3.38	-6.42	2.08
RoW	-1.01	4.05	-0.11	0.00	-1.89	7.33	-0.20	0.02	-2.66	9.94	-0.30	0.02	…	-3.43	9.43	-0.44	-0.02
Wealth	-0.17	0.44	-0.02		-0.34	0.83	-0.02		-0.47	1.10	-0.04		…	-0.52	0.76	-0.04	
Simulation 3. U.S. cuts assets held in China by 50% & China cuts assets held in the U.S. by 50%																	
USA	1.00	-20.63	1.13	-0.34	1.83	-37.00	2.13	-0.68	2.55	-50.00	3.05	-1.01	…	3.19	-50.00	4.27	-1.63
China	-20.63	1.62	-1.64	0.46	-37.00	2.94	-2.99	0.94	-50.00	3.94	-4.17	1.34	…	-50.00	3.50	-4.92	1.53
RoW	-0.39	3.04	-0.10	0.04	-0.80	5.58	-0.19	0.06	-1.21	7.67	-0.29	0.07	…	-1.98	7.80	-0.44	0.03
Wealth	-0.13	0.28	0.00		-0.25	0.56	0.00		-0.35	0.76	-0.01		…	-0.37	0.55	-0.04	

* Shaded entries are exogenous

the 2016 panel for simulation 1 in Table 3]; a further 20.63 per cent reduction in 2017 giving a cumulative -37.00 per cent deviation [see the (China,USA) entry in the 2017 panel for simulation 1]; and a final 20.63 per cent reduction in 2018 giving a cumulative -50.00 per cent deviation [see the (China,USA) entry in the 2018 panel for simulation 1]. The -50 per cent deviation is maintained to the end of the simulation [see the (China,USA) entry in the 2025 panel for simulation 1].

Simulation 1 shows that an exogenous reduction in U.S. assets in China causes a redirection of U.S. wealth towards domestic and RoW assets. By end-2025, U.S. holding of domestic assets is 1.34 per cent above baseline and U.S. holding of RoW assets is 1.65 per cent above baseline. These positive deviations for U.S. holdings of domestic and RoW assets slightly outweigh the 50 per cent reduction in U.S. holdings of Chinese assets, leaving U.S. wealth 0.16 per cent above baseline. As will be discussed in subsection 3.3.1, simulation 1 shows favorable macro effects for the U.S., generating extra income and saving, and thus extra wealth.

Redirection of U.S. funding towards domestic assets allows additional investment projects (projects with lower expected rates of return than in the baseline) to be undertaken. Consequently, capital in the U.S. increases (0.36 per cent in 2025).

For China, the reduction in capital inflow from the U.S. causes increased reliance on domestic sources to finance domestic capital (a 0.25 per cent increase in Chinese ownership of Chinese assets in 2025). Chinese ability to purchase foreign assets is reduced leading in 2025 to negative deviations in Chinese assets in the both the U.S. and RoW (-1.82 per cent and -1.53 per cent). The overall wealth effect for China in the long run is negative (-0.22 per cent in 2025). This reflects unfavorable macro effects for China, to be discussed in subsection 3.3.1. Capital in China is reduced (a deviation of -0.58 per cent in 2025). The redirection of U.S. funding causes elimination of some investment projects in China.

For RoW, there is reduced ownership of assets in the U.S. (-0.38 per cent in 2025). RoW ownership is displaced by U.S. ownership. At the same time, there is increased RoW ownership of Chinese assets (1.73per cent in 2025). RoW ownership fills part of the gap left by the U.S. The overall effect on RoW wealth in 2025 is negligible. However there is a small long-run positive effect on RoW capital (a deviation of 0.06 per cent). The reduction in the supply of funds from China is slightly outweighed by the increase in supply from the U.S. allowing a reduction in the expected rates of return required for RoW investment projects to be funded.

The asset-liability results for simulation 1 in 2018 are quite similar to those in 2025, implying that most of the effects take place within the implementation period for the shocks, 2016-18. However, U.S. capital continues to adjust beyond 2018 (from a deviation of 0.28 per cent in 2018 to a deviation of 0.36 per cent in 2025). This reflects lags built into GTAP's investment-capital accumulation specification. But what about China? In the early years the downward adjustment overshoots the long-run result (a deviation of -0.67 per cent in 2018 recovering to a deviation of -0.58 per cent on 2025). This reflects a recovery in Chinese employment which is initially reduced below baseline by the withdrawal of U.S. finance (see subsection 3.3.1).

3.2.2. Asset and liability values in simulation 2

The results from simulation 2 in Table 3 can be understood in qualitative terms by reworking the commentary from subsection 3.2.1 with China and U.S interchanged. Redirection of Chinese wealth away from the U.S. causes increased Chinese ownership of domestic assets (a deviation of 3.38 per cent in 2025) and assets in RoW (a deviation of 9.43 per cent in 2025). Favorable macro effects (see subsection 3.3.2) give China extra wealth (a deviation of 0.76 per cent in 2025). A greater supply of funds to China reduces the expected rate of return required for an investment project in China to proceed, leading to increased physical capital in China (a deviation of 2.08 per cent in 2025). For the U.S., the effects of China's withdrawal of funds causes reductions in wealth and physical capital (deviations of -0.52 per cent and -2.00 per cent in 2025). The U.S. reconfigures its wealth holdings: more funding of domestic assets and less funding of assets in both China and RoW.

Quantitatively the results in simulation 2 are larger than the corresponding results in simulation 1. The percentage wealth and capital increases in 2025 for China in simulation 2 are larger than those for the U.S. in simulation 1 (deviations of 0.77 and 2.08 per cent compared with 0.16 and 0.36 per cent). Similarly the percentage wealth and capital reductions in 2025 for the U.S. in simulation 2 are greater than those for China in simulation 1 (deviations of -0.52 and -2.00 per cent compared with -0.22 and -0.58 per cent).

Chinese holdings of assets in the U.S. at the start of 2015 were worth 2.6 times U.S. holdings of assets in China ($US3.00t compared $US1.14t, see Table 2). Consequently we can think of the shock in simulation 2 as being 2.6 times larger than the shock in simulation 1. However, this doesn't explain all of the difference in the scale of the effects in simulation 2 relative to simulation 1. The percentage wealth and capital effects in 2025 for China in simulation 2 are 4.8 and 5.8 times larger than those for the U.S. in simulation 1. We return to this problem in subsection 3.3.3.

3.2.3. Asset and liability values in simulation 3

The results from simulation 3 in Table 3 are approximately an addition of the results from simulations 1 and 2. For example the deviation in simulation 3 in U.S. holding of U.S. assets in 2025 is 3.19 per cent, approximately the sum of the deviations in simulations 1 and 2 (1.34+2.34). Thus, simulation 3 doesn't require separate explanation from simulations 1 and 2.

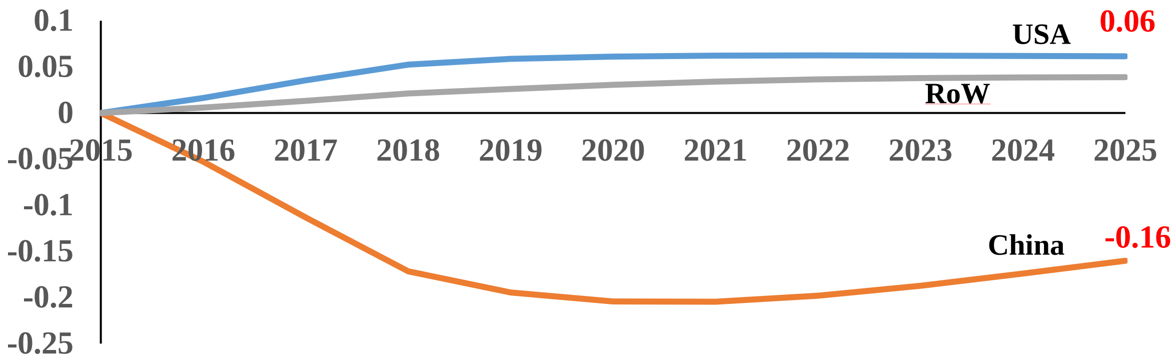
Apart from non-linearities in the model, there is one technical issue that prevents the add-up from being exact. Looking at the China-USA entries in the 2025 results, we see that the add-up cannot apply. In simulations 1 and 3, a shock of -50 per cent is imposed. In simulation 2, the China-USA entry moves endogenously by -8.77 per cent.

3.3. Macro results

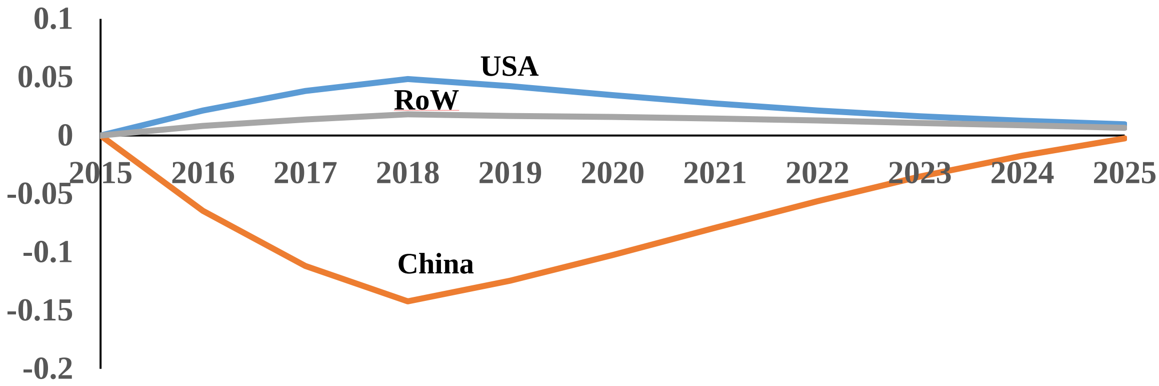
Figures 1, 2, and 3 show results from our three simulations for real GDP, employment and physical capital. In looking at these results, it is worth noting that in Table 3 in subsection 3.2 the deviation results for capital refer to *values* of physical capital stocks. In this section we are concerned mainly with *quantities* of physical capital stocks. The movements in values and quantities are similar because we assume no change in the world price level or nominal exchange rates. However, prices of capital in one country can change relative to prices in another so that movements in values and quantities of capital are not identical.

Figure 1. Simulation 1: U.S reduces its financial assets in China by 50% over 3 years

A. GDP: percentage deviations from baseline



B. Employment: percentage deviations from baseline



C: Capital: percentage deviations from baseline

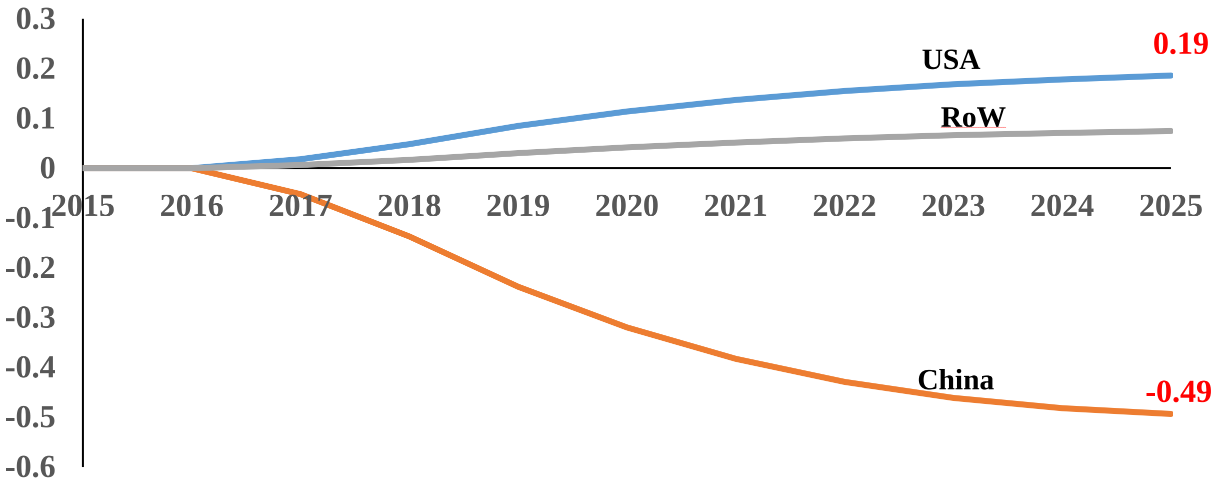
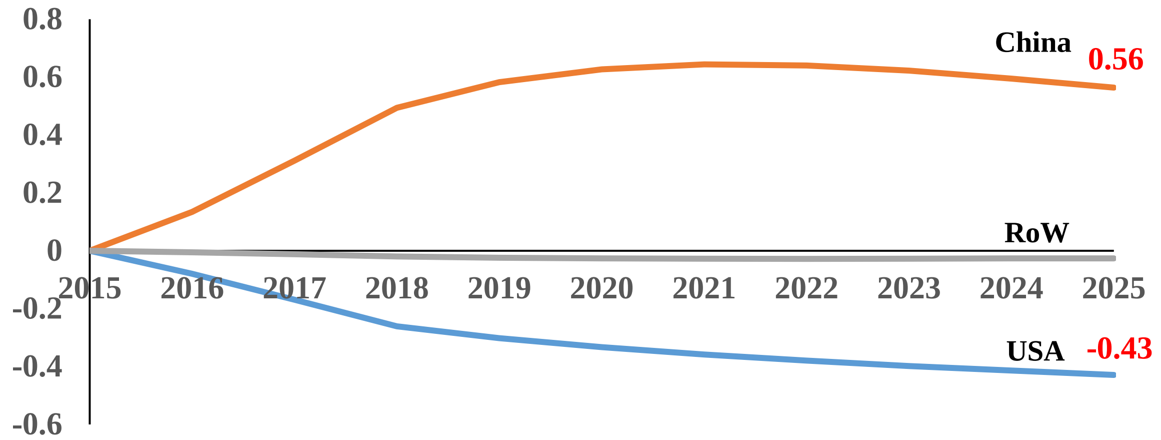
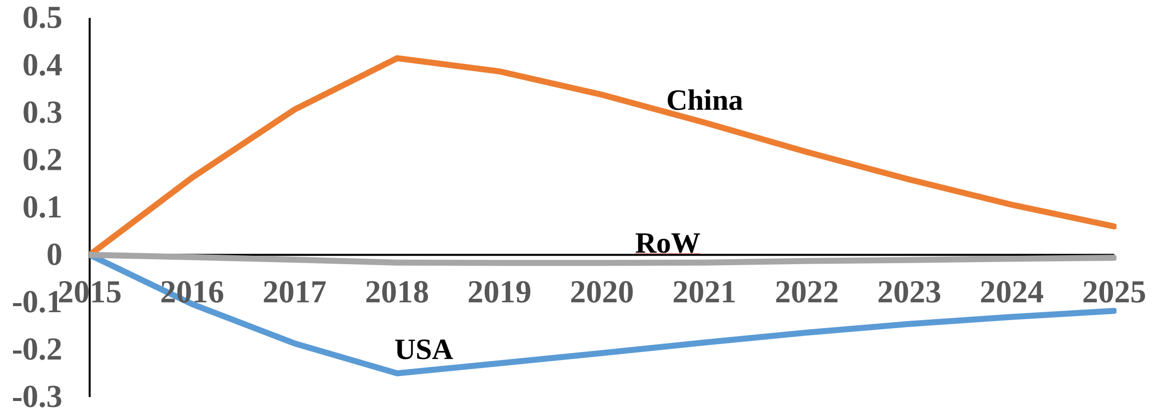


Figure 2. Simulation 2: China reduces its financial assets in the U.S. by 50% over 3 years

A. GDP: percentage deviations from baseline



B. Employment: percentage deviations from baseline



C: Capital: percentage deviations from baseline

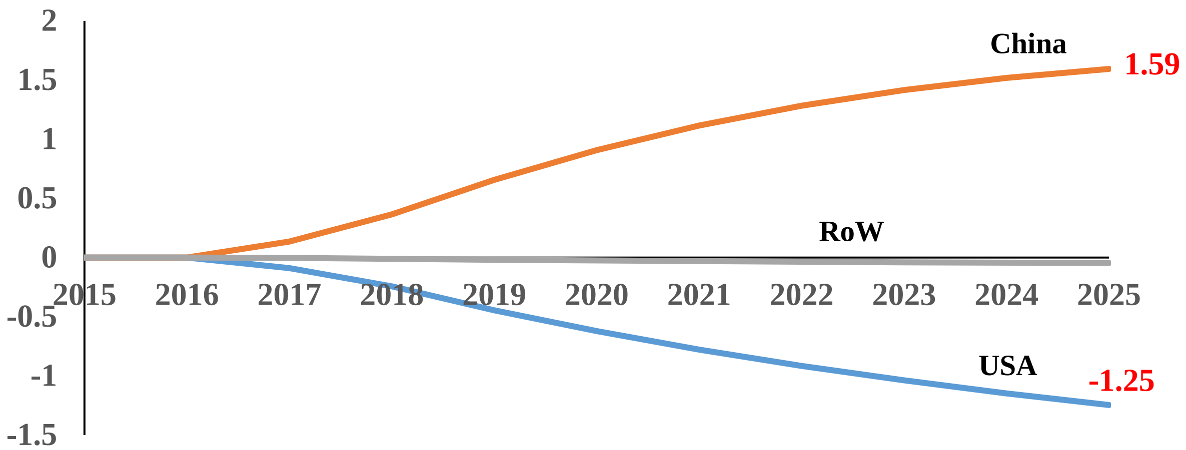
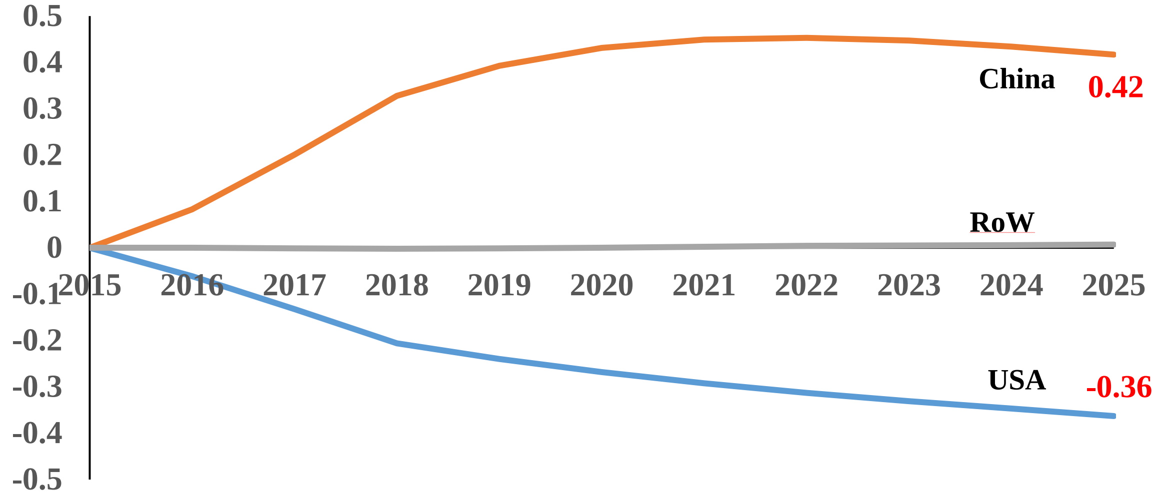
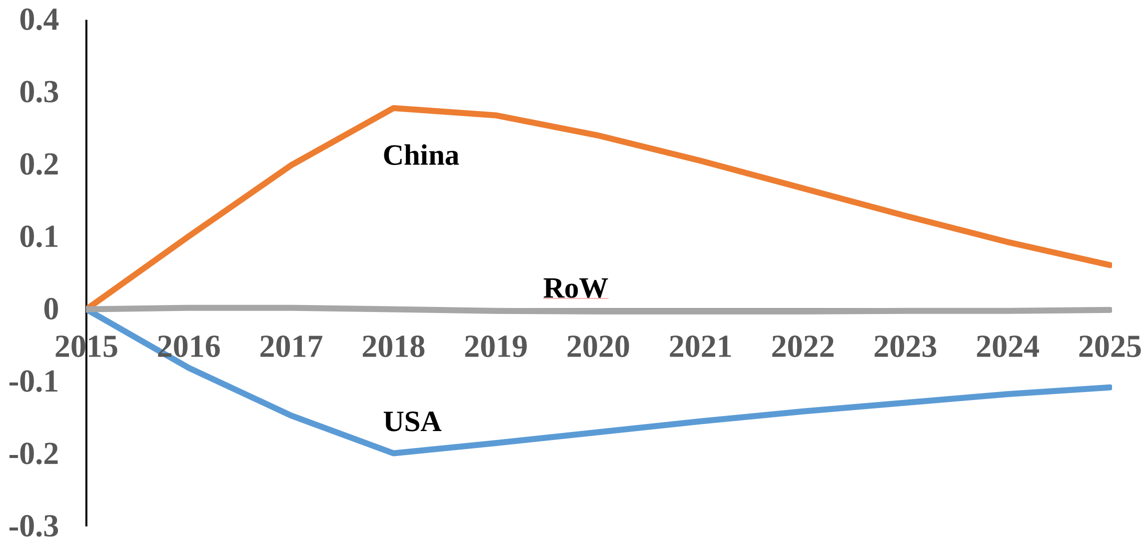


Figure 3. Simulation 3: U.S reduces its financial assets in China by 50% & China reduces its financial assets in the U.S. by 50% over 3 years

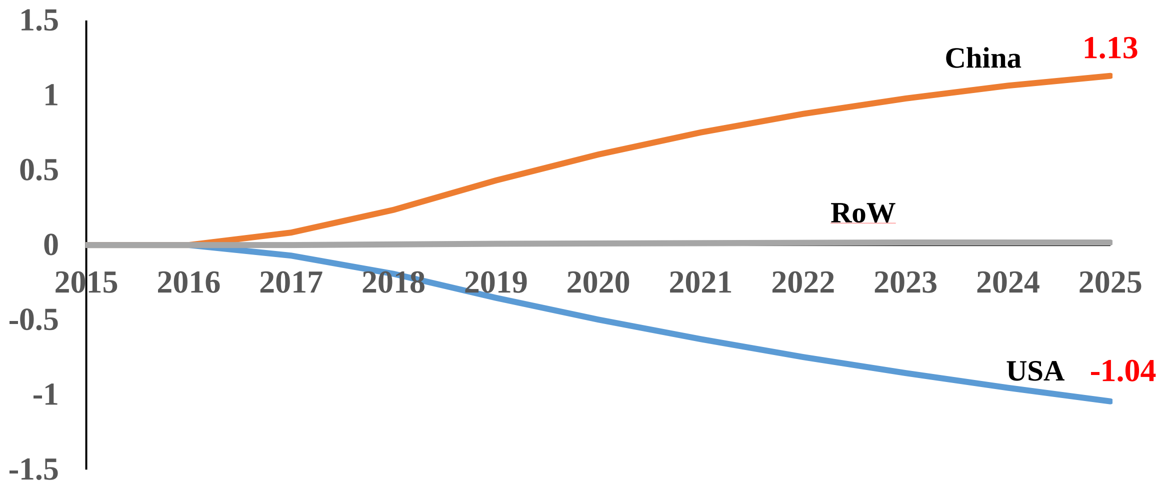
A. GDP: percentage deviations from baseline



B. Employment: percentage deviations from baseline



C: Capital: percentage deviations from baseline



3.3.1. Macro results in simulation 1

Reduction of U.S. assets in China redirects U.S. funding towards domestic assets. This reduces the expected rate of return required for an investment project in the U.S. to receive funding. Thus there is a boost to U.S. investment and, as illustrated in Figure 1C, the U.S. capital stock moves above baseline. Under the sticky-wage-adjustment mechanism built into GTAP-Fin, extra capital in the U.S. temporarily boosts U.S. employment (Figure 1B). Eventually wage rates adjust, returning employment to baseline, but leaving the benefit of a permanent increase in real wage rates. Both the capital and employment effects contribute to an increase in real GDP (Figure 1A).

Extra employment in the U.S. generates extra income and saving. Extra saving accumulates into extra wealth (a deviation of 0.16 per cent in 2025, Table 3). An effect captured by GTAP-Fin, but not shown here, that also contributes to the growth in U.S. saving and wealth in simulation 1 is an improvement in the U.S. terms of trade. Greater capital creation in the U.S. strengthens the real exchange rate and increases the price of exports relative to the price of imports.

The results for China in Figure 1 are qualitatively the opposite of those for the U.S. The withdrawal of U.S. funding increases required rates of return for investment in China. This reduces capital in China (Figure 1C), temporarily reduces employment (Figure 1B), reduces real GDP (Figure 1A), and reduces wealth.

For RoW, the effects are small but positive. As we saw earlier, in simulation 1 RoW gains investible funds from the U.S. and loses funds from China, but the gain outweighs the loss. RoW benefits from U.S. increased wealth because the U.S. invests about 42 per cent of its wealth in RoW ($US19.97t out of $US47.70t, Table 2). By contrast, China invests only about 18 per cent of its wealth in RoW ($US7.62t out of $US42.56t, Table 2).

3.3.2. Macro results in simulation 2

As in our discussion of Table 3, we can understand the macro results for simulation 2 in qualitative terms by reworking the results for simulation 1 with China and the U.S. interchanged. In simulation 2, the GDP, employment, capital and wealth effects for China are favorable (Figure 2 and Table 3), while for the U.S. they are unfavorable. For RoW, the effects are slightly unfavorable.

In subsection 3.2.2, we explained that the shock in simulation 2 can be thought of as being 2.6 times larger than that in simulation 1. But we saw that the factor of 2.6 didn't apply to wealth and capital: the percentage wealth and value-of-capital effects in 2025 for China in simulation 2 are 4.8 and 5.8 times larger than those for the U.S. in simulation 1. Now we see a similar phenomenon for the GDP and quantity-of-capital results. The percentage GDP and capital quantity effects in 2025 for China in simulation 2 are 9.3 and 8.4 times larger than those for the U.S. in simulation 1 (0.56 compared with 0.06 and 1.59 compared with 0.19, Figures 2 and 1).

The explanation is savings rates. For the U.S., savings is about 9 per cent of GDP whereas in China it is about 36 per cent. Thus, a GDP benefit for China translates much more strongly into a long-run wealth increase than a similar GDP benefit in the U.S.

3.3.3. Macro results in simulation 3

The macro results for simulation 3 are approximately the sum of those from simulations 1 and 2. Because simulation 2, which favors China, has a "bigger" shock than simulation 1, which favors the U.S., we would expect the combined simulation to be favorable to China. This is shown in Figure 3 where the GDP, employment and capital deviations for China are positive and those for the U.S. are negative. The favorable results for China in simulation 3 are not just a reflection of simulations 2's "bigger" shock. Even if the size of the shocks were equalized, China would still have a net benefit flowing from its high saving rate. We confirmed this by repeating simulation 3 but with the withdrawal of funds by China from the U.S. scaled down by a factor of 2.6 to match the withdrawal of funds by the U.S. from China.

4. Conclusion

Over the last 25 years, GTAP has been used in literally thousands of analyses of policies in which a region aims to discriminate in favor or against *trade flows* with another region. With the addition of a financial module, GTAP becomes a tool for analyzing the effects of policies in which a region aims to discriminate in favor or against *financial flows* with another region. We refer to this extended model as GTAP-Fin.

Section 3 reports the initial application of GTAP-Fin. We showed that the U.S. would gain by limiting its capital flows to China, leading to a redirection of finance to the domestic economy. This would stimulate investment in the U.S. with favorable temporary effects on employment and favorable permanent effects on capital stocks, real GDP, wealth and real wage rates. At the same time, investment in China would decline with negative effects on Chinese capital stocks, real GDP, wealth and real wage rates.

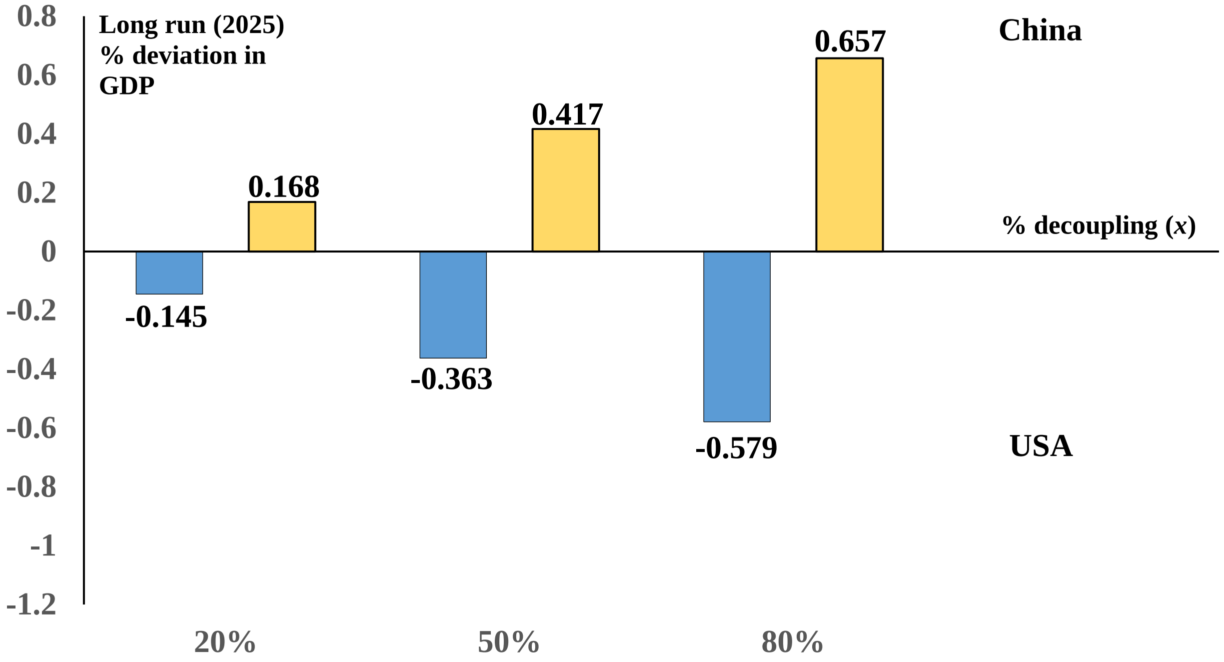
Similarly, China would gain by limiting its capital flows to the U.S. and the U.S. would lose.

In a tit-for-tat situation in which each country reduces it financial-asset holding in the other country by 50 per cent, the winner would be China. The primary reason is that the value of Chinese financial assets in the U.S. is considerably greater than the value of U.S. financial assets in China. A reinforcing mechanism is that initial gains for China are translated strongly into long-run gains through China's very high saving rate. A low saving rate for the U.S. means that this mechanism is weaker in the U.S.

Many other experiments could be conducted to investigate implications of U.S.-China financial decoupling. Figure 4 shows long-run GDP effects of different levels of financial decoupling: 20%, 50% and 80%. The 50 per cent results are those from simulation 3. Notice that the results in Figure 4 imply an approximately linear relationship between the percentage of decoupling and the percentage deviations in GDP. This means that approximately valid results can be obtained by linear combinations of the results presented in section 3, without re-running the model.

In Appendix 7, we present simulation results on the effects of different levels of *trade* decoupling. These can be compared with the effects of *financial* decoupling. We interpret x per cent trade decoupling as a situation in which the U.S. reduces its imports of all commodities from China by x per cent and China reduces its imports of all commodities from the U.S. by x per cent. In our simulations we limit trade between the two countries by the imposition of tariffs.

Figure 4. U.S. reduces its financial assets in China by x% and China reduces its financial assets in the U.S. by x%



As shown in Figure 5, trade decoupling reduces GDP in both countries, more in China than in the U.S. Appendix 7 explains that existing Chinese tariffs mean that limiting trade has particularly adverse efficiency effects on Chinese GDP. Unlike Figure 4, the effects in Figure 5 are quite far from linear. For example, the effect on U.S. GDP is multiplied by a factor of 3.78 (= 0.208/0.055) when decoupling increases from 20 per cent to 50 per cent (a factor of 2.5). This reflects the idea that raising the landed-duty-paid price of an import by 1 per cent through an increase in an already *high* tariff has a more negative percentage effect on GDP than raising the landed-duty-paid price of an import by 1 per cent through an increase in a *low* tariff.

Figure 5. U.S. reduces its imports from China by x% and China reduces its imports from the U.S. by x%

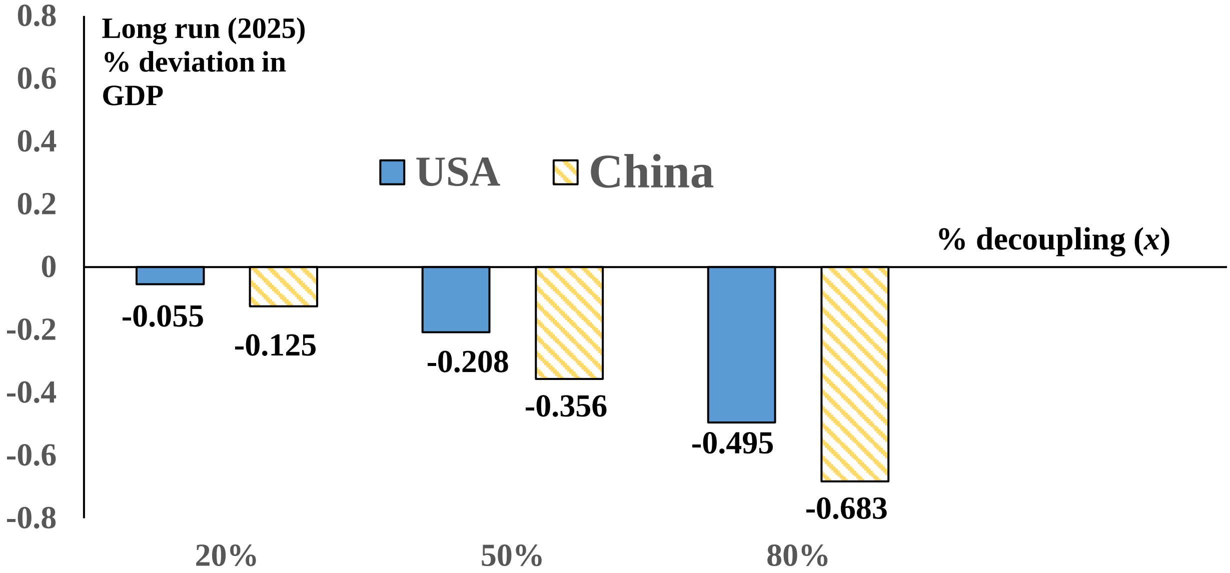
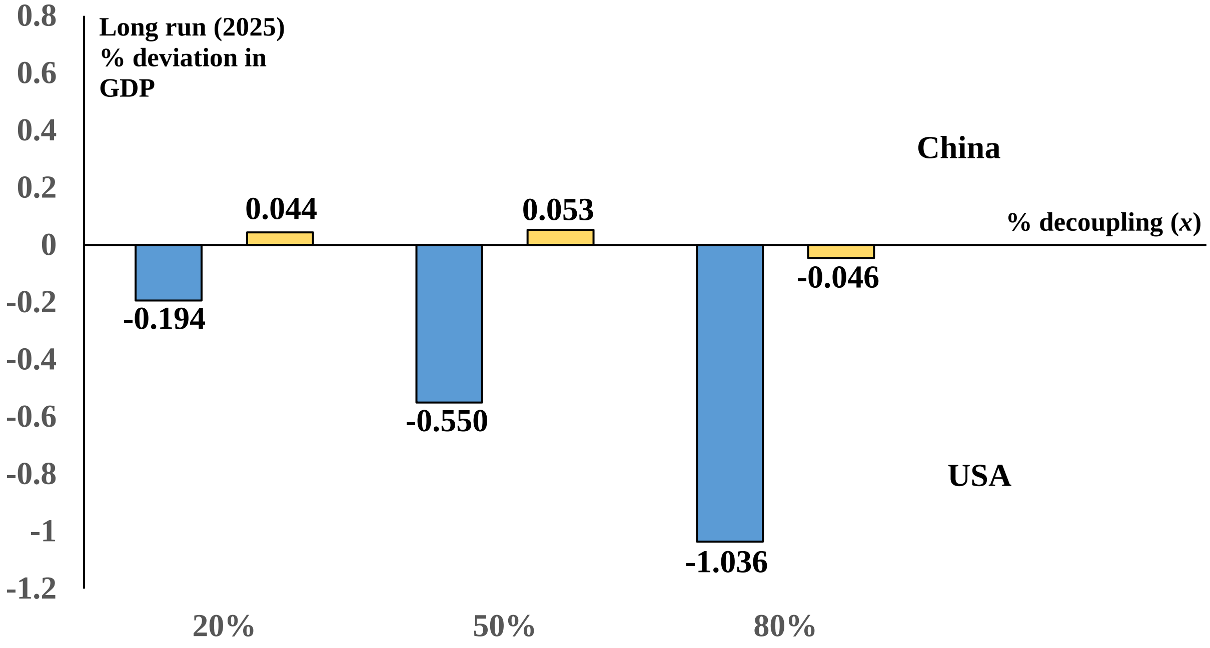


Figure 6 shows that in combination with financial decoupling, trade decoupling largely eliminates any GDP gain that China would obtain from financial decoupling. For the U.S., trade decoupling would add to the GDP loss suffered from financial decoupling.

Figure 6. U.S. and China reduce their financial assets in each other's countries by x% and also reduce their imports from each other by x%



Since 2014, we have added financial modules to several single-country computable general equilibrium models.[2] The financial modules in these single-country models disaggregate financial instruments into loans, bonds, equity, cash, and special drawing rights & gold. There are also separate asset-allocating optimization decisions for households, banks, non-bank financial institutions, retirement funds, industries and government. We are working towards introducing these disaggregations into the multi-country GTAP framework presented here.

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[2] Papers describing and applying CoPS CGE financial models include: Dixon *et al.* (2015), Giesecke *et al.* (2016 & 2017), and Nassios *et al.* (2019a & b).

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Appendix 1. Estimating the foreign assets and liabilities of the U.S. and China

This appendix explains how we derived the USA-China and China-USA entries in the assets/liability table for the start of 2015 (Table 1). There are small discrepancies between the estimates derived here and the corresponding entries in Table 1. For example, our USA-China estimate is $US3.03t whereas the entry in Table 1 is $US3.00t. The discrepancies were caused by the RAS procedure.

A1.1. U.S. foreign assets and liabilities

All countries

The "All countries" columns Table A1.1 show the foreign assets and liabilities of the U.S. at the start of 2015 and the start of 2020. The data in rows 2, 6, 7, 9 and 13 are from BEA IIP Table 1.2 available at https://apps.bea.gov/itable/itable.cfm?reqid=62&step=6 . The data in rows 4 and 5 are from the U.S. Treasury, available at https://www.treasury.gov/resource-center/data-chart-center/tic/Pages/ticsec2.aspx . The data in rows 11 and 12 are from the U.S. Treasury, available at https://ticdata.treasury.gov/Publish/shlhistdat.html . Rows 1 and 8 are derived by addition. The entries shown in these rows are close to the BEA estimates, but not exactly consistent because we used Treasury numbers in rows 4 and 5 and 11 and 12.

China & Hong Kong

The "China & HK" columns of Table A1.1 show U.S. financial claims on China & Hong Kong (part of U.S. assets) and China & Hong Kong financial claims on the U.S. (part of U.S. liabilities). The entries in row 2 were derived by looking at the Chinese&HK share in U.S. direct assets in the BEA's "Balance of Payments and Direct Investment Position Data, U.S. Direct Investment Abroad, U.S. Direct Investment Position Abroad on a Historical-Cost Basis"available at https://apps.bea.gov/iTable/iTable.cfm?ReqID=2&step=1 . The entries in row 9 were derived by looking at the Chinese&HK share in U.S. direct liabilities in the BEA's "Balance of Payments and Direct Investment Position Data, Foreign Direct Investment in the U.S., Foreign Direct Investment Position in the United States on a Historical-Cost Basis" available at https://apps.bea.gov/iTable/iTable.cfm?ReqID=2&step=1. The data in rows 4 and 5 are from the U.S. Treasury, available at https://www.treasury.gov/resource-center/data-chart-center/tic/Pages/ticsec2.aspx . The data in rows 11 and 12 are from the U.S. Treasury, available at https://ticdata.treasury.gov/Publish/shlhistdat.html . The entries in rows 6 and 13 were derived as the "China & Hong Kong" share of U.S. trade applied to the U.S. entries for "Other investment". Note, Other investment is mainly bank accounts and loans which we interpret as being motivated to facilitate trade. Rows 1 and 8 are derived by addition.

A1.2. Chinese foreign assets and liabilities

China & Hong Kong

The entries in rows 2, 4, 5 and 6 of the "U.S." columns of Table A1.2 are taken from liability entries in Table A1.1. The entries in rows 9, 11, 12 and 13 are taken from asset entries in Table A1.1. Rows 1 and 8 are derived by addition.

Table A1.1. U.S. foreign assets and liabilities

		Start 2015		Start 2020	
		All countries	China & HK	All countries	China & HK
1	U.S. foreign assets (excl derivatives)	21.11	1.17	26.62	1.47
2	Direct investment	7.24	0.21	8.80	0.29
3	Portfolio investment				
4	Debt	2.49	0.006	3.17	0.02
5	Equity	6.70	0.266	9.46	0.390
6	Other investment	4.25	0.69	4.67	0.76
7	Reserve assets	0.43		0.51	
8	U.S. foreign liabilities (excl derivatives	28.52	3.03	37.58	3.12
9	Direct investment	6.38	0.04	10.55	0.12
10	Portfolio investment				
11	Debt	10.27	1.71	11.90	1.64
12	Equity	6.51	0.40	8.63	0.30
13	Other investment	5.36	0.88	6.50	1.06

Table A1.2. China's foreign assets and liabilities

		Start 2015		Start 2020	
		All countries	U.S.	All countries	U.S.
1	China foreign assets (excl derivatives)	10.615	3.03	13.429	3.12
2	Direct investment	1.083	0.04	2.483	0.123
3	Portfolio investment				
4	Debt	3.698+?	1.71	3.120+?	1.640
5	Equity	?	0.40	?	0.300
6	Other investment	?	0.88	?	1.062
7	Reserve assets	0.142		0.120	
8	China foreign liabilities (excl derivatives)	8.141	1.17	9.728	1.47
9	Direct investment	?	0.21	?	0.292
10	Portfolio investment				
11	Debt	?	0.006	?	0.023
12	Equity	?	0.266	?	0.390
13	Other investment	?	0.69	?	0.763

All countries

The data in rows 1 and 8 in the "All countries" columns in Table A1.2 are derived from the IMF, available at https://data.imf.org/regular.aspx?key=60961513 . This source ends at end-of-year 2018. We extended this to end-of-year 2019 (start 2020) by extrapolation. We derived the data in row 2 by accumulating China's direct investments in each year from 2005, assuming a 3 per cent annual rate of appreciation (inflation above the rate of depreciation). These direct investments are given in https://www.aei.org/china-global-investment-tracker/ .

The data in rows 4 and 7 of the 2020 "All countries" column of Table A1.2 are a split of China's official reserves from *China's State Administration of Foreign Assets*, "Official reserve assets - July 2020", available at https://www.safe.gov.cn/safe/2020/0207/15340.html . We obtained official reserves for start 2015 as 3.84 trillion, see chart in https://en.wikipedia.org/wiki/Foreign-exchange_reserves_of_China#:~:text=The%20foreign%2Dexchange%20reserves%20of,national%20currency%20(the%20renminbi).&text=The%20composition%20of%20foreign%2Dexchange,a%20state%20secret%20in%20China . We split the 3.84t between portfolio debt assets and reserve assets in the 2020 proportions.

The "All countries" columns of Table A1.2 contains question marks. In row 4, these draw attention to the idea that official reserves are likely to be only part of China's portfolio debt assets. The question marks in the other rows are where we haven't done sufficient work to nail down an entry.

A1.3. Interpretation

Table A1.1 tells us that in 2020 China is the destination for 5.5 per cent of U.S. capital outflow (= 100*1.47/26.62). China receives only about 3 per cent of U.S. Direct foreign investment (=100*0.29/8.80). The U.S. holds almost no portfolio debt instruments issued by Chinese agents. About 4 per cent of U.S. portfolio equity assets are liabilities of China (=100*0.39/9.46). The most significant asset that U.S. residents hold in China is in the category Other investment. This is mainly bank balances and loans, consistent with China being a major trade partner for the U.S.

Table A1.1 shows that the U.S. owes China $3.12t. This is 8.3 per cent (=100*3.12/37.48) of U.S. foreign liabilities, or about 15 per cent of GDP. Over half of what the U.S. owes China is debt. While not shown in the table, we know that this is predominately U.S. government bonds held by Chinese government instrumentalities. The only other significant number in U.S. liabilities to China is Other investment, mainly bank balances and loans consistent with China's status as a major trade partner.

Table A1.2 is not as complete as Table A1.1. Nevertheless, we can see from Table A1.2 that the U.S. is a major destination for Chinese capital outflow. In 2020, assets in the U.S. accounted for 23.2 per cent of Chinese foreign assets (= 100*3.12/13.429). Very little of Chinese investment in the U.S. is direct or even portfolio equity. Most of Chinese assets in the U.S. are portfolio debt ($1.64t) or bank deposits and loans ($1.062t).

U.S. residents hold about 15 per cent of the foreign liabilities issued by China (=100*1.47/9.728). About 46 per cent of U.S. assets in China are equity (direct investment and portfolio equity), and about 51 per cent are bank balances and loans (Other investment).

Our impression from Tables A1.1 and A1.2 is that from the U.S. point of view, China is probably more important as a trade partner than as a finance partner. From China's point of view, the U.S. is a moderately important destination for parking surplus funds.

Appendix 2. Optimizing behavior for the foreign-asset allocating agent in country r

In year *t*, the asset-allocating agent in region r chooses r's end-of-year distribution of wealth across domestic and foreign assets to maximize

$$U_r\left[R(s,r)*Z1(s,r),\ \text{for all s}\right] \qquad \text{(A2.1)}$$

subject to

$$\sum_s Z1(s,r) = ZTOT1(r) \qquad \text{(A2.2)}$$

where

U_r is *r's* objective function;
Z1(s,r) is the end-of-year value of *r's* assets in *s* (the s,r entry in the asset-liability table);
ZTOT1(r) is the end-of-year value of *r's* wealth (the sum down the r^{th} column of the asset-liability table); and
R(s,r) is the rate of return that *r* expects on its assets in *s*.

We assume that U_r is a CES function with substitution elasticity σ. We also assume that the allocation of *r's* wealth at the start of year *t* is consistent with the solution of (A2.1) and (A2.2) conducted with R and ZTOT1 values for year *t-1*. Under these assumptions, we can derive the percentage-change form:

$$z1(s,r) = ztot1(r) + (\sigma - 1)*\left(r(s,r) - \sum_j Sh(j,r)*r(j,r)\right) \qquad \text{(A2.3)}$$

where

z1(s,r) is the percentage change between years *t*-1 and *t* in the end-of-year value of *r's* assets in *s*;
ztot1(r) is the percentage change between years *t*-1 and *t* in the end-of-year value of *r's* wealth;
r(s,r) is the percentage change between years *t*-1 and *t* in the rate of return that *r* expects on its assets in *s*; and
Sh(j,r) is the share of *r's* wealth that is held as assets in *j*. This share is calculated as

$$Sh(j,r) = Z1(j,r)/ZTOT1(r) \qquad \text{(A2.4)}$$

In (A2.4), Z1(j,r) and ZTOT1(r) are calculated at values approximately half way between their end-of-year *t-1* and end-of-year *t* values. Because the values in the initial year (2015 in the simulations in section 3) are consistent with the real world situation, our optimization problem preserves home biases and existing bilateral links. The database shares are modified gradually by reallocations caused by changes in relative expected rates of return.

As explained in section 3, our simulations show the effects of exogenous movements in z1(China,USA) and z1(USA,China). The parameter σ, which we set at 3, is important in determining the movements in r(China,USA) and r(USA,China) required to achieve the exogenous movements in z1(China,USA) and z1(USA,China). But we are not concerned with the results for r(China,USA) and r(USA,China). Once we have specified z1(China,USA) and z1(USA,China), the model determines the reallocation of Chinese and U.S. assets and the consequent effects on the two economies and the rest of the world in a way that is largely independent of σ.

Appendix 3. Estimating the asset-liability table for the start and end of 2015

We started by estimating a foreign-asset-foreign-liability (FA-FL) table for the start of 2015. An FA-FL table is an asset-liability table (such as Table 1) but with zeros on the diagonal.

Using IMF data we derived start-of-2015 values for foreign assets and foreign liabilities for each of the 18 regions. This gives us column and row sums for the FA-FL table. Using the method outlined in Appendix 1 we derived the China-USA and USA-China components of the FA-FL table. Then we applied a slightly modified RAS to fill in the rest of the FA-FL table. We derived the starting point for the RAS by setting the regional compositions of each country's foreign liabilities to reflect the regional composition of world foreign assets. If region *d* accounts for *x* per cent of world foreign assets, then in our initial guess we assume that region *d* holds *x* per cent of the liabilities of each region *s*. The slight modification ensured that the RAS process introduced minimal movements in the China-USA and USA-China components.

Other parts of the 2015 database give us start-of-year values for capital in each region. Using the capital data together with the start-of-year values for foreign liabilities, we can derive start-of-year values for the diagonal components (domestic ownership of domestic assets) of the asset liability table, thus completing the derivation of the start-of-year table for 2015. Then we can derive start-of-year values for wealth in each region.

We also require an end-of-2015 asset-liability table. The model's database includes investment and saving for 2015. This allows us to derive end-of-2015 estimates for capital and wealth (row and column totals of the required asset and liability table). We derived the diagonal components for the end-of-2015 table by solving the following three equation system:

$$W = DA + FA \tag{A3.1}$$

$$K = DA + FL \tag{A3.2}$$

$$DA = \mu * FA^{0.5} * FL^{0.5} \tag{A3.3}$$

where

W is the end-of-year wealth for a region (column total for the region in the asset-liability table, known);
DA is the end-of-year value for the region of domestic ownership of domestic assets (diagonal component);
FA is the end-of-year value of the region's foreign assets (sum of the off-diagonal components of the region's column);
K is the end-of-year value of the region's capital stock (row total, known);
FL is the end-of-year value of the region's foreign liabilities (sum of the off-diagonal components of the region's row); and
μ is determined from (A3.3) by using start-of-year values for FA, FL and DA.

The unknowns in this system are FA, FL and DA. Equations (A3.1) and (A3.2) are identities. (A3.3) is an equation introduced into GTAP by Ianchovichina and McDougall (2012). In their version of GTAP, (A3.3) operates in the solution for every year. We use this equation only in establishing the end-of-year asset-liability table in the database year, 2015.

To solve the three equation system we substitute from (A3.1) and (A3.2) into (A3.3) to obtain the quadratic equation

$$\left(\mu^2-1\right)*FL^2+\left(\mu^2*W-\mu^2*K+2*K\right)*FL-K^2=0 \tag{A3.4}$$

which we solve in the GEMPACK for FL as:

$$FL=\frac{-\left\{\left(\mu^2*W-\mu^2*K+2*K\right)\right\}+\left[\left\{\left(\mu^2*W-\mu^2*K+2*K\right)\right\}^2+4*\left(\mu^2-1\right)*K^2\right]^{0.5}}{2\left(\mu^2-1\right)} \tag{A3.5}$$

FA and DA can then be deduced from (A3.1) and A3.2)

A3.1. Interpretation of (A3.1) – (A3.3)

Given the determination of μ from start-of-year values we know that if the end-of-year values of W and K happen to be the same as the start-of-year values, then the end-of-year values of FA, FL and DA will be the same as start-of-year values. If W and K both increase by *x* per cent, then FA, FL and DA will also increase by *x* per cent.

What if the end-of-year value for K is greater than the start-of-year value but the end-of-year value for W is the same as the start-of-year value? By working through the four possibilities (both FA and FL increase, both decrease, etc,) we can quickly establish that FL must increase, FA must decrease and DA must increase. We can think of this as being the situation in which a region discovers new mineral resources with an immediate growth in investment and foreign-capital inflow, and relatively little growth in wealth. Quite reasonably, under these circumstances, (A3.1) – (A3.3) implies that the region would share the financing of the extra investment with foreigners (DA increases) by reducing its foreign assets (FA decreases).

What if the end-of-year value for W is greater than the start-of-year value but the end-of-year value for K is the same as the start-of-year value? By working through the four possibilities we can establish that FA must increase, FL must decrease and DA must increase. We can think of this as being the situation in which a region gets a windfall gain from a terms-of-trade improvement with an immediate growth in wealth but relatively little growth in capital. Quite reasonably, (A3.1) – (A3.3) implies that the region would acquire more foreign and domestic assets (FA and DA increase) while at the same time reducing its foreign liabilities (FL decreases).

Once we have put in place end-of-year values for FA and FL for each region, we can finish the estimation of the end-of-year FA-FL table by a second RAS. This time with use the start-of-year FA-FL table as the initial guess. With the end-of-year diagonal components (the DA's) already estimated, this completes the estimation of the end-of-year asset-liability table for 2015.

Appendix 4. Regional investment and rates of return in GTAP-Fin

Investment in each region is determined by the interaction of demand for and supply of investible funds.

The expected rate of return on physical investment projects in region s [rore(s)] is a downward-sloping function of the volume of investment in region s (see equation ROREXPECTED). This can be thought of as the demand curve.

Expected rates of return on financial investments in s by r [rore_s(s,r)] are linked to the expected rate of return on physical investment projects [see equation E_rore_s].

The supply of investible funds to region s is an aggregate of the supply from each region r. Via the asset-optimizing specification [see E_wqht1_d and E_wqhf1a], the supply from region r to s is an increasing function of the rate of return expected by r on its financial investments in s relative to the rate of return it expects on its financial investments in other regions.

The global supply of funds is equal to global investment. This is what determines the absolute levels of expected rates of return. To see how this happens, we write stylized versions of the demand and supply functions for investible funds:

$$W(s,r) = F_{s,r}\left(1, \frac{R(2)}{R(1)}, ..., \frac{R(n)}{R(1)}; S(r)\right) \quad r = 1, 2, \ldots, n, \ s=1, 2, \ldots, n \qquad (A4.1)$$

$$Z(s) = \sum_{r \in Reg} W(s,r) \quad s=1, 2, \ldots, n \qquad (A4.2)$$

$$I(s) = I_s\left(R(s)\right) \quad s=1, 2, \ldots, n \qquad (A4.3)$$

$$Z(s) = I_s(s) \quad s=1, 2, \ldots, n \qquad (A4.4)$$

Equation (A4.1) is a stylized version of the solution to r's asset optimization problem. In this equation:

W(s,r) is funds supplied from r to s;
R(s) is the rate of return expected by each region r on funds supplied to s (for simplicity we assume here that there are no wedges between rates on return on physical and financial assets); and
S(r) is saving in region r.

Equation (A4.2) defines the supply of investible funds to region s, Z(s). Equation (A4.3) is a stylized version of GTAP equation, ROREXPECTED, that relates expected rates of return to levels of investment. Equation (A4.4) equates investment and supply of investible funds in each region.

We rewrite (A4.1) – (A4.4) as:

$$I_s(R(s)) = \sum_{r \in Reg} F_{s,r}\left(1, \frac{R(2)}{R(1)}, ..., \frac{R(n)}{R(1)}; S(r)\right) \quad s=2, \ldots, n \qquad (A4.5)$$

$$I_1(R(1)) = \sum_{r \in Reg} F_{1,r}\left(1, \frac{R(2)}{R(1)}, ..., \frac{R(n)}{R(1)}; S(r)\right) \qquad (A4.6)$$

(A4.5) – (A4.6) has n equations to solve for R(1) to R(n). We would expect to be able to solve the system either directly or iteratively.

A possible iterative approach which illustrates the idea that the absolute levels of expected rates of return is determined by the equality between the global supply of funds and global investment is as follows. Guess the absolute level of rates of return by guessing R(1). Given a value for R(1), (A4.5) can be solved for R(2), …, R(n). Then we can check in (A4.6). If the left hand side is greater than the right hand side, then our guess for R(1) is too low: it implies that global investment is greater than global saving.[3] So R(1) needs to be increased. This will reduce the left hand side of (A4.6) (decrease investment that can be undertaken in region 1) and increase the right hand side (more money is lent to region 1 when R(1) is increased). With a new increased value for R(1) we return to (A4.5) and resolve for R(2) to R(n).

Appendix 5. Why we include an endogenous slack in the add up equation for foreign liabilities (E_wqtf1)

Our model implies that global savings equals global investment in each year. This is enough to ensure that global wealth at the end of each year is equal to the value of global capital. Hence,

$$\sum_r W1(r) = \sum_r VK1(r) \qquad (A5.1)$$

where

W1(r) and VK1(r) are end-of-year wealth and value of capital in region r.

Via equations E_wqht1 and E_wq_f1 in the GEMPACK code for GTAP-Fin, we enforce the identities

$$W1(r) = DA1(r) + FA1(r) \qquad (A5.2)$$

$$VK1(r) = DA1(r) + FL1(r) \qquad (A5.3)$$

where

DA1(r) is r's end-of-year ownership of capital in region r; and

FA1(r) are FL1(r) are r's end-of-year foreign assets and foreign liabilities.

With d_chk_wqht1(r) exogenous on zero, the GEMPACK code enforces the identity

$$FA1(d) = \sum_s A1(s,d) \qquad (A5.4)$$

where

A1(s,d) is d's end-of-year foreign assets held in s.

Via E_wqtf1 we include an equation that in stylized form can be written as

$$FL1(s) = \sum_d A1(s,d) \quad + \quad SLACK \qquad (A5.5)$$

If SLACK is exogenous on zero, then (A5.5) enforces the identity that s's end-of-year foreign liabilities are the sum of liabilities incurred in each country d [A1(d,d) = 0]. However, the

[3] $Globalsav = \sum_r \sum_s W(s,r)$. If LHS of (A4.6) > RHS, we have

$Globalinv = I_1(1) + \sum_{s=2,...,n} I_s(s) = I_1(1) + \sum_{s=2,...,n} \sum_r W(s,r) > \sum_r W(1,r) + \sum_{s=2,...,n} \sum_r W(s,r) = Globalsav$.

system (A5.1) to (A5.5) implies that SLACK equals zero endogenously. Thus, SLACK cannot be set exogenously or omitted from (A5.5).

Appendix 6. Development of closures for GTAP-Fin

The baseline for the simulations in this paper used the closure up to the end of Part 2 below. Then the policy in the simulation 1 (section 3) used the closure through to the end of Part 3.

```
!*******************************************************************************!
!  ********** 1.  SETTING UP A STANDARD SHORT-RUN CLOSURE  **********************!
!  ******************************************************************************!
!  The main features of this closure are:
!  (i) regional employment determined exogenously but split endogenously between
skilled and non-skilled
!  (ii) regional capital predetermied from end of year capital in previous year
!  (iii) complete capital mobility between industries within a region
!  (iv) split of net national product (NNP) in each region between public
consumption,
!       private consumption and saving is effectively exogenous
!  (v) investment in each region adjusts to generate an expected rate of return
compatible with
!       willingness to finance by asset-allocating optimizing agents (see Appendix
4)

Exogenous
!  Most of these variables are from standard GTAP and are usually exogenous
          pop
          psaveslack
          pfactwld   ! Numeraire
          profitslack incomeslack endwm_slack
          endws_slack
            tradslack
          ams3 ams4 atm atf ats atd
          aosec aoreg avasec avareg
          afcom afsec afreg afecom afesec
          afereg aoall afall afeall aflab
          au dppriv dpgov
          ff_cgdsgdp  ! scalar shifter in equation that links investment to GDP
          fdpsave
          f_qg
          to tp tm tms tx txs
          qo(ENDWS_COMM,REG) ! exogenous treatment of Land and Natural resources
          f_rw_pt tpm  tpd
          lsreg
          f_ls ! Turn on labour supply function for skilled and unskilled
          ff_rorc
          uepriv
          ads ams2
          fsave ! Allows saving in each region to be determined as an exogenous
fraction of NNP
          f_qo_LAB ! Links employment to labor supply
          rorg ! We turn off the equation in which this variable appears by
endogenizing cgdslack
```

```
! Exogenous variables to record baseline values that will be useful in the short-
run
! specification of sticky wages
          f_realwage_o ! Shift in equation that sets the value of realwage_o
          ftax_l_r_o ! Shift in equation that sets the value of tax_l_r_o
          f_rwage_pt_o ! Shift in equation that sets the value of realwage_pt_o
          f_qo_o ! Shift in equation that sets the value of qo_o for skilled and
unskilled labor
          f_ls_o ! Shift in equation that sets the value of ls_o for skilled and
unskilled labor

! The following 5 variables come to life in the closure used to generate
! year-on-year solutions with industry specific capital.
          tfg tfph ! Introduces genuine and phantom powers of taxes on the use of
endowments.
                    ! These variables play a key role when we switch from
homogeneous
                    ! capital within regions to industry-specifica capital within
regions
          del_unity ! Moves from zero to one to distinguish between first and
subsequent years
          ff_rore ! Introduced so that we can turn off the standard GTAP
investment
                  ! theory where capital is homogeneous in regions.
          f_rore_i ! Shifter to allow expected rates of return to be equalized
across inds in regions
                   ! This variable does not appear in standard GTAP where capital
is homogeneous
                   ! within regions

!  Shift variables in the specification of asset-optimizing behaviour
          ff_pen !  Shift in relative rate-of-return expectations on asset
acquisitions in s, reflects relatice confidence in s
          ror_penalty ! Can be used to change region d's expected rate of return
on holding assets in s
          f_wqht1_d ! Preference variable for d's asset acquisitions in s
!   wqht1_d(d,d) is the percentage change in the diagonal of the fgn-asset/fgn-
liability matrix.
!   This meaningless variable whose level is zero.  We treat it as exogenous and
turn off its
!   determination the optimizing problem by endogenizing f_pm4
          wqht1_d("USA","USA")
          wqht1_d("China","China")
          wqht1_d("Japan","Japan")
          wqht1_d("SKorea","SKorea")
          wqht1_d("France","France")
          wqht1_d("Germany","Germany")
          wqht1_d("Brazil","Brazil")
          wqht1_d("India","India")
          wqht1_d("Russia","Russia")
          wqht1_d("Australia","Australia")
          wqht1_d("ROAmerica","ROAmerica")
          wqht1_d("ROAsia","ROAsia")
          wqht1_d("ROEurope","ROEurope")
          wqht1_d("Africa","Africa")
```

```
          wqht1_d("ROW","ROW")
          wqht1_d("UK","UK")
          wqht1_d("Canada","Canada")
          wqht1_d("Mexico","Mexico")

! We determine start-year values (mainly stocks) at end-previous-year values. In
most cases this is done with equations that use the variable
! del_U or deltime,see for example E_wqht_d and E_wqhf which set the start-year
values for components of asset-liability table to end-previous
! year values. In some of these equations we include shifters that should be set
exogenously on zero:
          deltime  del_U ! Move from zero to one to link start-year values to end-
previous-year values
          d_pm3   ! Determines start-year dom assets dom owned from end-previous
year
          d_f_kb ! Determines value of start-year capital stock for a region as
end-previous-year value
          swqh ! Determines start-year wealth as end-previous-year wealth
          d_f_pcgds_l ! In valuing stat-year capital stocks we use price from
previous year
! In some cases we determine start-year stock values by adding up start-year
values of components:
          d_chk_wqht ! Makes start-year fgn assets for d equal sum of d's assets
held in each other region
          d_chk_wqtf  ! Determines start-year fgn liabilities as sum over asset
agents

!  Exogenization of this group of variables puts in place the budget constraint
for the asset optimizer in each region.
!  Also refer to Appendix 5
          swqh1_2 ! Allows end-year wealth to be start-year wealth (revaluated)
plus saving
          d_chk_wqht1 ! Makes end-year fgn assets for d equal sum of d's assets
held in each other region
          d_chk_wqtf1 ! Determines end-year fgn liabilities calculated as sum
across asset holders

;
Rest Endogenous ;

!
*********************************************************************************!
!  ************* 2.     SETTING UP A BASELINE FORECAST  CLOSURE    ***************!
!  *******************************************************************************!

! We set up a baseline closure that has 3 differences from the standard short-run
closure
! First, we exogenize GDP so that we can take on macro forecasts.
Correspondingly, we endogenize
! total-factor productivity.  We also set world inflation via U.S. inflation.
! Second, we link investment to GDP in each region rather than to rates of return.
This treatment
! tends to produce a blander baseline, which gives less trouble in policy
simulations.  Effectively,
! we turn off the asset-liability optimization behaviour by endogenizing ff_pen.
```

```
! Third , we make capital in each region industry-specific.

! First !
swap afereg  = qgdp;
swap pfactwld =wgdp("USA");

! Second !
swap ff_pen = f_cgdsgdp;
swap ff_cgdsgdp = ff_pen_ave;

! Third !
!  These 3 swap introduce industry-specific capital
swap tfph(TRAD_COMM,REG)=f_kb_i; ! Capital is now pre-determined at the industry
level in each region
                         ! A phantom tax or subsidy on the use of capital at the
industry level
                         ! is endogenized to guide demand for capital to the
available predetermined level.
swap d_f_kb = d_col_phc; ! The net collection of phantom taxes and subsidies in
each region is exogenized
                         ! at zero, and aggregate capital in each region is
determined as an addition across
                         ! industries, rather than being predetermined in equation
E_d_f_kb.
swap ff_rore = slack_ke; ! End-of-year capital is a weighted sum over industries.
Determination of expected
                         ! rate of return on homogeneous aggregate capital in each
region is turned off:
                         ! regional capital is no longer homogeneous.


!
*****************************************************************************!
!  ************ 3.      SETTING UP A Policy  CLOSURE     ************************!
!  ***************************************************************************!
!  We reverse the first two sets of swaps from the baseline: we want qgdp to react
to the policy  and we want
!  investment to react to policy-induced changes in rates of return.
!  We add the sticky-wage treatment of the labor market:
!  we want both employment and wages to increase in the short run in response to
favorable
!  shocks.
!  The final swaps in this section are specific to the policy under investigation.

swap qgdp = afereg   ;
swap wgdp("USA") = pfactwld;

swap f_cgdsgdp = ff_pen ;
swap ff_pen_ave = ff_cgdsgdp ;


!  Turns on sticky-wage specification.
swap f_realwage_o = realwage_o; ! Introduces into policy sim the forecast paths
for real wage rates by skill
swap ftax_l_r_o =tax_l_r_o;! Introduces into policy sim the forecast paths for tax
```

```
rates on labor by skill
swap f_rwage_pt_o =realwage_pt_o;
                      ! Introduces into policy sim the forecast path for real
post-tax wage rates by skill
swap f_qo_o =qo_o;! Introduces into policy sim the forecast paths for employment
by skill level
swap f_ls_o = ls_o;! Introduces into policy sim the forecast paths for labor
supply  by skill level
swap f_qo_LAB=f_rwage_pt; !Employment is now determined by sticky-wage equation,
not labor supply


!  swap to facilitate policy of reducing U.S. financial assets in China
swap ror_penalty("China","USA") =wqht1_d("China","USA") ;
```

Appendix 7. Trade decoupling between the U.S. and China

How do the effects of financial decoupling compare with those of trade decoupling?

To answer this question we conduct three trade-decoupling simulations (simulations T1, T2 and T3) with GTAP-Fin and compare the results with simulations 1, 2 and 3 in section 3 on financial decoupling.

The baseline in our trade-decoupling simulations is the same as that in the financial-decoupling simulations. Paralleling the approach in section 3, in the first trade-decoupling simulation (T1) we phase in a 50 per cent reduction over three years in all U.S. imports from China. In the second trade-decoupling simulation (T2) we phase in a 50 per cent reduction over three years in all Chinese imports from the U.S. In the third trade-decoupling simulation (T3) we combine simulations T1 and T2 by phasing in 50 per cent reductions in all U.S. imports from China and all Chinese imports from the U.S.

The exogenous reductions in imports are achieved by endogenous increases in tariffs. In the discussion of the results, we often refer to T1 as a simulation in which the U.S. imposes tariffs on imports from China, T2 as a simulation in which China imposes tariffs on imports from the U.S., and T3 as a simulation in which both countries impose tariffs.

A7.1. Overview of results

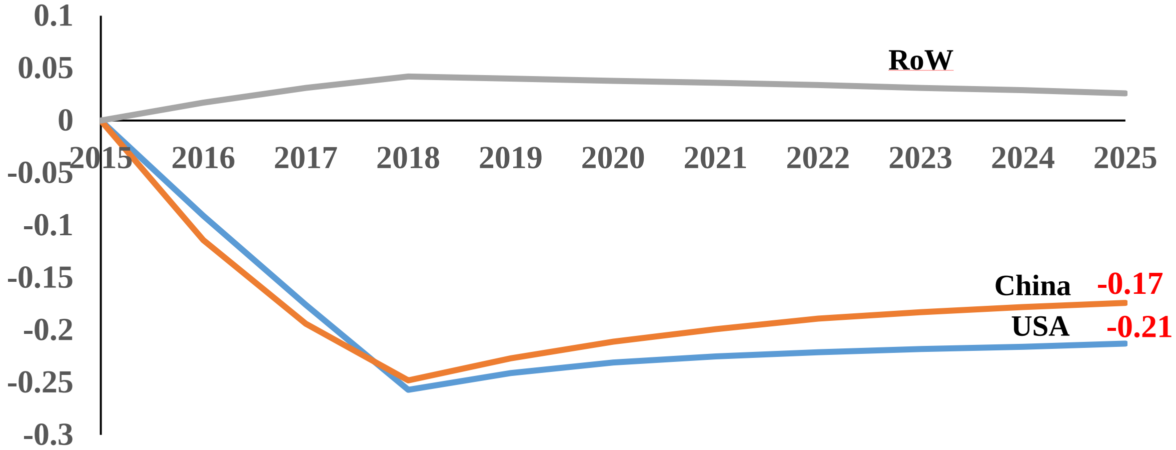
The results from the three trade-decoupling simulations for GDP, employment and capital in the U.S., China and RoW are given in Figures A7.1, A7.2 and A7.3.

Figure A7.1A shows that the 50 per cent reduction in U.S. imports from China in simulation T1 damages GDP in both countries by approximately equal amounts. Figure A7.2A shows that the 50 per cent reduction in Chinese imports from the U.S. in simulation T2 damages GDP in China, but has almost no effect on GDP in the U.S.

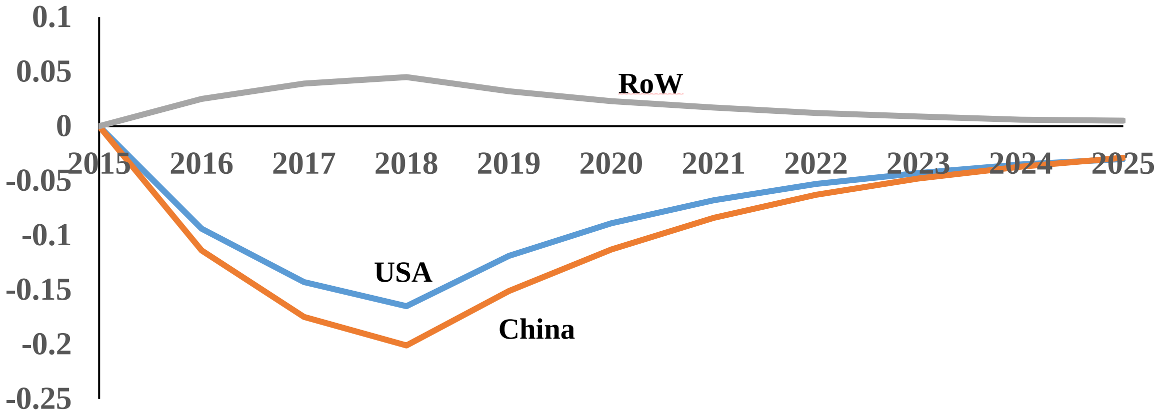
RoW makes small GDP gains in both simulations T1 and T2. When the U.S. blocks Chinese access to its markets this opens opportunities for other countries to export to the U.S. Similarly, when China blocks U.S. access to its markets this opens opportunities for other countries to export to China.

Figure A7.1. Simulation T1: U.S reduces its imports from China by 50% over 3 years

A. GDP: percentage deviations from baseline



B. Employment: percentage deviations from baseline



C: Capital: percentage deviations from baseline

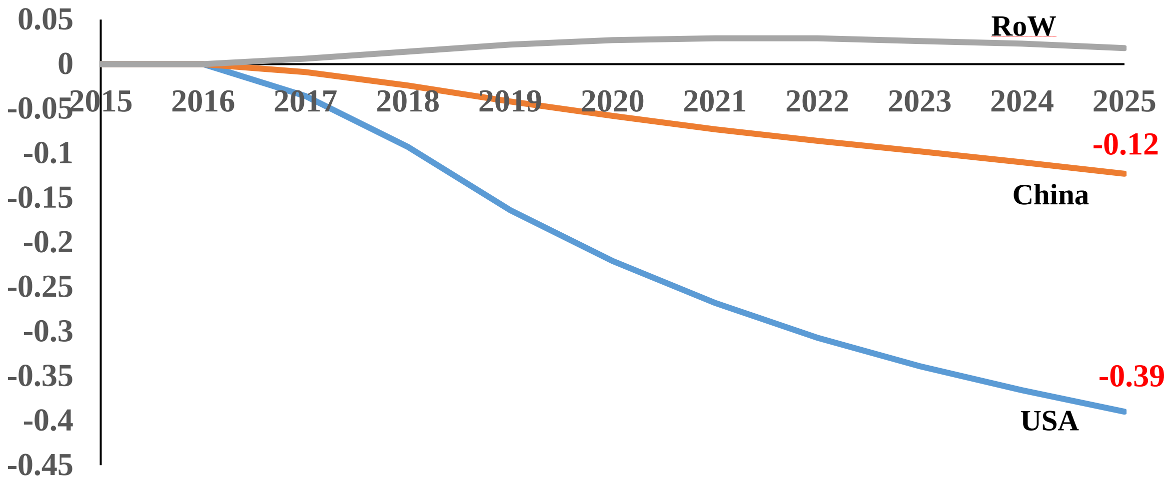
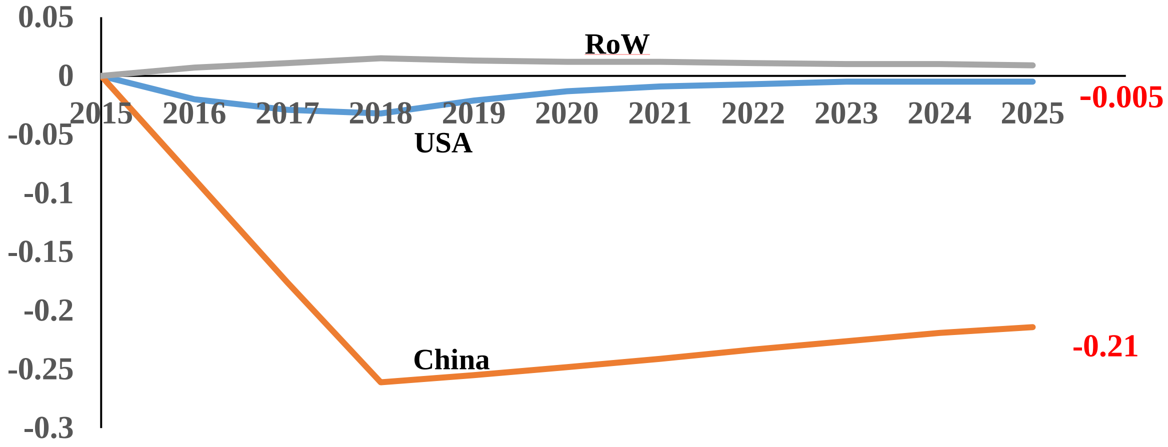
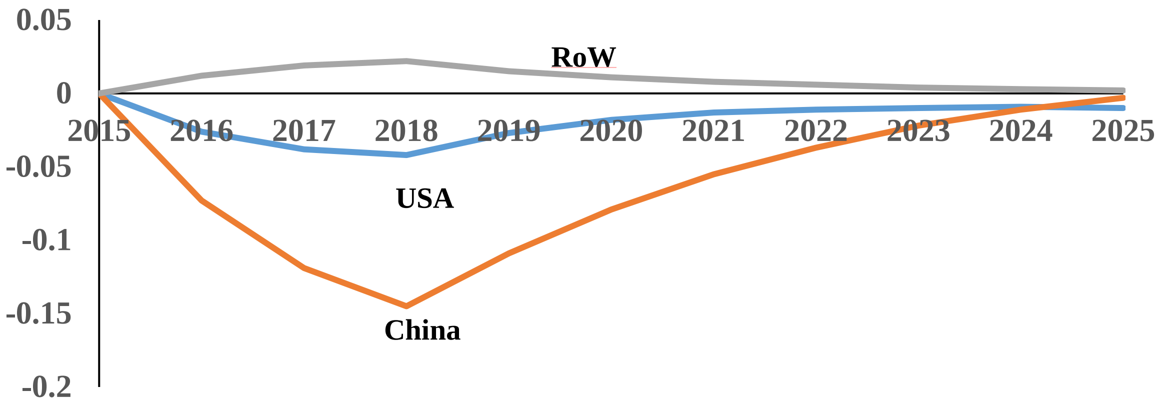


Figure A7.2. Simulation T2: China reduces its imports from the U.S. by 50% over 3 years

A. GDP: percentage deviations from baseline



B. Employment: percentage deviations from baseline



C: Capital: percentage deviations from baseline

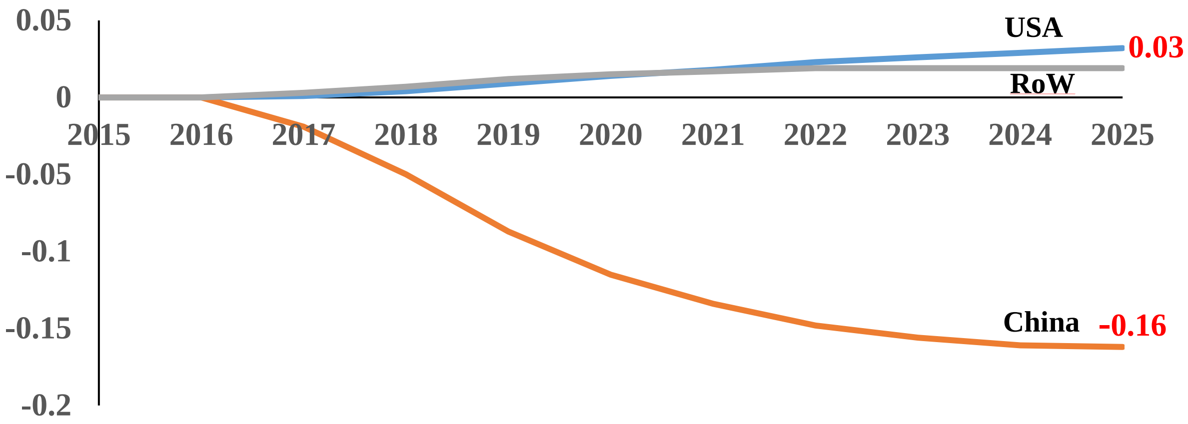
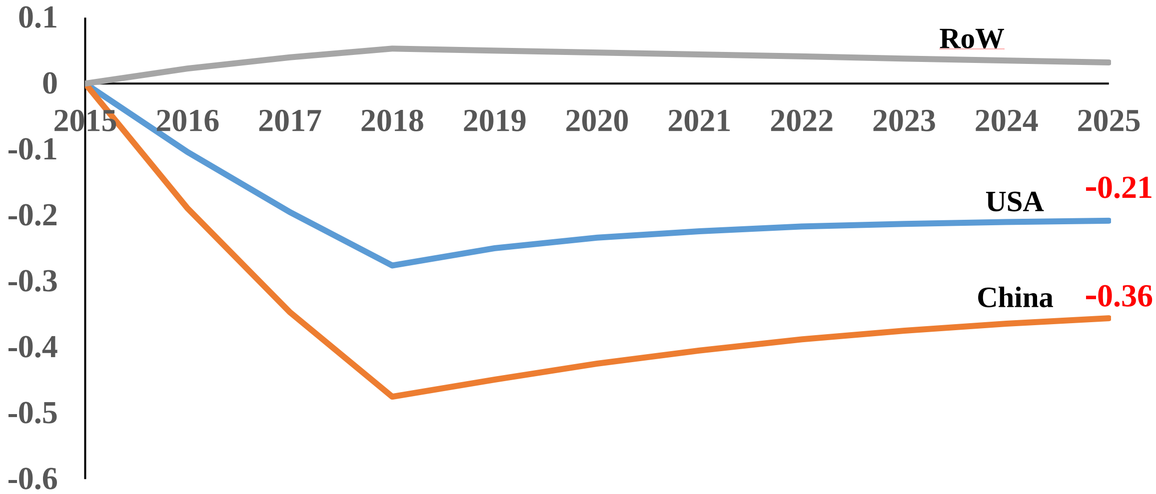
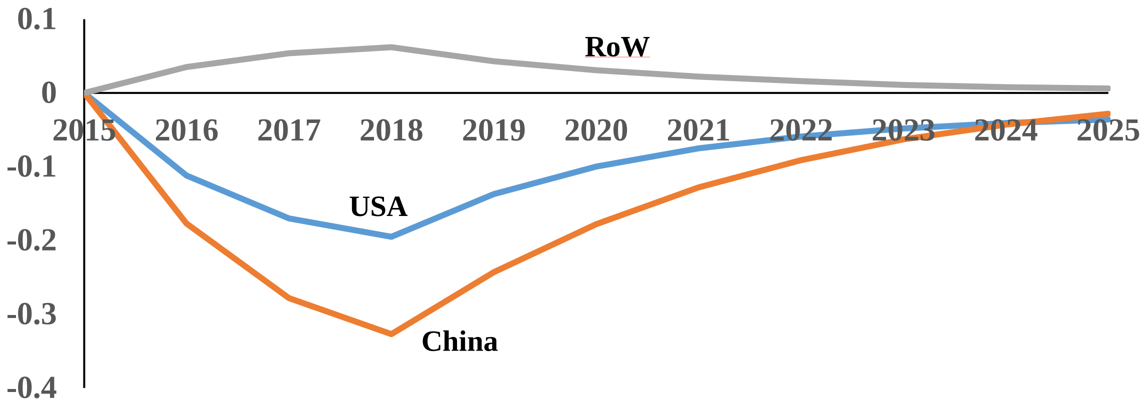


Figure A7.3. Simulation T3: the U.S. and China reduce their imports from each other by 50% over 3 years

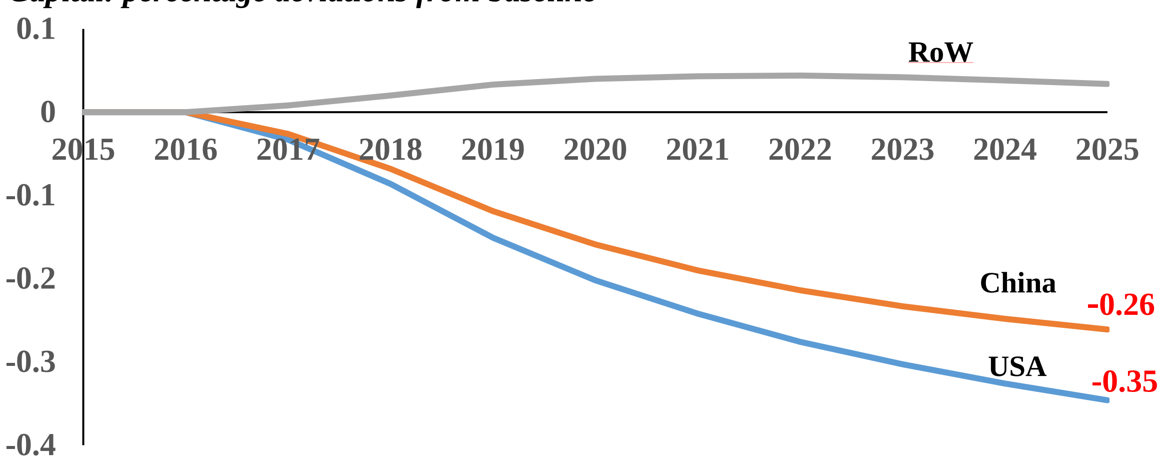
A. GDP: percentage deviations from baseline



B. Employment: percentage deviations from baseline



C: Capital: percentage deviations from baseline



The results in Figure A7.3 for simulation T3 are approximately an addition of those in simulations T1 and T2. Thus, in simulation T3 we find that the 50 per cent reductions in U.S. imports from China and Chinese imports from the U.S. harm GDP in both counties but the damage is more pronounced for China than the U.S.

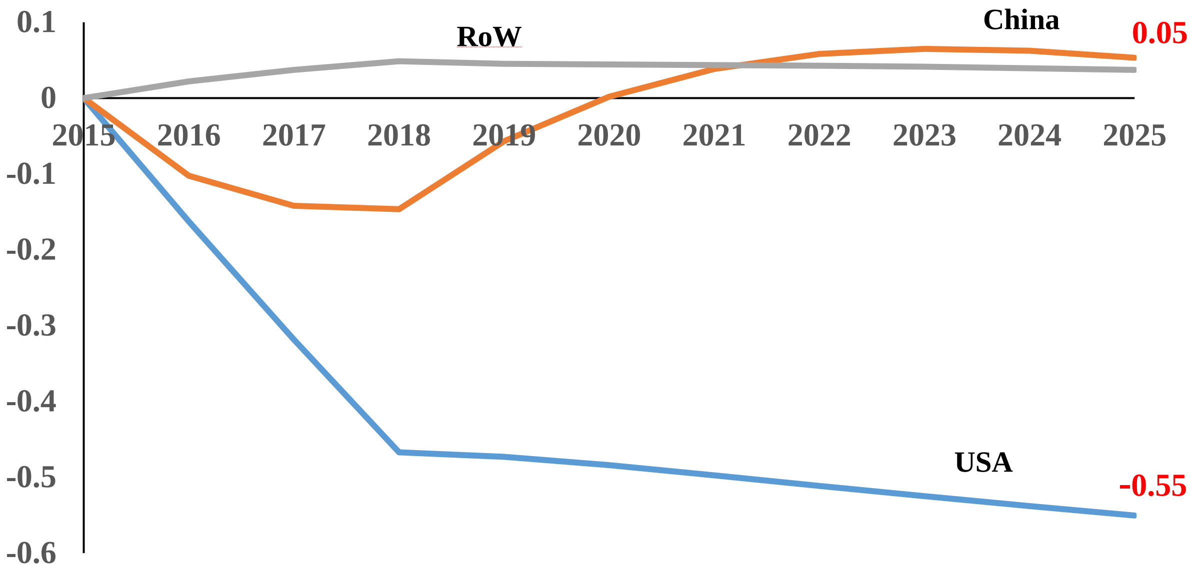
With regard to the main question for this appendix, we see that the GDP effects from 50 per cent trade decoupling are of the same order of magnitude as for 50 per cent financial decoupling: generally between plus and minus half a per cent.

For the U.S., trade decoupling would reinforce the negative long-run effect of financial decoupling (-0.21 per cent in 2025 for trade decoupling in Figure A7.3A in addition to -0.37 per cent for financial decoupling in Figure 3.A).

For China, trade decoupling would largely eliminate the long-run GDP gain from financial decoupling (-0.36 per cent in 2025 for trade decoupling in Figure A7.3A largely offsetting the 0.43 per cent gain for financial decoupling in Figure 3.A).

Figure A7.4 shows GDP effects of a combined 50 per cent financial and trade decoupling.

Figure A7.4. Simulation 3&T3: the U.S. and China decouple by 50 per cent in both finance and trade



A7.2. The trade decoupling results in more detail

In this subsection we explain the results for T1 and T2. The results for simulation T3 can be understood as an approximate addition of those for T1 and T2.

Short-run effects

For either the U.S. or China, imposing tariffs on imports from the other country has a negative initial effect on employment. Tariffs are an indirect tax, reducing the real wage rate at which any given level of employment can be sustained.[4] Thus, under our sticky real-wage assumption, when a tariff is imposed employment falls until wages can adjust.

[4] This effect can be outweighed by a sufficiently large terms-of-trade movement. But that doesn't happen in these simulations.

As can be seen in simulation T1, when the U.S. imposes tariffs on China, U.S. employment initially falls and then returns towards baseline (Fig. A7.1B). Similarly, in simulation T2, when China imposes tariffs on the U.S., Chinese employment initially falls and then returns towards baseline (Fig. A7.2B).

Why does Chinese employment fall in the short run in simulation T1 in which the U.S. imposes tariffs (Fig. A7.1B)? Two effects are important. First, when the Chinese are blocked out of the U.S. market, they suffer a terms-of-trade reduction. They must switch exports to other markets, requiring reductions in their prices. A lower terms of trade means that less people can be employed at any given real wage, leading to a reduction in employment until wages adjust. Second, when the Chinese are blocked out of the U.S. market, there is an overall reduction in their exports and a corresponding reduction in their imports. This happens via real devaluation. Because China's imports are heavily taxed, a reduction in imports carries an efficiency loss.[5] This again requires a reduction in employment at any given real wage.

Similarly, U.S. employment falls in the short run in simulation T2 in which China imposes tariffs (Fig. A7.2B). This effect is quite small compared with the corresponding effect in simulation T1 (a reduction in U.S. employment in 2018 in T2 of 0.042 per cent compared with a reduction Chinese employment in 2018 in T1 of 0.201 per cent, Figs A7.2B & A7.1B). The short-run effect on U.S. employment in T2 is relatively small for two reasons. The first is that U.S. exports to China are small (1.1 per cent of U.S. GDP) compared with Chinese exports to the U.S. (4.6 per cent of Chinese GDP). Thus, faced with Chinese tariffs, the U.S. has to find new markets for a relatively small volume exports, generating a relatively small reduction in its terms of trade. The second reason is that U.S. imports are only lightly taxed. Just as Chinese imports contract in T1, U.S. imports contract in T2. However the contraction of U.S. imports does not carry a significant efficiency loss.

Long-run effects

For understanding the long-run, 2025, results for GDP in simulations T1 and T2, we need to look at capital and efficiency effects.

In simulation T1, the U.S. tariffs against China cause U.S. capital to be 0.39 per cent below baseline in 2025 (Fig. A7.1C). This is because the tariffs cause the U.S. to expand production of labor-intensive commodities such as textiles, computers and other high-tech equipment rather than importing these commodities from China. Biasing the economy towards labor-intensive activities means that for any given long-run level of employment the economy uses less capital. A reinforcing factor is that the U.S. tariffs increase the cost of capital goods (e.g. computers), with a negative effect on the U.S. capital/labor ratio.

A negative deviation of 0.39 per cent contributes a reduction of about 0.12 per cent to U.S. GDP (the capital share in GDP is about 30 per cent). Even by 2025, U.S. employment in T1 is still 0.03 per cent below baseline (Fig. A7.1B). This makes a further negative contribution to U.S. GDP of 0.02 per cent (the labor share in GDP is about 70 per cent). We calculated the long-run efficiency effect on U.S. GDP from limiting Chinese imports and replacing them

[5] Consider an import with a c.i.f. value of $1 and a landed-duty-paid value of $1.50. To "produce" this import requires an export worth $1. But the import has the value to consumers of $1.50. Thus, elimination of the import reduces GDP by $0.50: the economy losses something it values at $1.50 while freeing up resources that are valued in alternative uses at only $1. We say that there is an efficiency effect of -$0.50.

by imports from other sources or domestic production to be about -0.07 per cent. The total of these effects is, as shown in Fig. A7.1A, a long-run reduction in U.S. GDP of 0.21 per cent (= -0.12 - 0.02- 0.07).

For China, the imposition of U.S. tariffs in simulation T1 causes GDP in 2025 to be 0.17 per cent below baseline (Fig. A7.1A). The main contributing factor is a loss of efficiency associated with contraction in China's heavily taxed imports. This loss of efficiency together with a reduction in the terms of trade explains the reduction in China's capital stock which falls 0.12 per cent below baseline in 2025 (Fig.A7.1C). Both losses in efficiency and reductions in the terms of trade reduce the wage rate for any given level of employment. In the long run, this causes substitution of labor for capital, and a consequent reduction in the capital/labor ratio.[6] The final factor contributing to China's reduction in GDP in 2025 in simulation T1 is employment. This is still 0.03 per cent below baseline in 2025 (Fig. A7.1B).

In simulation T2, efficiency effects are again the main contributor to the long-run negative deviation in China's GDP (-0.21 per cent in 2025, Fig. A7.2A). These effects were already apparent in 2018. As we move from 2018 to 2025, Chinese employment recovers towards baseline but capital continues to decline. With regard to GDP, the recovery in employment outweighs the decline in capital giving the GDP deviation line for China in Figure A7.2A a slight positive slope between 2018 and 2025.

As explained earlier, the imposition of Chinese tariffs on U.S. products has only minor short-run macro effects on the U.S. By 2025, these effects are even smaller (-0.005 for U.S. GDP, Figure A7.2A).

A7.3. A linearity issue: results from different levels of trade decoupling

Figure A7.5 shows long-run GDP effects for the U.S. and China of different levels of trade decoupling. The 50 per cent results are from simulation T3, see Figure A7.3A.

As we change the level of trade decoupling, the GDP responses are non-linear. For example, the effect on U.S. GDP is multiplied by a factor of 3.78 (= 0.208/0.055) when decoupling increases from 20 per cent to 50 per cent (a factor of 2.5). This reflects the idea that raising the landed-duty-paid price of an import by 1 per cent through an increase in an already *high* tariff has a more negative percentage effect on GDP than raising the landed-duty-paid price of an import by 1 per cent through an increase in a *low* tariff.

[6] We also considered the capital intensity of Chinese exports to the U.S., but found that this is not a contributing factor to the long-run negative deviation for capital in China in simulation T1. China's principal exports to the U.S., which include Textiles, Computers and Electronic equipment, have labor intensities slightly above the average across all Chinese industries.

Figure A7.5. Long-run effects on GDP of different levels of trade decoupling