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**GLOBAL FISCAL ADJUSTMENT AND
TRADE REBALANCING**

**WARWICK J MCKIBBIN
ANDREW B STOECKEL
YINGYING LU**

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Global Fiscal Adjustment and Trade Rebalancing¹

Warwick J McKibbin

Research School of Economics, Australian National University,
& The Brookings Institution

and

Andrew B Stoeckel

Centre for Applied Macroeconomic Analysis,
Australian National University

and

YingYing Lu

Centre for Applied Macroeconomic Analysis
Australian National University

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ABSTRACT

The emergence of substantial fiscal deficits and a large build up of government debt in major advanced economies will inevitably lead to a period of fiscal consolidation in coming years. In an earlier paper, McKibbin and Stoeckel (2010) explored the effects of this fiscal adjustment in advanced economies on the global economic outlook. This paper focuses on the differences between the impacts of fiscal policy in advanced versus emerging economies. In particular, the need for more fiscal spending on infrastructure in emerging economies and the need for fiscal consolidation in advanced economies leads naturally to the question of what this asymmetric fiscal adjustment might do to global trade balances as well as global economic growth over the coming decades. The adjustment needed in both regions is substantial and the asymmetry of the adjustment implies important consequences for trade and capital flows between regions as well as asset price adjustments within and between regions.

1. Introduction

Two pressing economic issues facing the world economy are the need for fiscal consolidation in most major advanced economies and the ongoing need for more spending on infrastructure in emerging countries to support growth. While each issue has separate origins, resolving each affects the other. This asymmetric world fiscal policy adjustment has implications for global growth, trade balances and capital flows and is the focus of this paper.

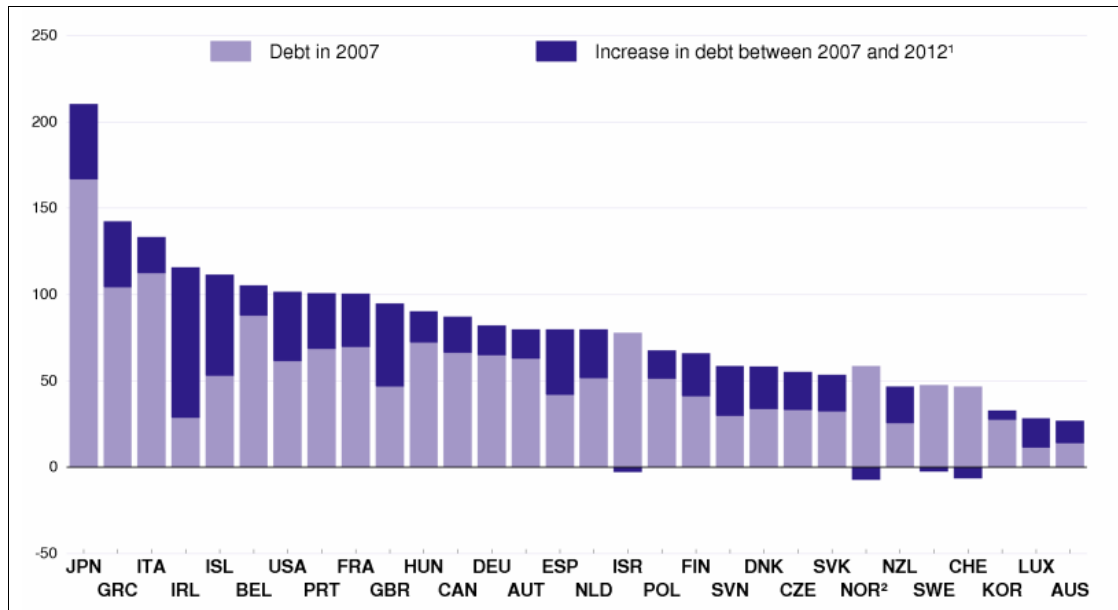
Extra public borrowing by advanced economies in the aftermath of the 2009 financial crisis has meant there is less capital for investment by emerging countries. But the extra fiscal spending and borrowing has shored up growth, initially at least, in advanced economies and has meant extra demand for exports from emerging countries than would otherwise have occurred. How does the balance of these forces pan out? It is an empirical question depending on trade patterns, elasticities, multipliers and the role that extra infrastructure spending can play in emerging countries. An empirical model is therefore used to analyse the asymmetrical fiscal adjustment through a series of plausible simulations of what could be involved and the alternatives. These simulations imply some background on the size of the debt problem and the fiscal consolidation that could occur in advanced economies.

The particular the source of government debt expansion varies across countries. For some countries, a well-known example being Greece, the deterioration in fiscal position as a result of the global financial crisis came on the back of high levels of government debt that were already causing concern. Before the crisis, Greece had a level of debt to GDP of around 100 percent. Two years after the crisis, Greece's debt had ballooned to over 125 percent of GDP². It is expected to deteriorate further. For Ireland, the level of debt to GDP was low at around 30 percent, but increased dramatically when the Irish Government bailed out several large banks. Figure 1 shows the increase in government debt of OECD economies.

The change of fiscal policy stance from fiscal expansion in the immediate aftermath of the crisis to consolidation in coming years has fuelled another debate that has two related aspects. One is the impact of fiscal consolidation on economies that are tightening and the flow-on effects to the world economy. The other debate is how much tightening there should be and how soon, and what those effects might be. Many commentators argue that too much austerity now will simply drive the world economy back into recession and potentially bring on another financial crisis as the health of bank balance sheets and that of households have not yet fully restored. Yes, so the argument goes, fiscal austerity is needed at some stage — but, because households and businesses are busily paying down debt, now is not the time for premature tightening by governments.

² On a Maastricht criteria basis as computed by the OECD Economic Outlook and taking the start of the crisis to be 2008 when Lehman Bros collapsed.

Figure 1: Government debt in OECD economies



Source: OECD Economic Outlook 88 Database (November 2010).

As noted in the International Monetary Fund's (IMF) May 2010 *Fiscal Monitor*, fiscal balances in advanced economies are, on average, worsening despite the improvement in the global economy³. The IMF chief writes, '...it is now urgent to start putting in place measures to ensure that the increase in deficits and debts resulting from the crisis, mostly from the loss of output and revenues, does not lead to fiscal sustainability problems'⁴. The countries that are either consolidating or debating fiscal austerity are the most indebted, which includes many of the more advanced economies (many of which are in the OECD). The overriding generalisation is that emerging countries are in far better shape with respect to public deficits than most advanced economies⁵. This point is borne out by figure 2. Whereas gross debt ratios in G-20 advanced economies are expected to worsen to 2015 (approaching 120 per cent of GDP on average), those of emerging and low income economies are much lower and expected to be around a third that of advanced economies by 2015.

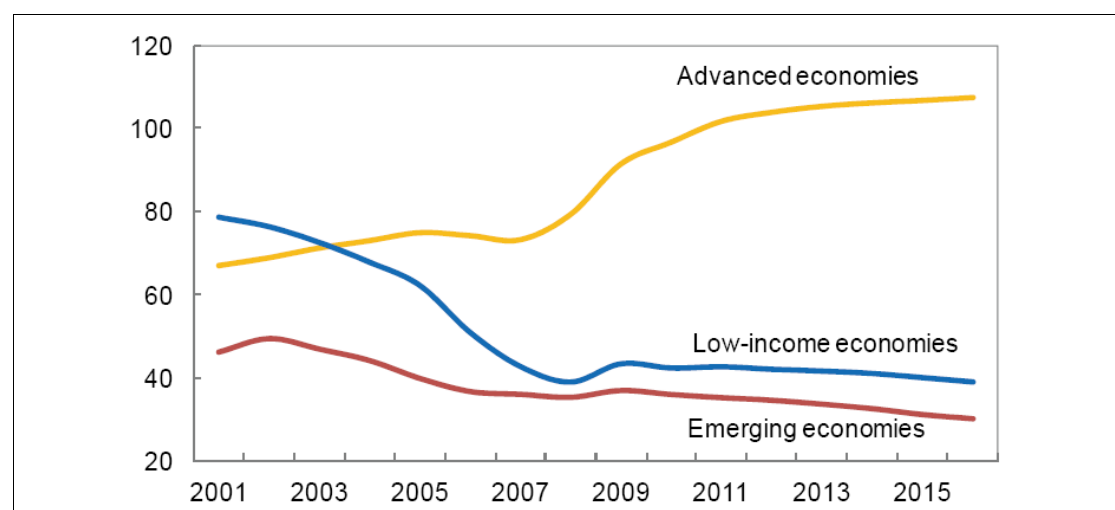
The fiscal consolidation called for by the IMF is partly an advanced/emerging world debate because, in general, emerging countries are in better shape than most major advanced economies. Because of different starting positions, the fiscal consolidation effort differs across the world and needs to be taken into account.

³ IMF (2010), p. 7.

⁴ Dominique Strauss-Kahn (2010, p. 6) in IMF (2010).

⁵ There are a few OECD economies with fiscal deficits and public debt levels that are not a cause for concern.

Figure 2: **General government gross debt ratios** Percent of GDP, 2009 PPP–GDP weighted average



Source: IMF (2011) based on staff estimates from the April 2011 WEO projections.

The issue of asymmetric adjustment is an interesting one because there are two related aspects. One is direct trade linkages since a substantial share of the emerging world's exports ends up in advanced economies. The second aspect is that the fiscal deficits of many of the advanced economies (like the United States) are financed by capital outflows from emerging countries (like China and South Asia)⁶. These capital flows stem from differences in savings and investment balances between economies, which are affected by real interest rates that are in turn affected by, among other things, the stance of fiscal policy. To understand these aspects a comprehensive global economy-wide framework is needed.

The framework we use to analyse the effects of fiscal consolidation empirically is the G-cubed multi-country model. This is a large scale multi-sectoral DSGE model, with rigidities and inertia calibrated to observed economic dynamics in various economies.

This paper is structured as follows. We outline the model underlying this study in section 2 — the framework and the country and sectoral composition. In section 3 we explore the extent of fiscal consolidation required in each country or region required to reach 'more sustainable' levels. In section 4 we explore four different questions.

The first question is: 'What is the impact of taking 1 percent of world GDP and spending that in advanced economies versus spending it in emerging economies, and what if it was spent particularly on infrastructure in emerging economies?' To answer this question we run three different scenarios:

- a 1 percent of world GDP increase in government spending on goods and services in advanced economies financed by issuing debt;
- a permanent 1 percent of world GDP increase in current spending on goods and services in emerging economies financed by issuing debt; and

⁶ An implicit assumption in the simulations in this paper is that this appetite by China to lend to the US remains the same. This assumption is relaxed in a separate paper (McKibbin and Stoeckel 2011).

- a permanent 1 percent of world GDP increase in current spending on goods and services in emerging economies financed by issuing debt except that the spending is focussed on infrastructure capital.

These three scenarios give us fiscal multipliers as a benchmark for the impact of fiscal policy across regions.

The second question shifts the focus from simple fiscal multipliers to exploring what happens to global trade balances if advanced countries undertake the fiscal adjustment proposed by the IMF. The scenario that is run is a reduction in fiscal deficits in advanced countries from 2011 to 2020 such that the ratio of government debt to GDP is stabilised at a maximum of 60 percent by 2030. Results are presented where the deficits required to do this are undertaken over ten years compared to a case where the same amount of deficit reduction is phased in over four years.⁷

A third related question is what happens when the fiscal contraction in the advanced economies is matched by an equal magnitude fiscal expansion on infrastructure spending in emerging countries.

The fourth question, which builds on the third, is what happens if the US alone undertakes a substantial fiscal consolidation while the amount of money not spent in the US is instead matched by an increase on infrastructure spending in emerging countries.

The first question and associated scenarios give a benchmark for establishing standard fiscal multipliers. The second and third questions relate to required fiscal adjustments which are progressively rising over time and different in time profile and magnitude to the fiscal multipliers. Indeed a key insight from this paper is that using static fiscal multipliers to evaluate fiscal policy can be misleading when the actual fiscal adjustments are phased in over time. The timing of fiscal policy is shown to matter.

A summary and conclusion is contained in section 5.

⁷ Clearly, the debt to GDP ratio is different, but the deficits reductions are comparable to get a measure of the role of timing.

2. The model

The G-Cubed model is an intertemporal general equilibrium model of the world economy. The theoretical structure is outlined in McKibbin and Wilcoxon (1999)⁸. It builds on the model of McKibbin and Sachs (1991) and Jorgenson and Wilcoxon (1990). A number of studies — summarized in McKibbin and Vines (2000) — show that the G-cubed modelling approach has been useful in assessing a range of issues across a number of countries since the mid-1980s⁹. Some of the principal features of the model are as follows.

The model is based on explicit intertemporal optimization by the agents (consumers and firms) in each economy¹⁰. In contrast to static CGE models, time and dynamics are of fundamental importance in the G-Cubed model. The G-Cubed model is known as a DSGE (Dynamic Stochastic General Equilibrium) model in the macroeconomics literature and as a Dynamic Intertemporal General Equilibrium (DIGE) model in the computable general equilibrium literature. The main difference to small scale DSGE models now popular at central banks is the large amount of sectoral disaggregation and considerable degree of country disaggregation.

In order to track the macro time series, the behaviour of agents is modified to allow for short run deviations from optimal behaviour either due to myopia or to restrictions on the ability of households and firms to borrow at the risk free bond rate on government debt. For both households and firms, deviations from intertemporal optimizing behaviour take the form of rules-of-thumb, which are consistent with an optimizing agent that does not update predictions based on new information about future events. These rules-of-thumb are chosen to generate the same steady state behaviour as optimizing agents so that, in the long run, there is only a single intertemporal optimizing equilibrium of the model. In the short run, actual behaviour is assumed to be a weighted average of the optimizing and the rule-of-thumb assumptions. Thus, aggregate consumption is a weighted average of consumption based on wealth (current asset valuation and expected future after-tax labour income) and consumption based on current disposable income. Similarly, aggregate investment is a weighted average of investment based on Tobin's Q (a market valuation of the expected future change in the marginal product of capital relative to the cost) and investment based on a backward looking version of Q. In the model software, it is possible to change the information set of forward looking agents after a scenario begins to unfold.

There is an explicit treatment of the holding of financial assets, including money. Money is introduced into the model through a restriction that households require money to purchase goods.

The model also allows for short run nominal wage rigidity (by different degrees in different countries) and, therefore, allows for significant periods of unemployment depending on the labour market institutions in each country. This assumption, when taken together with the explicit role for money, is what gives the model its

⁸ Full details of the model including a list of equations and parameters can be found online at www.gcubed.com.

⁹ These issues include: Reaganomics in the 1980s; German unification in the early 1990s; fiscal consolidation in Europe in the mid-1990s; the formation of NAFTA; the Asian crisis; and the productivity boom in the US.

¹⁰ See Blanchard and Fischer (1989), and Obstfeld and Rogoff (1996).

‘macroeconomic’ characteristics. (Here again the model’s assumptions differ from the standard market clearing assumption in most CGE models.) Equilibrium between aggregate demand and aggregate output is maintained by flexible prices, which causes demand to adjust as well as short term supply.

Global accounting identities are imposed on the model so, for example, for every borrower there is a lender — thereby avoiding the fallacy of composition. Likewise, the model gives a careful treatment of stock-flow relations such as the accumulation of current account deficits into foreign claims on domestic output, which has to be serviced by future trade surpluses. On the fiscal side, which is the focus of this study, the accumulation of fiscal deficits into government debt has to be serviced from future revenues — though it does not have to be completely paid off.

The model distinguishes between the stickiness of physical capital within sectors and within countries and the flexibility of financial capital, which immediately flows to where expected returns are highest. This important distinction leads to a critical difference between the quantity of physical capital that is available at any time to produce goods and services, and the valuation of that capital as a result of decisions about the allocation of financial capital.

As a result of this structure, the G-Cubed model contains rich dynamic behaviour, driven on the one hand by asset accumulation and, on the other, by wage adjustment to a neoclassical steady state. It embodies a wide range of assumptions about individual behaviour and empirical regularities in a general equilibrium framework. The interdependencies are solved out using a computer algorithm that solves for the rational expectations equilibrium of the global economy¹¹. It is important to stress that the term ‘general equilibrium’ is used to signify that as many interactions as possible are captured, not that all economies are in a full market clearing equilibrium at each point in time. Although it is assumed that market forces eventually drive the world economy to neoclassical steady state growth equilibrium, unemployment does emerge for long periods due to wage stickiness.

In the version of the model used here (version 95N) there are six sectors (energy, mining, agriculture, manufacturing durables, manufacturing non-durables and services) as well as a generic capital producing sector in each country. There are 16 countries/regions as set out in table 1. Details on the composition of regions can be found in appendix 2.

Table 1: Countries/regions

United States	ROECD
Japan	China
United Kingdom	India
Germany	Other Asia
Rest of Euro Zone	Latin America
Canada	Other emerging countries
Australia	Eastern Europe & former S U
New Zealand	Oil-exporting & Middle East

¹¹ Not all households and firms are forward looking but those that are forward looking (usually 30%) are assumed to use the model to forecast future events.

3. Modelling fiscal policy

a) Fiscal consolidation in the advanced economies

There is no specific number that indicates that a country's debt is too high. Indeed, the debt is not the issue. Rather, the issue is the quality of expenditure increase or tax reductions that the debt has enabled. Nonetheless, a figure of 60 percent debt to GDP is generally taken to be a reasonable measure based on the following reasoning. A decade ago, gross debt/GDP ratios were a bit above 60 percent (see earlier figure 2). This is the generally accepted number for 'reasonable stability'. It was, for example, one of the Maastricht criteria for EU members to enter the Euro. The important thing is to bring the primary fiscal balance (the total government deficit less interest payments on debt) into surplus to service the debt¹². So, for advanced economies, average debt/GDP ratios have to fall from around 100 percent to 60 percent. For emerging economies, debt levels are, on average, less than 40 percent, with only India as one of the large standout economies with a ratio of 75 percent. The IMF takes 40 percent debt/GDP as a reasonable target for emerging economies.

The IMF (*Fiscal Monitor*, April 2011)¹³ has calculated the reduction in the cyclically adjusted primary balance to bring gross debt/GDP down to 60 percent for advanced economies and 40 percent for emerging economies over ten years¹⁴. These are the starting consolidation numbers used here, except for the following. For those economies with debt/GDP ratios already less than 60 percent, the assumption the IMF makes is to stabilise debt at expected end-2012 levels, but this implies a significant contraction by Australia, which has the lowest debt/GDP ratio of the advanced economies. For others (for example, Korea), the implication is for negative consolidation — that is, stimulus. So the change in the fiscal position of Korea has been assumed at zero and for Australia and New Zealand it is assumed to be 1 percent of GDP. Of note too is the assumption by the IMF for Japan to consolidate to 80 percent debt/GDP, partly reflecting their special status where virtually all their borrowings are made from domestic residents.

The assumed ten year consolidations are set out in table 2 (for consolidation over four years the annual consolidation is proportionally adjusted).

¹² For stable debt dynamics, the present value of the primary budget surplus (not necessarily a surplus in each and every period) must equal the initial stock of debt to be serviced. That is, a government with a large initial debt burden will have to run larger primary surpluses in future than one with smaller initial debt. These debt dynamic conditions are fully built into the G-Cubed model used here.

¹³ <http://www.imf.org/external/pubs/ft/fm/2011/01/pdf/fm1101.pdf>

¹⁴ A similar analysis is undertaken in the OECD *Economic Outlook*, November 2010 (chapter 4) although the extent of consolidation varies due to different assumptions about rates of economic growth.

Table 2: **Assumed fiscal consolidation**

<i>Country/regional grouping</i>	<i>Gross debt/GDP ratio</i>	<i>Fiscal consolidation in primary balance 2010 to 2020</i>
	%	% of GDP
United States	92.7	11.3
Japan	225.8	13.3
United Kingdom	76.7	9.3
Germany	75.3	2.2
Rest of Euro Zone	95.0	8.0
Canada	81.7	4.4
Australia	21.9	1.0
New Zealand	32.1	1.0
ROECD	44.5	2.3
China	19.1	0.0
India	75.1	0.0
Other Asia	30.0	0.0
Latin America	51.5	0.0
Other emerging countries	30.0	0.0
Eastern Europe & former Soviet Union	52.0	0.0
Oil-exporting & Middle East	12.9	0.0
Average advanced (PPP base)	97.3	7.8
Average emerging (PPP base)	37.4	0.0

Source: IMF (2011), Fiscal Monitor, April and author calculations.

b) Modelling the effect of infrastructure spending in emerging countries

Examining the empirical effect of expanding infrastructure spending in emerging countries requires some estimates of the impact of infrastructure spending in the economy. The lack of infrastructure in labour abundant emerging countries can be an important constraint on growth and improving welfare. Besides expanding capital per worker and boosting labour productivity, extra infrastructure can remove bottlenecks and boost productivity more generally in the economy¹⁵.

The direct impact of increasing infrastructure spending is to build a greater infrastructure capital stock in an economy. The empirical evidence suggests that greater infrastructure increases the marginal product inputs into private sector production. In the G-Cubed model this would show up as an increase in labour augmenting technical change. The model covers regions with various income levels and degrees of economic development. Hence, there is a need to specify the possible effects of infrastructure spending on different economies, especially to distinguish the effects on advanced and emerging countries. It is natural to assume that infrastructure capital return in emerging countries is different from that in advanced countries. It is recognised that infrastructure capital has rapidly diminishing returns (Canning and Bennathan 2000). Therefore, emerging countries that usually have lower infrastructure stock may get more marginal return from increasing infrastructure spending.

¹⁵ See Henckel and McKibbin (2010).

In order to get estimates of infrastructure capital stock in each country into the model to facilitate the analysis in this paper, we make the following assumptions. First, advanced countries have approximately equal rates of return in public infrastructure and private capital. Second, there is an obvious difference in the rates of return in public infrastructure and private capital in emerging countries; and we calculate this difference by comparing the infrastructure stock/output (GDP) ratio and assume the output elasticity of infrastructure capital is equal across all the regions in the model. This is supported by Calderon, Moral-Benito and Serven's (2011) recent study. Third, we also assume that the private capital return is the same across regions. In this sense, the 'capital return' we refer here is more like an estimated scalar rather than a real estimated value. The aim to do so is to derive a reasonably comparable size of infrastructure stock so that we can accommodate the productivity shocks for each region in the model simulation. A more detailed illustration of our calculation method can be found in appendix 1.

Once we have an estimate of the infrastructure capital stock in each region we can apply the results from Calderon, Moral-Benito and Serven (2011) who find that for every 10 percent increase in the stock of infrastructure capital, productivity in private sector output rises by 0.8 percent. In the scenarios considered below the permanent changes in fiscal spending mean an accumulating infrastructure capital stock, which, even with the assumed depreciation of 5 percent per year, leads to a large change in the stock after a decade in many emerging economies.

4. Scenarios for fiscal consolidation

a) Fiscal multipliers

The first set of results focus on the question of what happens if 1 percent of world GDP was spent in advanced economies versus emerging economies beginning in 2011. This spending is assumed to be generated by regional governments through permanently increasing fiscal deficits by 1 percent of world GDP with subsequent increases in debt to GDP. This experiment is done in two steps. First, we present results where the fiscal spending occurs in the advanced economies where the 1 percent of world GDP is spent with each country raising their deficit by their share of world GDP. The end result is that the aggregate spending increase is equal to 1 percent of world GDP. The second experiment is where the same amount of dollars is raised by emerging countries. In the model, emerging countries made up 47 percent of world GDP in 2006 and advanced economies made up 53 percent of world GDP. This implies that each emerging country increases fiscal spending by 2.68 percent of own GDP and each advanced economy increases spending by 1.98 percent of own GDP. Thus, spending in emerging economies is larger as a share of their economies than as a share in advanced economies because we are taking the same amount of global spending increase and allocating over a small scale of economies.

The results are shown in figures 3 and 4. All results are expressed as a percentage deviation from a baseline of the model. In other words, the results are a comparison relative to a baseline (that is not shown). A zero, therefore, implies that the variable is unchanged from baseline. The baseline assumes that the primary debt to GDP in 2010 is continued forever with a lump sum tax gradually rising to cover all additional costs of servicing the resulting government debt. The baseline also makes a wide range of assumptions about future population growth by country and productivity growth by country and sector as well as wide range of other assumptions set out in detail in McKibbin, Pearce and Stegman (2009).

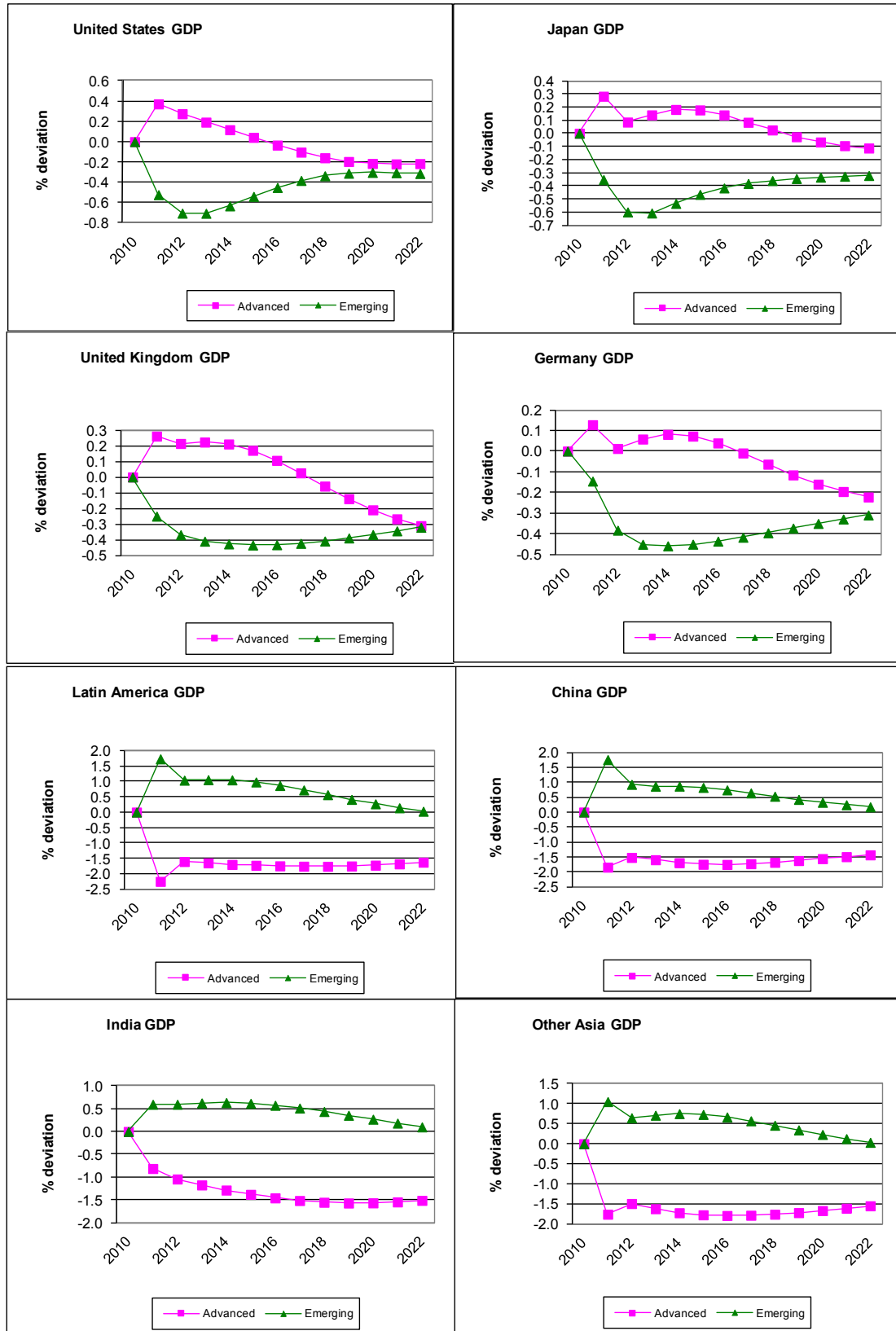
Note again that two separate scenarios are shown in these results. One for a spending boost by advanced economies and a separate experiment where the spending boost occurs in emerging economies. Several points are obvious from these results. When a country undertakes a fiscal expansion the impact on its own GDP is initially positive for several years, but it eventually becomes negative as the financing constraint of a permanently larger stock of government debt acts as a drag on overall economic activity. When advanced economies stimulate their economies and emerging countries do nothing, emerging countries tend to experience lower GDP. The same applies when emerging countries undertake a fiscal expansion while the advanced economies do not. The negative spillovers between economies occur because resources are needed to finance the increase in government spending. As the government borrows, long term real interest rates (figure 6 shows nominal interest rates) around the world rise and capital flows into the expanding economy. This outflow of capital from some countries reduces the capital stock in economies not undertaking an expansion and, therefore, production falls. Investment falls globally (figure 5) because capital that would have gone into private investment partly goes into government borrowing for purposes that are assumed not to be productive (they do, however, give higher utility in the model). This mechanism of draining capital out of the global economy operates

through higher real interest rates. There is also a decline in investment because corporations ‘know’ (remember from the description of the model that agents are forward looking) that future GDP will be lower over time and, therefore, the return to capital will be lower.

Note in the figures that fiscal expansion in either region raises interest rates in all regions. Also, rates rise by more in the countries stimulating because, over time, their exchange rates have to depreciate to generate the trade surpluses required to service the extra foreign borrowing that partly financed the fiscal stimulus. With an expected exchange rate depreciation, countries must pay higher rates to compensate for the depreciation over time.

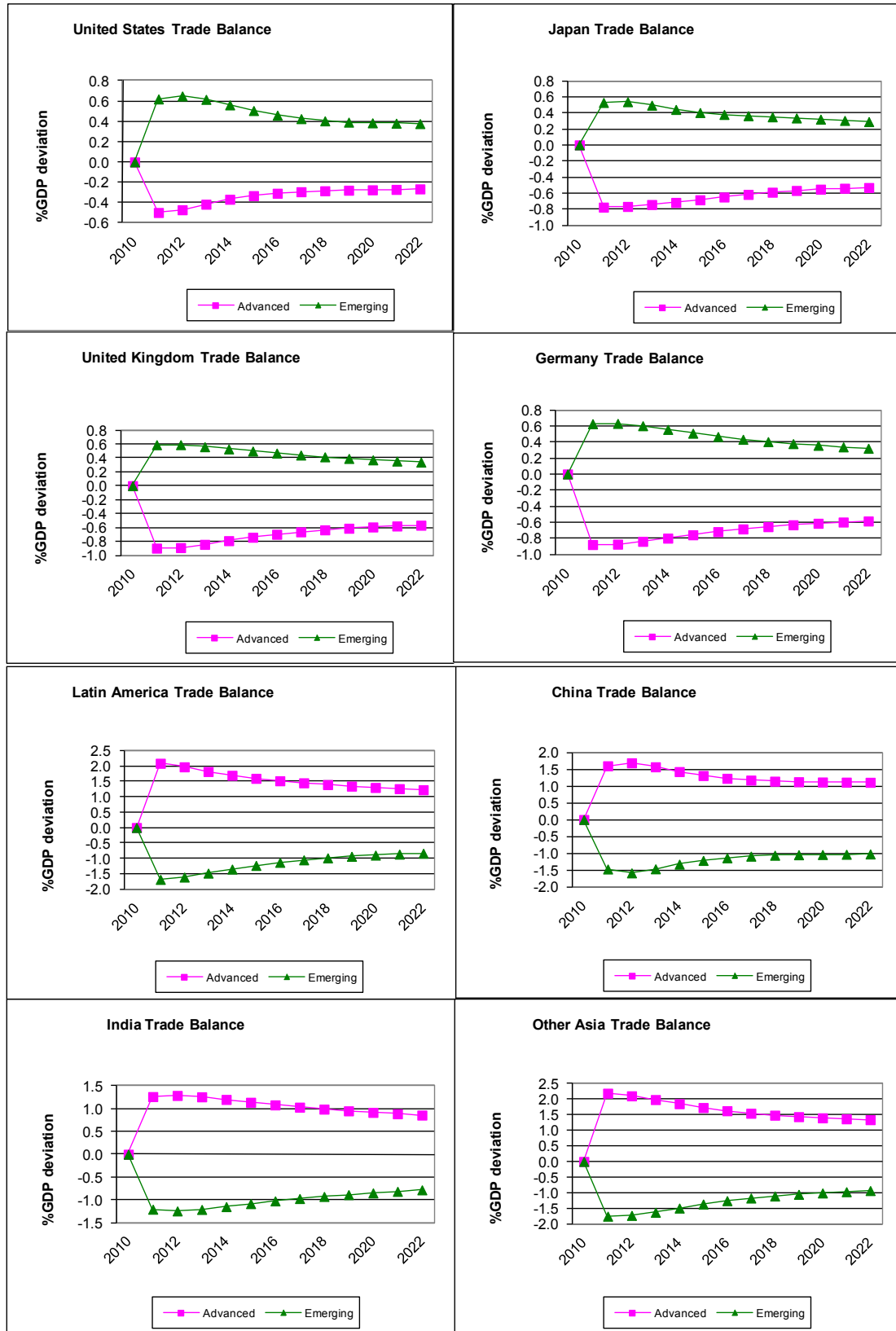
It is also clear from the results that a country undertaking a fiscal stimulus tends to worsen its trade balance and a country not stimulating tends to experience an improvement in its trade balance. Again, this reflects the capital flows that move from countries who are not stimulating into countries that are stimulating as part of the financing of the fiscal deficits. The shift of capital changes real exchange rates, which appreciate for stimulating economies and, by crowding out net exports, enable a trade balance deficit that reflects an inflow of capital.

Figure 3: **Real GDP changes from 1 percent world GDP fiscal stimulus in each region**
Deviation from baseline



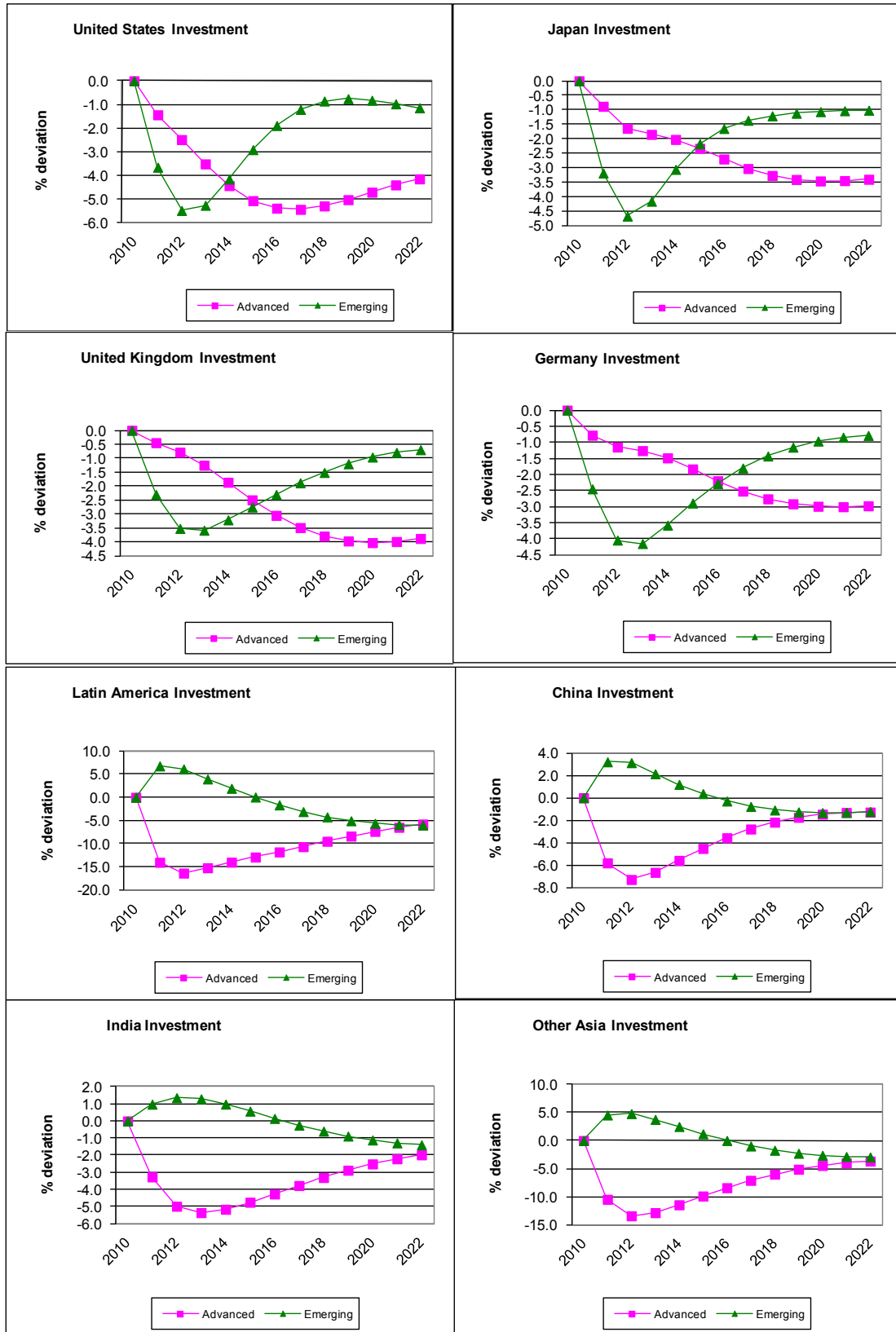
Source: Simulations with G-Cubed (v95N) model.

Figure 4: Trade balance changes from 1 percent world GDP fiscal stimulus in each region Deviation from baseline



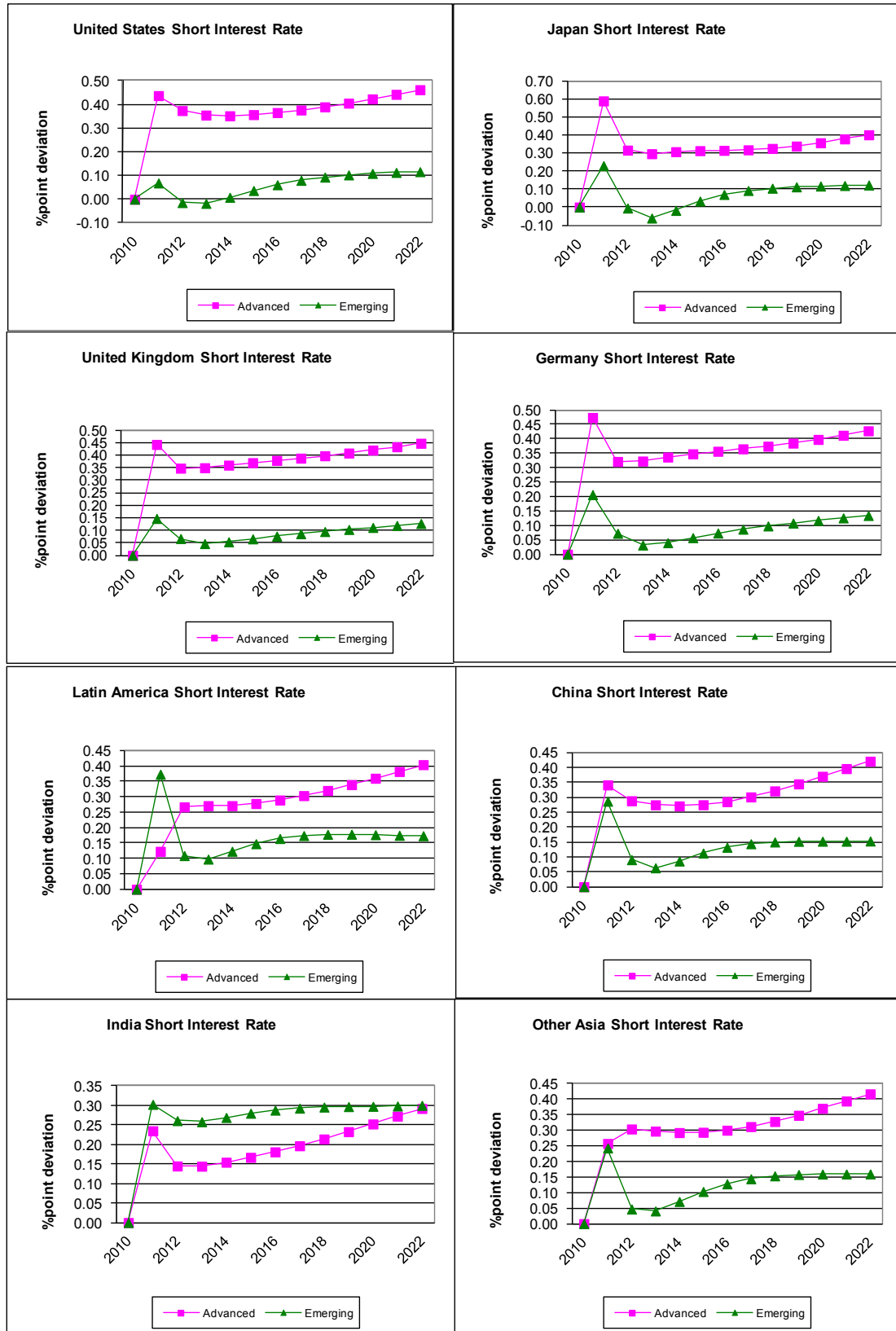
Source: Simulations with G-Cubed (v95N) model.

Figure 5: Investment changes from 1 percent world GDP fiscal stimulus in each region
Deviation from baseline



Source: Simulations with G-Cubed (v95N) model.

Figure 6: **Nominal interest rate changes from 1 per cent world GDP fiscal stimulus**
Deviation from baseline



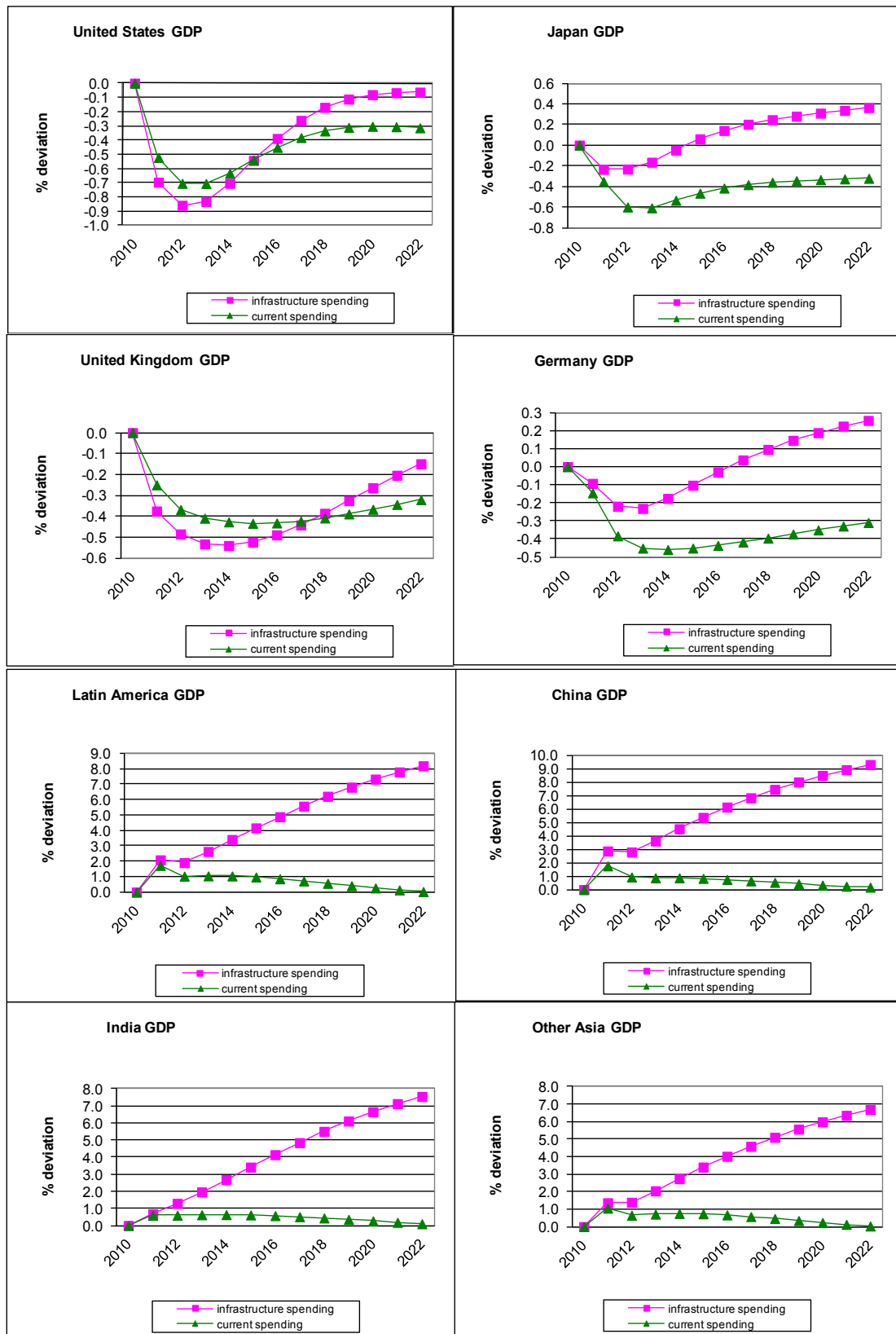
Source: Simulations with G-Cubed (v95N) model.

The next set of figures compares the difference between a rise in government spending on goods and services versus a rise in spending on infrastructure in emerging countries. As mentioned in section 3, the way we model infrastructure is through the empirical link between infrastructure spending and the impact on sectoral productivity. The increase in fiscal deficits adds to the infrastructure capital stock each year, which implies a gradual increase in the level of labour augmenting technical change.

The results in figures 7 and 8 show the large impact of the spending assumption. In emerging countries the crowding out of private spending that eventually causes the fiscal multiplier to go negative is no longer present when the spending is on infrastructure. A higher stock of infrastructure capital implies higher private sector productivity and this is enough to fund the larger fiscal deficit without sacrificing private capital accumulation. It is clear that the productivity story dominates the results for emerging economies.

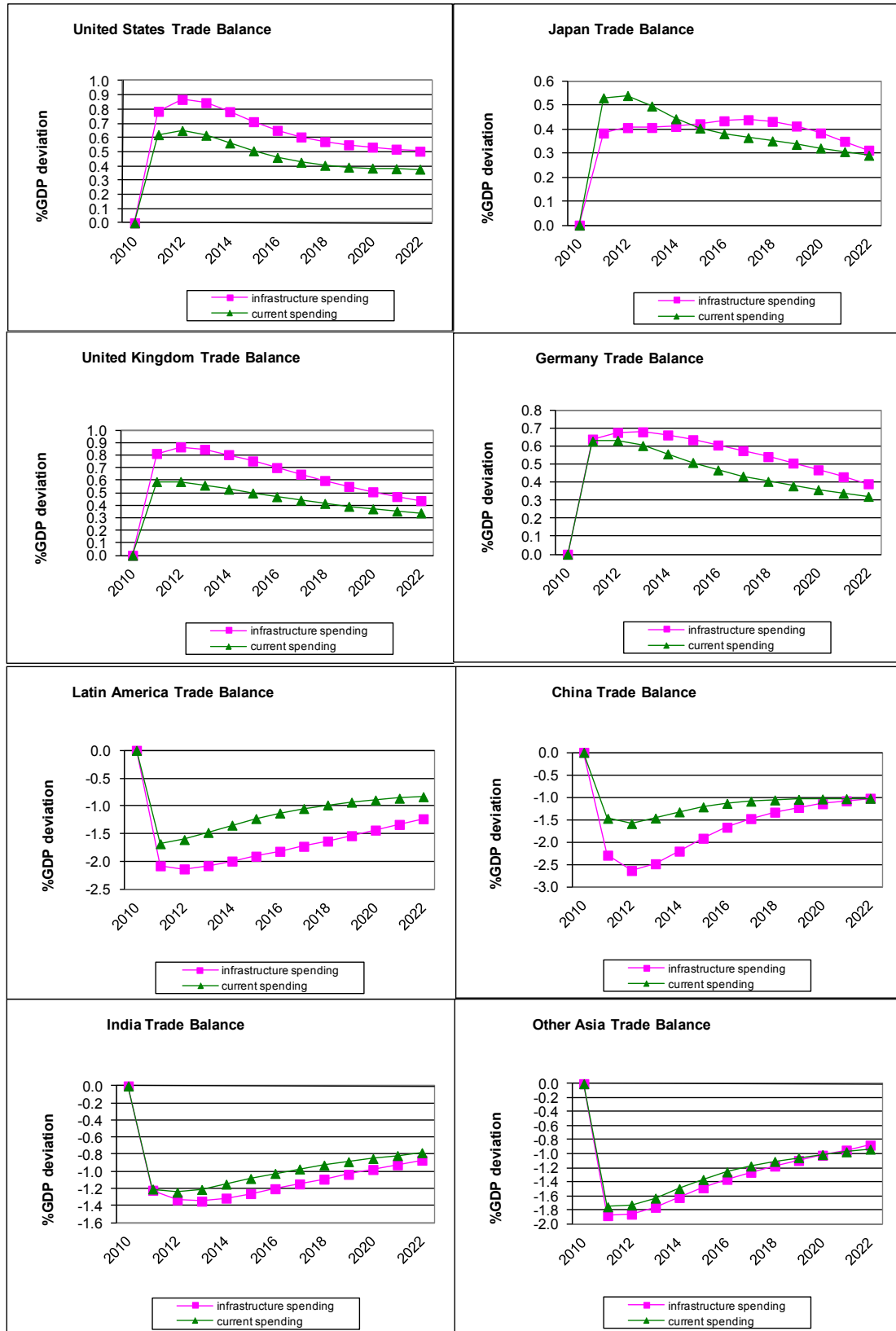
The spillover effects between emerging and advanced economies changes under the different spending assumptions. Because spending on infrastructure raises private returns to capital in emerging countries, more capital flows into these economies to finance the government expansion and the private sector expansion. Thus, the trade balance of the advanced economies (figure 8) improves by more under infrastructure spending than when the emerging country spending is purely on goods and services. This larger outflow of capital from advanced economies also implies a more negative spillover in the short run (figure 7), but a positive spillover in the medium run. There are exceptions depending on the extent of trade links between advanced economies and the more rapidly growing emerging countries. In particular, capital exporters such as Germany do very well out of growth in infrastructure in emerging countries. Over time, as emerging countries become substantially richer, the higher income spills back into advanced economies through trade flows and capital investment so that, eventually, the entire world economy shares in the benefits of investment in infrastructure in emerging economies.

Figure 7: **Real GDP change for emerging country fiscal stimulus — current spending versus infrastructure** Deviation from baseline



Source: Simulations with G-Cubed (v95N) model.

Figure 8: Trade balance change for emerging country fiscal stimulus — current spending versus infrastructure Deviation from baseline



Source: Simulations with G-Cubed (v95N) model.

b) Impacts of advanced country phased-in fiscal consolidation

The second set of scenarios focuses on the question: does it make much difference how fast advanced countries cut their deficits? Because expectations play such an important role in the model, cutting deficits over four years is compared to cutting deficits over ten years to reach the same end point described earlier, which was mostly 60 percent debt to GDP ratio for advanced economies.

The results are shown in figures 9 and 10. Again, recall that all results are expressed as percentage deviations from a baseline of the model. In other words, the results are a comparison relative to a baseline (that is not shown) and, as before, a zero therefore implies that the variable is unchanged from baseline.

The first thing to note about the results is that when countries such as the United States, Japan and the Rest of Euro-zone make large cuts to government deficits, they have significant contractions in their economies relative to baseline. But for those economies where the required deficit reduction is smaller, such as Germany, China and other Asia, there is an expansion of real GDP above baseline (see figure 9). This positive spillover is even stronger for countries like China that partly peg their exchange rate to the US dollar. As the US dollar depreciates due to the policy shift, monetary policy in China loosens commensurately so as to slow down the rate of appreciation of the Chinese currency. Thus, China gets an additional stimulus from loose monetary policy than it would have experienced if it had a floating exchange rate¹⁶.

The contraction and then expansion phase lasts for most of the next decade. Whereas the United States and Japan contract by around 3 percent of real GDP below baseline in 2014 under a ten year fiscal consolidation, Germany and China expand by well over 3 percent of real GDP above baseline by 2020.

The reason for the contraction and expansion difference is what happens to savings, investment and capital flows. The large drop in government spending leads to a fall in GDP as government spending is removed from the economy. The current and expected decline in real GDP in the United States means it is less attractive to investors until after the economic contraction has been sustained and eventually private investment is above baseline as private spending is eventually crowded-in (figure 10). The government is borrowing less and, with consumption initially changing little, there is an excess of savings over investment. Hence, there must be a capital outflow (or much less inflow from base) and, for this to occur, the US dollar must depreciate — that is, the Euro (and many other currencies) must appreciate. The extra capital inflows into countries like Germany and China, and commensurate changes in trade balances (figure 11), causes investment in those economies to rise above baseline and is most significant for Germany. Meanwhile, the large depreciation of the US dollar causes a spike in inflation (not shown) in 2011, which has to be addressed with monetary policy so nominal interest rates also spike in 2011.

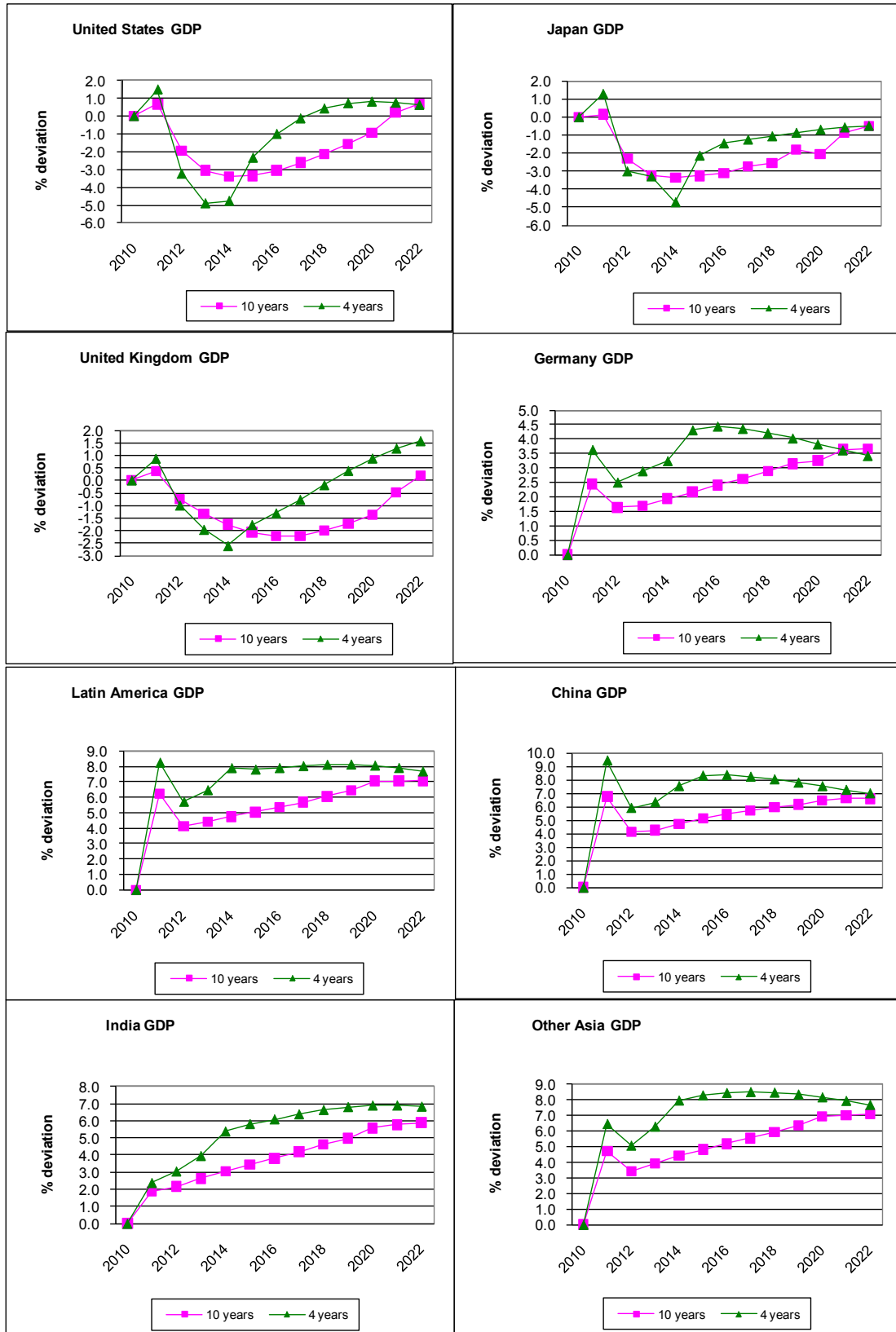
¹⁶ Other researchers (for example, Prasad 2008) have noted the monetary stimulating effect of China intervening to prevent the nominal appreciation of their currency against the US dollar as it leads to excessive credit growth by banks. But Woo and Zhang (2011) reject this credit growth channel and observe that the People's Bank of China had no trouble limiting credit growth in the first half of 2008 at a time when there was heavy foreign exchange intervention to prevent the Chinese currency from appreciating.

Undertaking a more rapid consolidation worsens the medium run economic outcomes, but this also means a more rapid economic recovery after the fiscal cuts are in place. A more rapid contraction also has the interesting result of temporarily stimulating the consolidating economies through a larger, present value, improvement in future economic conditions. Thus, as can be seen in figure 10, investment recovers much more quickly once the future tax liabilities are reduced. Note that this scenario assumes the policy of fiscal consolidation is completely credible to the 30 percent of firms and households in each country who are forward looking.

The improvement in the trade balances of consolidating countries also occurs more quickly when the cuts are phased in more quickly.

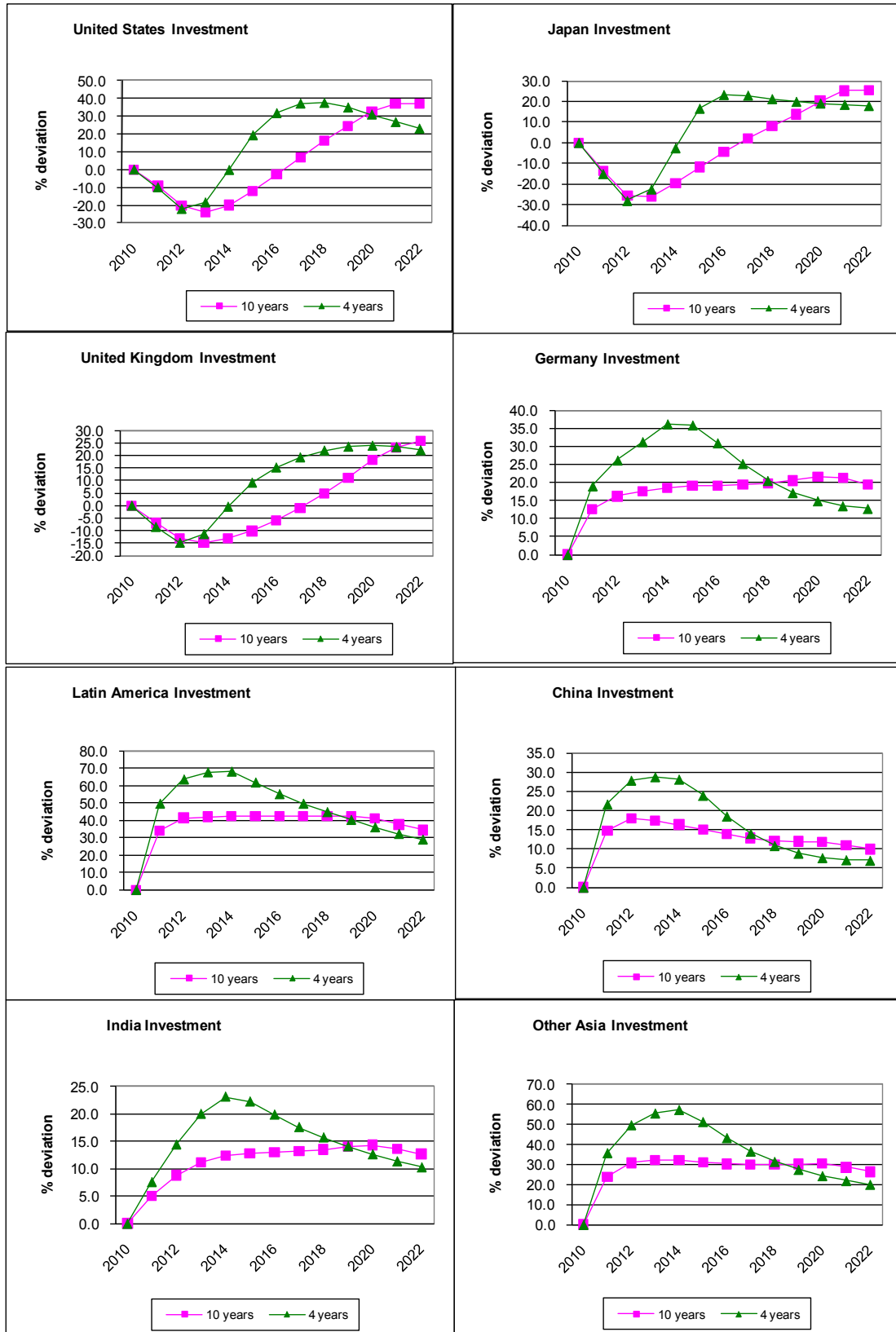
Figure 12 shows some financial consequences of the fiscal cuts. Those countries that cut spending experience both real and nominal exchange rate depreciation. Those countries that do not cut spending experience a real and nominal exchange appreciation due to the change in capital flows in the global economy. Interestingly, capital flowing into Germany and out of the rest of Europe leads to an overall exchange rate appreciation of the Euro, which does not help the non-German parts of Europe in their real output losses. Also, note that in figure 12 China experiences an exchange rate appreciation even though they are partially pegging to the US dollar. This is because the model assumes that, in addition to leaning against the exchange rate, the Chinese central bank also cares about inflation and excessive output growth. The surge in the Chinese economy as a result of the advanced economies' fiscal adjustment is partially dealt with by allowing some exchange rate appreciation.

Figure 9: **GDP change for advanced economies fiscal consolidation — four versus ten years** Deviation from baseline



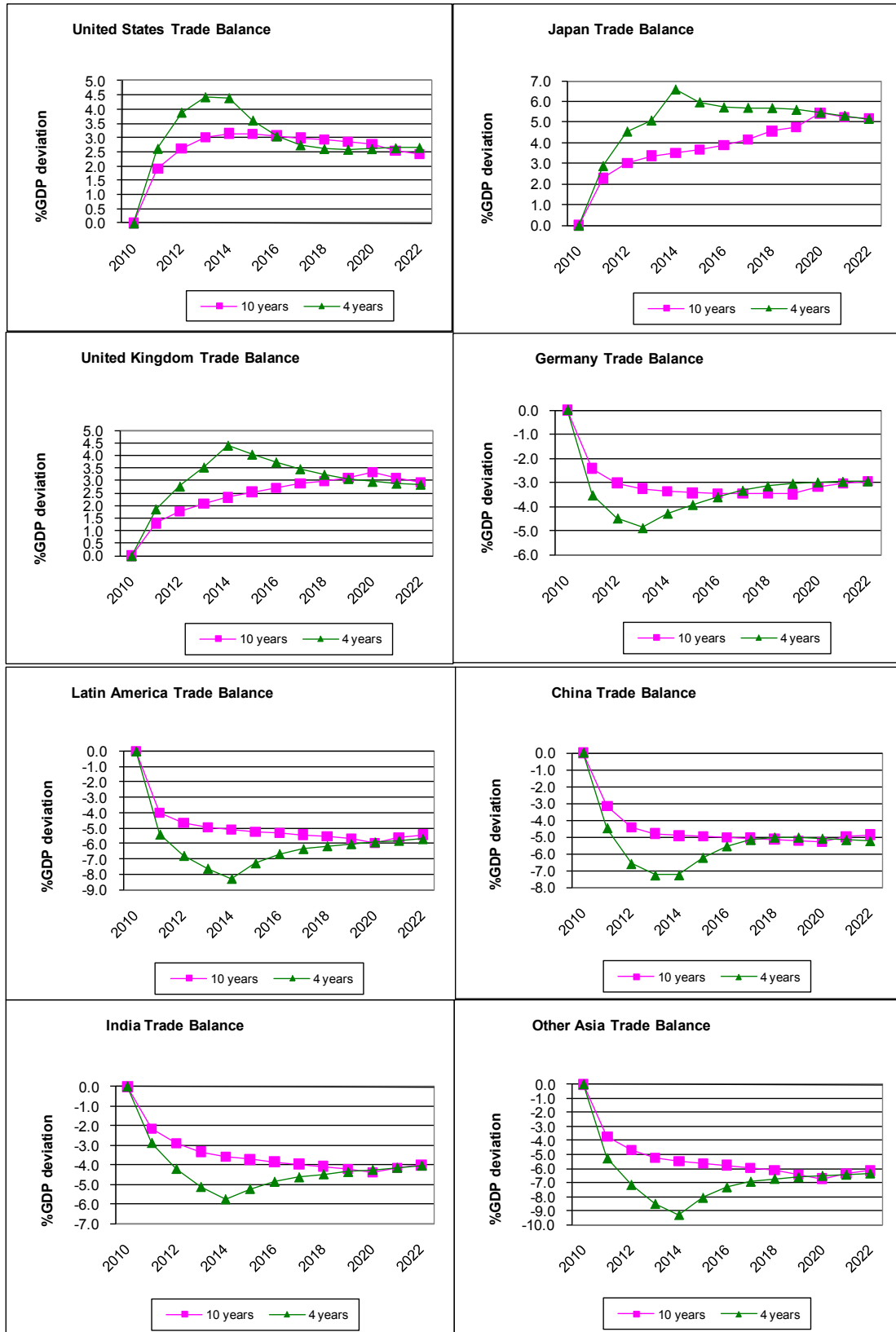
Source: Simulations with G-Cubed (v95N) model.

Figure 10: Investment change for advanced economies fiscal consolidation — four versus ten years Deviation from baseline



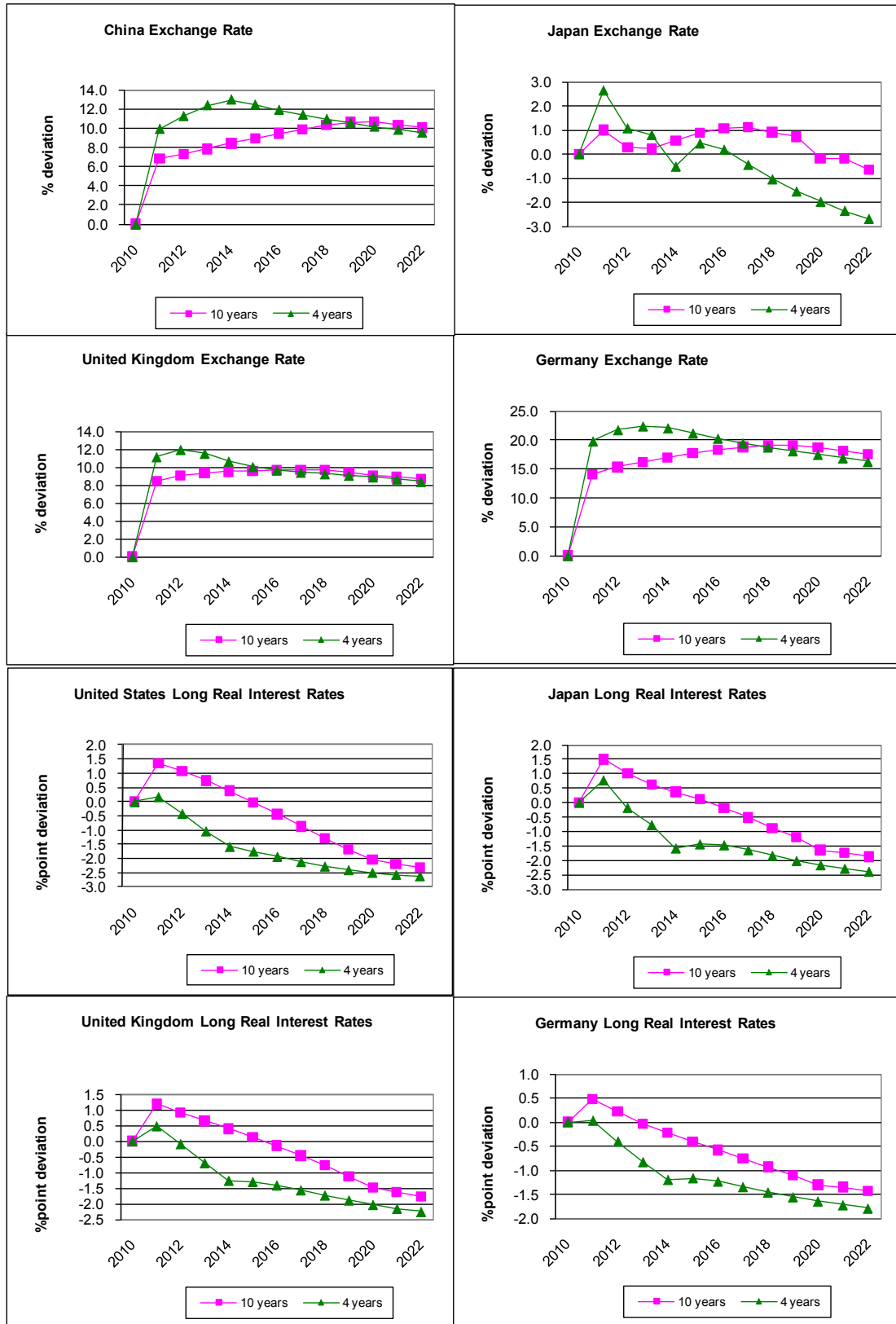
Source: Simulations with G-Cubed (v95N) model.

Figure 11: Trade balance change for advanced economies fiscal consolidation — four versus ten years Deviation from baseline



Source: Simulations with G-Cubed (v95N) model.

Figure 12: **Financial effects of advanced economies fiscal consolidation — four versus ten years** Deviation from baseline



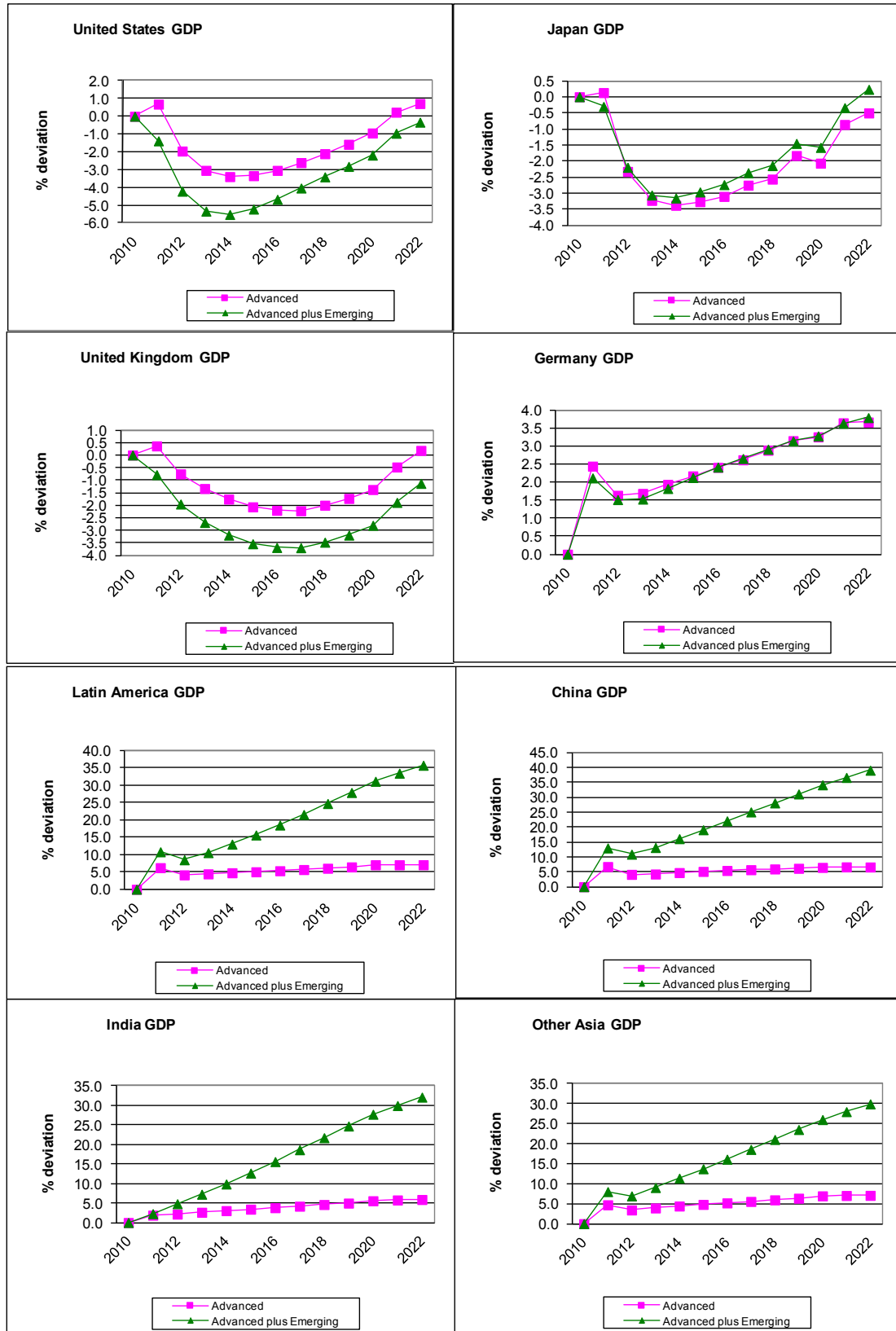
Source: Simulations with G-Cubed (v95N) model.

c) Advanced country fiscal contraction accompanied by emerging country fiscal spending increase on infrastructure

We now address the question of what happens if the cuts in advanced economies are matched by equal dollar fiscal stimulus measures in emerging economies where this additional fiscal expenditure is on additional infrastructure. Figures 13 and 14 show that, in the short run, the additional spending from emerging economies worsens the outcome in the advanced economies for half a decade, but, after that initial period, GDP globally rises above baseline. The outcomes for GDP for emerging economies is very large as the growth opportunities provided by a large increase in infrastructure are substantial. Interestingly, this benefit takes half a decade to emerge, but it is enjoyed forever.

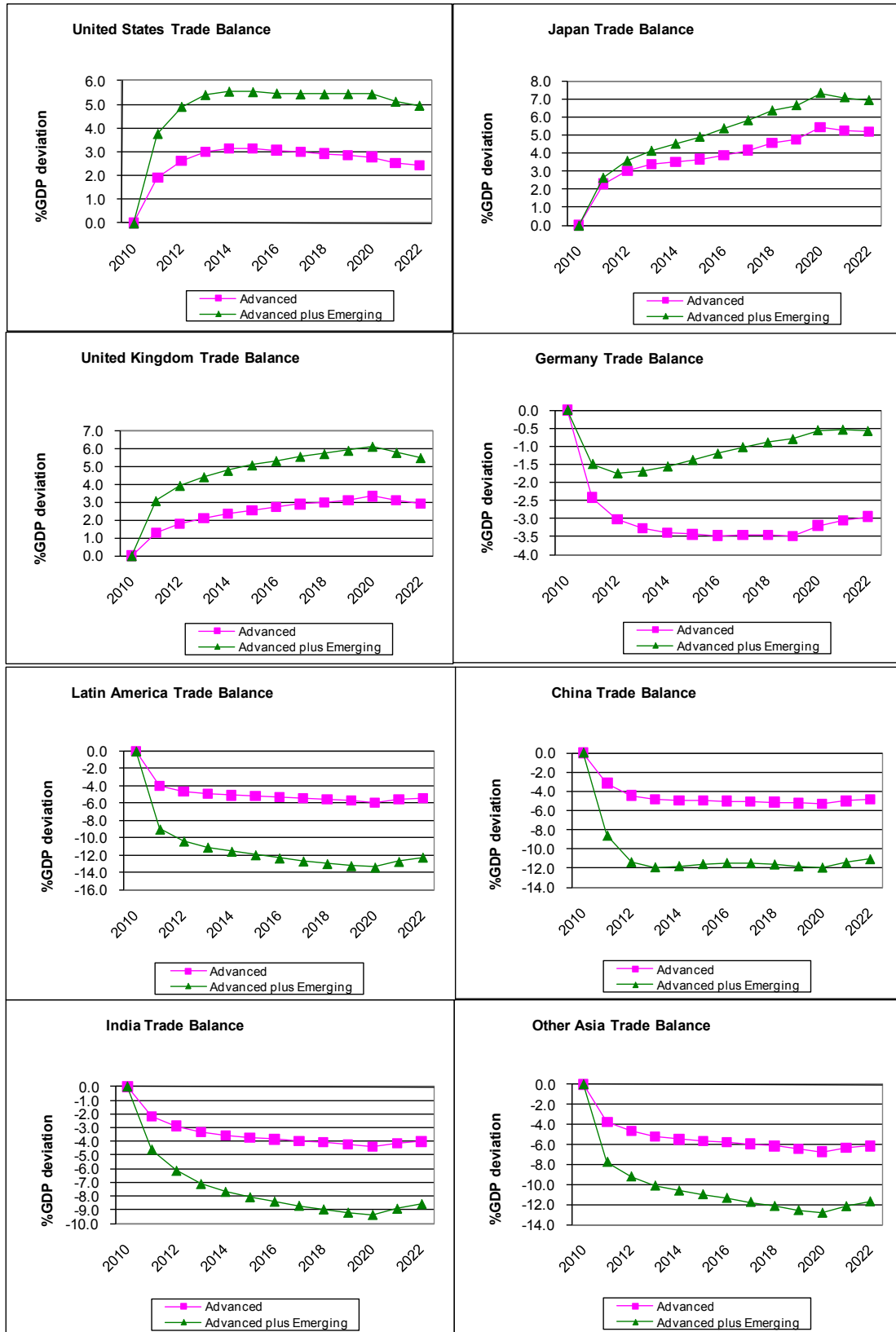
Figure 14 shows that there are substantially different trade outcomes as a result of the investment in infrastructure in emerging economies. The current large US trade deficit is eliminated as are the large trade surpluses in China and other emerging economies.

Figure 13: **GDP change from advanced economies fiscal cuts and emerging economies infrastructure expansion** Deviation from baseline



Source: Simulations with G-Cubed (v95N) model.

Figure 14: Trade balance change from advanced economies fiscal cuts and emerging economies infrastructure expansion Deviation from baseline



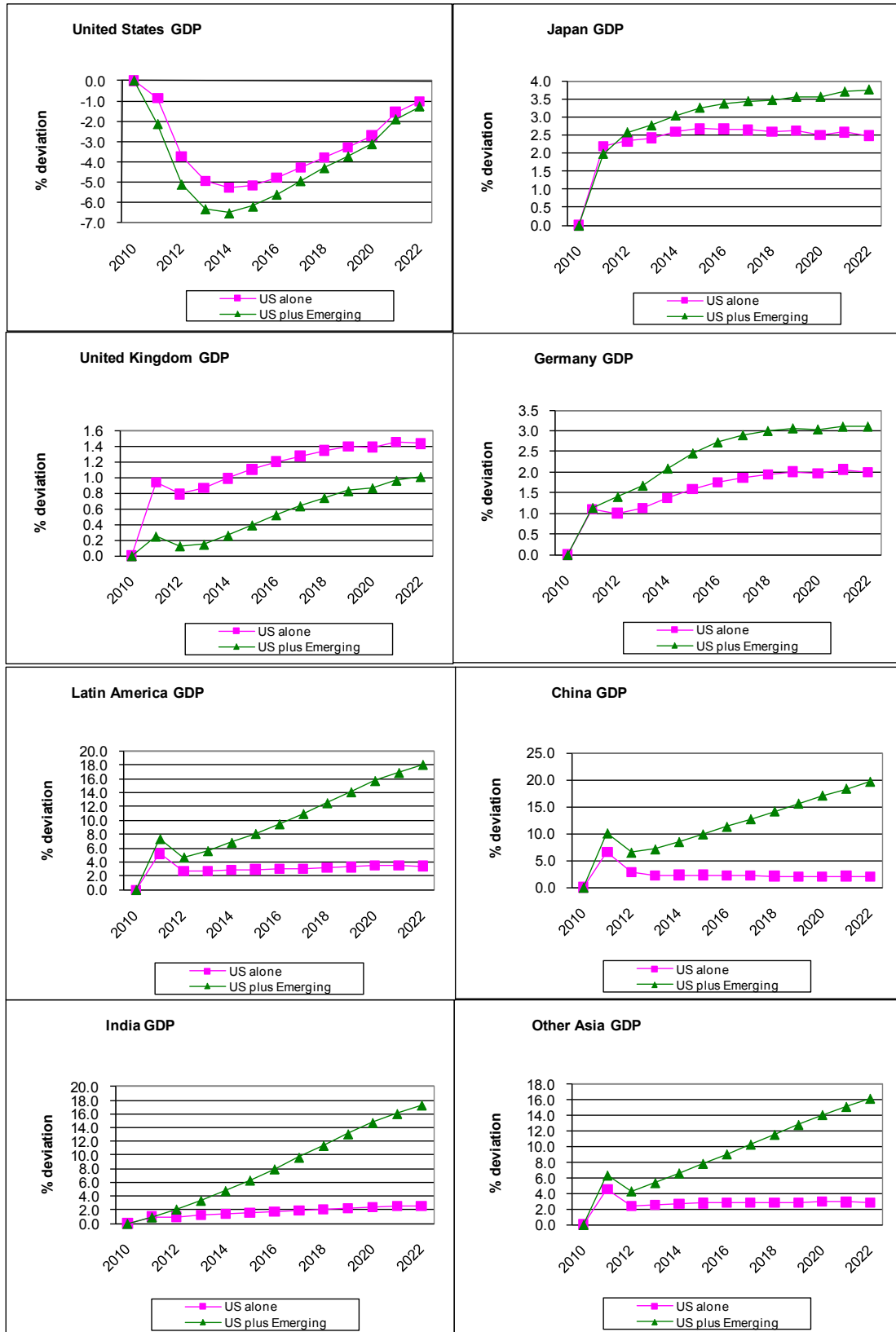
Source: Simulations with G-Cubed (v95N) model.

d) US fiscal contraction accompanied by emerging country fiscal spending increase on infrastructure

The final set of results look at the same idea as the previous section except that the only country taking fiscal consolidation is the United States and this action is offset with infrastructure spending in emerging economies.

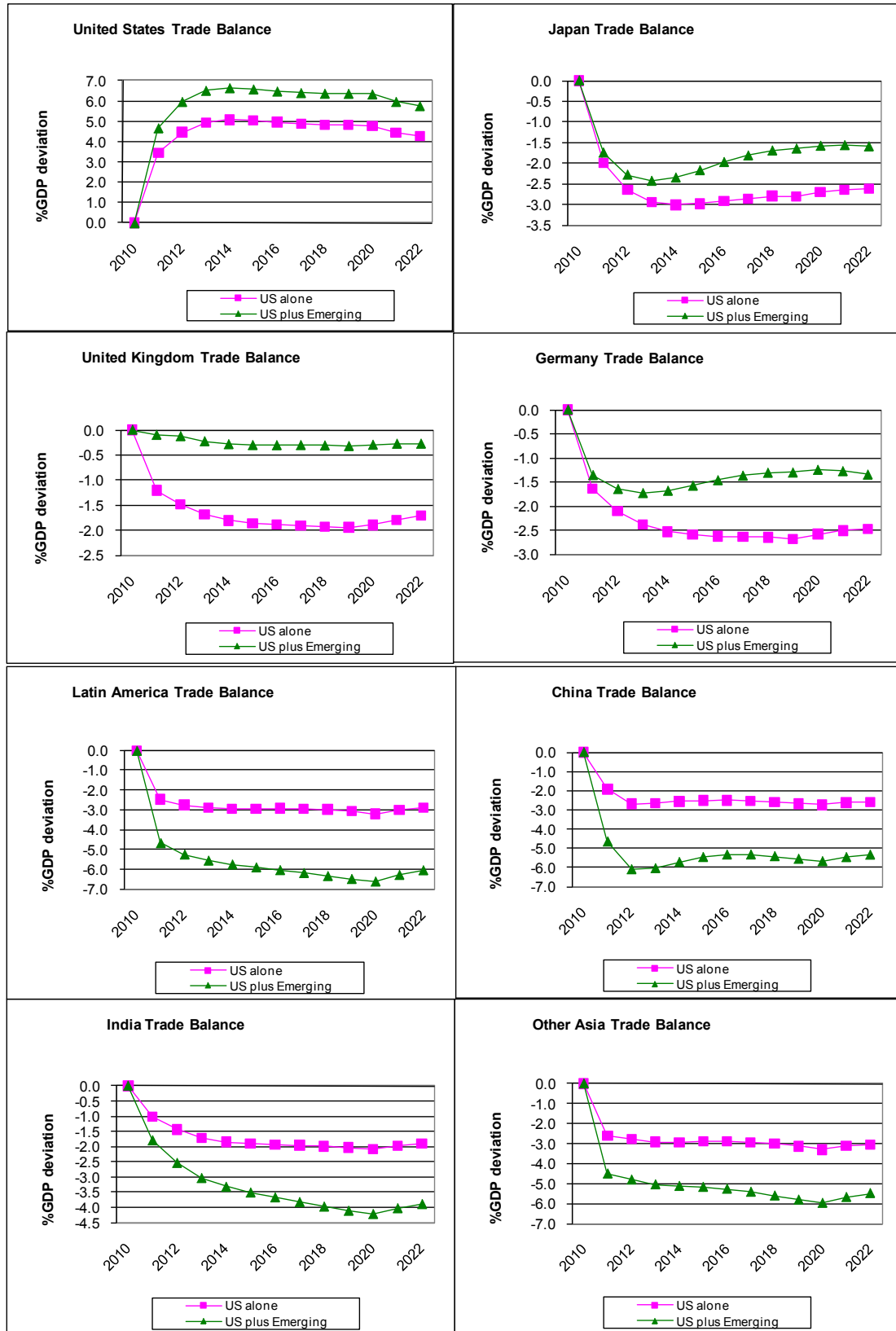
Figures 15 and 16 show similar results to those already discussed above except at a smaller scale. The interesting thing to note is that the cut in the US alone stimulates the other advanced economies significantly. This is the opposite argument to popular commentary that a fiscal consolidation in the United States would cause a global recession because of the direct consequence of reduced US imports. In contrast, the increase in savings generated by US policy reversal would be a positive for the world economy in the short and long term.

Figure 15: **GDP change from US fiscal cuts and emerging economies infrastructure expansion** Deviation from baseline



Source: Simulations with G-Cubed (v95N) model.

Figure 16: Trade balance change from US fiscal cuts and emerging economies infrastructure expansion Deviation from baseline



Source: Simulations with G-Cubed (v95N) model.

5. Summary and conclusion

Fiscal consolidation by advanced economies (in proportion to the size of their debt problem) has the temporary effect of lowering economic activity in those economies, but has a positive effect on emerging countries and a few advanced economies not undertaking fiscal consolidation.

The reason is that the negative flow-on effects from trade linkages by advanced economies reducing imports and stimulating exports with the emerging world are offset by favourable financial flow-on effects, which provides capital for emerging countries to increase GDP.

As prospects temporarily weaken in advanced economies as spending contracts with fiscal consolidation and governments borrow less, real long bond rates eventually fall. However, short real interest rates temporarily rise as future spending is brought into the present and central banks tighten monetary policy in response to higher inflation. Lower real long bond rates boost investment prospects in the emerging world and this positive effect outweighs the negative direct trade effects. Consequently, there is a capital outflow from advanced economies to the emerging world.

Emerging countries receiving a capital inflow experience a decline in their trade balance, with the effect that global trade imbalances become smaller.

It makes some difference for emerging countries whether the fiscal consolidation by high-income economies is fast (over four years) or slow (ten years). The benefits are a quicker recovery period after four years, but the cost is a sharper decline in economic activity in the short run. What matters for investment in emerging countries is the long term real rate of interest and this is affected by expectations over future debt/GDP ratios. Implicit in this conclusion is that the credibility of both the slow and fast consolidations is the same. There are competing forces here: a slow consolidation involves lower annual adjustment costs (more credible), but runs the greater risk of being derailed by a public tiring of austerity (less credible).

The important story from fiscal consolidation as modelled in this paper is the large scale and asymmetry in the required adjustment and the large impacts this has, not only within adjusting economies, but between the economies that are adjusting (mostly advanced economies) and emerging economies. The linkages through trade balance and exchange rate adjustment are large. The management of this will be a key problem for policymakers over the coming decade, including the need for them to resist the likely calls for trade protection as imbalances widen again — a point made by Knight and Wang (2011) in their examination of China's macroeconomic imbalances.

This paper also demonstrates that, if the empirical results of Calderón et al (2009) is reasonable and if there was a program of substantial investment in infrastructure investment in emerging economies, there can be a large impact on the trade imbalance in the global economy in the short run and a net benefit to all countries in the world in the long run. This requires that the investment in infrastructure is as productive as it has been historically. Note that the results of Calderon et al (2009) are based on the actual data on productivity returns to public infrastructure, not an optimistic assumption about theoretical returns given productivity gaps.

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Appendix 1: Calculating infrastructure capital stock in each region

Figure 1: Estimated infrastructure capital stock and relevant shocks

(1)	(2)	(3)	(4)	(5)	(6)
Regions ⁽¹⁾	Estimated infrastructure capital stock billion of national currency ⁽²⁾	Percentage infrastructure stock change for 1 percent GDP increase in infrastructure spending	Estimated annual TFP shocks for 1 percent GDP increase in infrastructure spending	Percentage change of Infrastructure capital stock in emerging countries by 2050 for 1 percent world GDP increase in spending	TFP shocks corresponding to column (5)
USA	4764.22	2.76%	0.22%	-	-
JPN	647198.82	0.78%	0.06%	-	-
GBR	332.95	3.96%	0.32%	-	-
DEU	929.52	2.51%	0.20%	-	-
EUZ	2744.39	2.22%	0.18%	-	-
CAN	395.05	3.65%	0.29%	-	-
AUS	251.84	3.98%	0.32%	-	-
NZL	80.17	2.03%	0.16%	-	-
OEC	2553.81	2.36%	0.19%	-	-
CHI	3820.44	5.69%	0.46%	265.91%	21.27%
IND	7346.60	5.38%	0.43%	251.69%	20.13%
OAS	93163.70	5.32%	0.43%	248.52%	19.88%
LAM	4238.01	5.57%	0.45%	260.21%	20.82%
LDC	5154.75	5.31%	0.42%	248.12%	19.85%
EEB	6785.30	5.23%	0.42%	244.53%	19.56%
OPC	8231.77	3.93%	0.31%	183.57%	14.69%

(1) See Appendix 2 for the definition of country and regional groupings.

(2) For advanced regions the infrastructure stock estimation is for 2002 from Kamps (2004). For emerging regions the estimation is for 2006, which is G-Cubed database's baseline year.

1. Estimation for column (2) public capital stock

To estimate the infrastructure capital stock we basically can employ two approaches: one is to directly estimate it from government investment series; the other is to find a way to split it from the total capital stock. For this study we mainly use the latter one but also need some direct estimation from government investment at certain stage.

First, we find that in Kamps(2004) 's empirical study for 22 OECD countries the government capital stock (infrastructure capital stock) is around 14.66percent of the total capital stock. This relationship is also consistent with Calderon and Serven (2003)'s findings that 'the share of infrastructure in total capital is small for telecommunications and at most 15percent for electric power and roads' [in footnotes of Calderon, Moral-Benito and Serven (2011)]. By this fact, we estimate the infrastructure capital stock by multiplying the total capital stock in G-Cubed database

by 14.66 percent. But in G-Cubed, we get the capital data from the value added rows in Input-Output table which is the measure of capital payment. Therefore, we need to estimate the capital return to get the estimated capital stock both for private and infrastructure. Kamps (2004)'s study got a well-estimated set of private and infrastructure capital stock data so that we can back up the capital return for those 22 OECD countries and fit in regions in G-Cubed (including USA, JPN, GBR, DEU, EUZ, CAN, AUS, NZL and OEC). Then we calculate the mean of capital return using these estimates (except Japan¹⁷) which is approximately equal to 0.1704 and assume that this return also applies to private capital. Finally, we can use this average capital return for the other regions in G-Cubed (including CHI, IND, OAS, LAM, LDC, EEB and OPC) to get the infrastructure capital stock by assuming that they all have the same rate of return.

However, we notice that the infrastructure capital return usually diverges to the private capital return, especially in the emerging countries (see Canning and Bennathan, 2000). Therefore, we need to adjust the stock again. Here, we assume in advanced countries there's little divergence between the private and infrastructure capital return; therefore, this is no need to adjust for regions such as USA, JPN, GBR, DEU, EUZ, CAN, AUS, NZL and OEC. But for emerging economies we assume there is more divergence between the capital returns in private and public sectors and certain adjustment is needed. To do this adjustment, we need the following assumptions.

- For simplification, the marginal product of government capital is $\theta \frac{Y}{G}$ in the Cobb-Douglas production form, where θ is the output elasticity of government capital and it is assumed to be the same across countries according to the study of Calderon, Moral-Benito and Serven (2009)¹⁸. Therefore, the key difference may come from the ratio $\frac{Y}{G}$.
- Assume that the difference between private capital return and government capital return in advanced countries is so small that we let them to be equal. But the emerging countries may subject to significant difference. Therefore, the stock (volume) need to be adjusted compared to their advanced counterparts.

We can easily get the average ratio $G/Y=51.40$ percent for the 22 OECD countries in Kamps (2004)'s study. The next step is to estimate the ratio in emerging countries. We used the Kamps(2004)'s methodology and get the data from the UNData set (<http://data.un.org/>) to estimated another available 25 countries (mainly emerging countries). But it is notable that several countries' government investment series is very short such that we cannot use the estimated capital stock directly. So we use these data to approximate the average ratio G/Y for these emerging countries and finally get 20.99% on average. Therefore, we estimate that the capital return in emerging countries is about 2.5 times of that in advanced countries. By using this result and assuming the private capital rates of return across regions are 0.1704 on average, we adjust the infrastructure capital stock for emerging countries by further dividing the values by 2.5 (recall that the infrastructure capital stock value is obtained

¹⁷ Japan is an exception in advanced countries who has a very high government capital stock and therefore, very low government capital return rate.

¹⁸ In their study, the results show no heterogeneity of the output elasticity of public infrastructure across different countries.

by multiplying total capital by 14.66percent and then dividing by average capital return 0.1704) .

Column (2) is the final results for this estimation and the bold numbers are the emerging regions where infrastructure capital returns are different from that in advanced regions.

2. Column (3)

Column (3) is just a simple calculation which takes the ratio of 1 percent of GDP from G-Cubed database to the infrastructure capital stock estimated in column (2) for each region in the model.

3. Column (4)

Given the empirical results in Calderon, Moral-Benito and Serven(2011)'s study, the output elasticity of infrastructure is 0.08. We multiply the number in column (3) by 0.08 and get column (4).

4. Column (5) and (6)

Column (5) reports the percentage shocks of infrastructure stock due to the assumed 1 percent world GDP proportionally allocated annually to the emerging countries and regions by 2050. And Column (6) is just the corresponding productivity shocks by then.

Appendix 2: Regional aggregation

USA	United States
JPN	Japan
GBR	United Kingdom
DEU	Germany
EUZ	Rest of Euro Zone
CAN	Canada
AUS	Australia
NZL	New Zealand
OEC	Rest of OECD
CHI	China
IND	India
OAS	Other Asia
LAM	Latin America
LDC	Other developing countries
EEB	Eastern Europe and former Soviet Union
OPC	Oil-exporting and the Middle East

Advanced economies:

United States, Japan, United Kingdom, Germany, Rest of Euro Zone, Canada, Australia, New Zealand, Rest of OECD

Emerging economies:

China, India, Other Asia, Latin America, Eastern Europe and former Soviet Union, Oil-exporting and the Middle East, Other developing countries,

Rest of Euro Zone:

France, Italy, Spain, Netherlands, Belgium, Luxemburg, Ireland, Greece, Austria, Portugal, Finland, Cyprus, Malta, Slovakia, Slovenia

Rest of OECD:

Norway, Sweden, Switzerland, Denmark, Iceland, Liechtenstein

Other Asia:

Hong Kong, Korea, Singapore, Taiwan, Vietnam, Malaysia, Philippines, Thailand, Indonesia

Latin America:

Argentina, Bolivia, Brazil, Chile, Costa Rica, Ecuador, Guatemala, Nicaragua, Panama, Peru, Paraguay, Uruguay, El Salvador, Honduras, Caribbean, Rest of South America

Oil-exporting and the Middle East:

Nigeria, Angola, Congo, Iran, Venezuela, Algeria, Libya, Bahrain, Iraq, Israel, Jordan, Kuwait, Lebanon, Palestinian Territory, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, Yemen

Eastern Europe and Former Soviet Union:

Albania, Armenia, Azerbaijan, Bulgaria, Belarus, Cyprus, Czech Republic, Estonia, Georgia, Croatia, Hungary, Kazakhstan, Kyrgyzstan, Lithuania, Latvia, Poland, Romania, Russian Federation, Ukraine, Republic of Moldova, Tajikistan, Turkmenistan, Uzbekistan

Other Developing Countries:

All countries not included in other groups.

(Note that Ecuador is included in the Latin Americas)

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