PEOPLE'S REPUBLIC OF CHINA

SPILLOVER REPORT FOR THE 2011 ARTICLE IV CONSULTATION AND SELECTED ISSUES

July 2011

The **Spillover Report** and **Selected Issues** on China were prepared by a staff team of the International Monetary Fund as background documentation for the periodic consultation with the member country. They are based on the information available at the time they were completed on June 27, 2011 and June 28, 2011, respectively. The views expressed in these documents are those of the staff team and do not necessarily reflect the views of the government of China or the Executive Board of the IMF.

The document listed below will be separately released.

People's Republic of China: Staff Report for the 2011 Article IV Consultation

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SPILLOVER REPORT—2011 ARTICLE IV CONSULTATION

June 27, 2011

KEY POINTS

Issues. Spillover reports explore the external effects of policies in systemic economies, focusing on issues raised by key partners. In the case of China, these partners saw benefits from its growth, especially during the crisis, but were also concerned to varying degrees about spillovers from (1) a potential disruption to China's so far steady growth; (2) the slow pace of currency adjustment; and (3) a further build up in foreign exchange reserves, already the largest in the world, and the closed capital account.

Findings. The main messages flowing from the analysis are as follows:

- China's capacity to both transmit and originate real shocks is rising, implying an important stake for the world in its stability. Insofar as its export-oriented growth model is a source of stresses, economic rebalancing is crucial.

- Currency appreciation is important to that process but alone yields only limited spillovers. Significant positive effects on others' output and trade require a comprehensive transformation that reduces China's household and corporate savings rates and raises depressed factor prices. The latter could also alleviate concerns that China's competitiveness is built on a distorted cost structure, thus easing trade tensions—itself a risk to the world economy.

- Conversely, *failure* to rebalance the growth model would imply unprecedented increases in export market share, potential overhang in capacity, and adverse spillovers from resulting stresses on corporate and bank balance sheets.

- China's policies can affect global capital flows, although that role is secondary to fundamentals such as emerging market country growth and advanced country liquidity conditions. While China's large purchases of reserve currency assets reduce their yields and push capital to emerging markets, it is unclear what the net effect of its closed capital account is, and what opening it up would do.

Approved By **Reza Moghadam and Anoop Singh**	The report was prepared by a staff team comprising Ranjit Teja (Head), Lorenzo Giorgianni, Rishi Goyal, Roberto Benelli, Nathan Porter, Kai Guo, Jarkko Turunen (all SPR); Papa N'Diaye (APD); and Shaun Roach (RES).

SPILLOVER REPORTS

Spillover reports examine the external effects of domestic policies in five systemic economies, i.e., the S5, comprising China, Euro Area, Japan, United Kingdom, and the United States. The mere existence of external effects does not imply that policy modifications or collective action is needed—that depends on many considerations, including the presence of economic externalities. The aim rather is to stimulate discussion, providing a global perspective for policy advice in Article IV discussions and input for the Fund's broader multilateral surveillance.

In each case, key partners are asked about *outward* spillovers from the economy in question, on the basis of which staff choose issues for analysis. To facilitate candor, spillover reports do not cite who raises a specific issue. For this report, the consulted were officials and analysts from the other S5 and from selected emerging markets (EMs)—Brazil, Hong Kong SAR, India, Indonesia, Korea, Mexico, Poland, Russia, Singapore, and Thailand.

This report does not try to capture the full extent and historical significance of China's new influence on the world economy. Rather, it focuses on a few forward-looking issues raised by partners, brings to bear relevant analysis, and describes the reactions of the Chinese authorities. Technical papers underlying the analysis can be found in China Spillovers: Selected Issues. A separate forthcoming report will summarize the themes emerging from discussions with the S5.

CONTENTS

I. BACKGROUND

1. Few countries have so obviously gained from integration into the open world trading system as China, its growth coinciding with its ascendancy as an exporter and manufacturer. China is now the first or second largest trading partner of 78 countries with 55 percent of global GDP (versus just 13 countries with 15 percent of global GDP in 2000). Still, there is more to its influence on the world economy [see background paper, China's Evolving Role in Global Trade]:

- From a network perspective, China is now the world's most "central" trader, with the most sizable connections to other major traders (Table 1). This means that China can *transmit* real shocks widely, whether these originate domestically or elsewhere.

Table 1. Centrality in Global Exports

(Rank, with 1 being the most central)

|	Total Exports		Capital Goods		Consumer Goods	
	2000	2008	2000	2008	2000	2008
China	4	1	5	1	1	1
Euro Area	1	2	3	3	2	2
Japan	3	4	1	2	3	4
U.K.	5	5	7	9	5	3
U.S.	2	3	2	4	4	5
Brazil	15	12	14	15	15	17
Russia	10	8	18	19	13	7
India	19	15	17	16	14	9
Korea, Rep.	7	6	8	5	7	6
Mexico	6	10	6	7	6	8

Source: Background paper, "China's Evolving Role In Global Trade"

- The caricature of China as merely a cog in the global supply chain—wherein imported inputs and exported processed goods respond passively to final demand

in the G7—is changing. This means China's capacity to *originate* shocks has risen, with its share of final demand in major partners doubling during 2000–2008 (Figure 1). Even if that share is half that of the United States and Euro Area, it is rising, and the planned emphasis on domestic consumption will only accelerate the trend.

**Figure 1. Contributions of Countries' Final Demand to Partners' GDP**

(Weighted average across major trading partners)
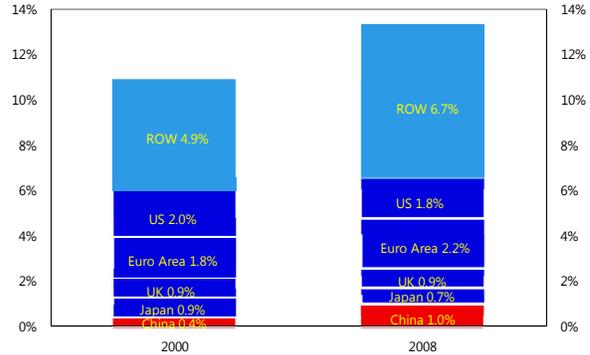
Source: Background paper, "China's Evolving Role in Global Trade"

- China has become a dominant importer across a range of commodities (Figure 2). In metals, per capita intensity now rivals that in advanced economies, rising from less than 15 percent of the level of advanced economies in 2000 to almost 90 percent in 2009. This partly reflects its manufactured exports orientation and role as processor but also the bias toward capital induced by domestic factor prices distortions (more on this below). Thus, as discussed in Section III, the spillover to world commodity prices is now significant.

Figure 2. China's Share of Global Commodity Trade

(Net imports, in percent of world imports)
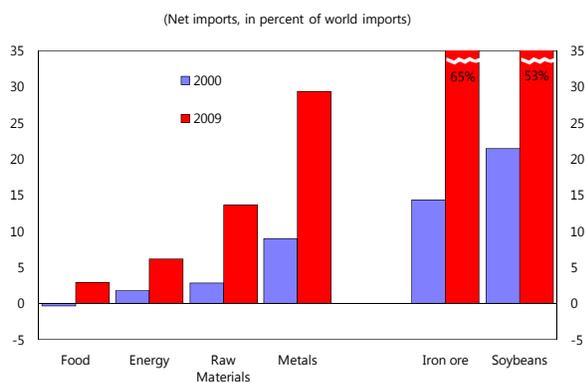
Source: Background paper, "China Spillovers: Global Commodity Markets"

2.   With a largely closed capital account, the main channel of Chinese spillovers to the rest of the world is trade. Figure 3 shows that Chinese output now accounts for a significantly higher share of the variance in G7 output [see <u>Mapping Cross-Border Financial Linkages</u>]. More generally, a simple global VAR model suggests that each 3 percent fall in China's industrial production (1 standard deviation, or 1 percent of GDP) reduces production in advanced partners by around 0.1 percent.

Figure 3. G7 Industrial Production: Contribution of "Own" and "Exogenous" Factors

(6-month ahead variance decomposition, based on 5-year rolling regression)
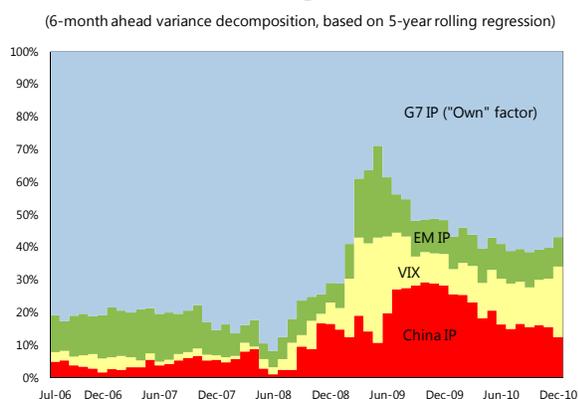
3.   China's ascent has yielded important growth effects in many parts of the world (Box 1). It has also brought obvious benefits to consumers in terms of low prices and fostered productivity-enhancing competition on a global scale. But that story is also associated with two underlying concerns.

4.   The first concern is that, even if fundamentals like scale economies, capital, skills, etc. explain China's growth path, that path also reflects a policy model geared to exports, with savings (the highest in the world) channeled into investment (also the highest) in manufacturing and infrastructure that supports trade expansion. At the risk of over-simplification, the dynamic is:

- Household savings are raised by an inadequate pension and health safety net. In addition, corporate savings (as large as those by households) tend to be high since firms, operating in a controlled financial system, retain profits for future use rather than distribute dividends.

- Excess savings depress real interest rates, reinforce savings behavior (a low return requires more saving in order to reach a targeted balance; see <u>China 2011 Article IV Staff Report</u>, Box 9), and encourage investment in capacity creation—capacity that is used to meet foreign demand at an attractive real exchange rate and low input prices. Figure 4 illustrates the total effect of distortions on the cost of capital, which in China has risen over time and helped keep capital costs low, thus spurring investment.

Figure 4. Imputed Tax/Subsidy on Capital Costs
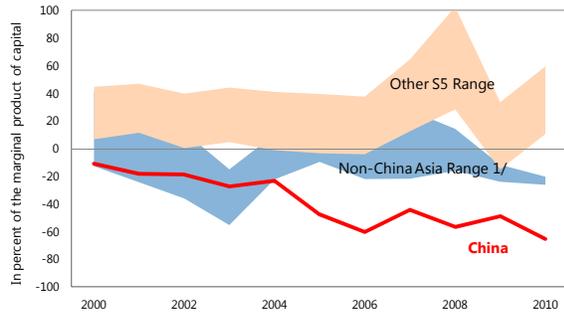
1/ Includes Indonesia, Korea, Singapore, and Taiwan Province of China.
Source: Background Paper, "Factor Pricing, Overcapacity, and Sustainability Risks"

Figure 5. Competition with China and Loss in Market Share
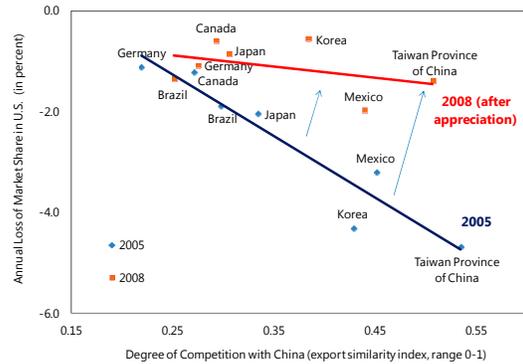
Source: Background Paper, "Impact of China's Competition: Brazil and Mexico"

5. The second underlying concern is the shift—some would say the *resulting* shift—in manufacturing output and jobs to China. Figure 5 relates the loss in market share for many countries with the similarity of their exports with China's. Interestingly, the intensity of that relationship fell between 2005 and 2008 when the RMB appreciated markedly. This is in line with other evidence that Chinese competition and currency matters for the export shares of EMs, although the effect is moderate (see background paper, Impact of China's Competition: Brazil and Mexico).

6. Not surprisingly, the sustainability of China's export-oriented growth model has been questioned—most importantly, in China itself. Indeed, the Chinese authorities recognize the need for economic rebalancing, with greater reliance on consumption, and this is official policy under the 12th Five Year Plan. The key issue for the rest of the world would be its timing, pace and spillover effects.

II. PARTNER CONCERNS

7. Looking ahead, there were three areas of interest to partners: (1) spillovers from the tail risk of disruption if stresses in the current growth model erupt before it can be changed; (2) the impact of policies to adjust the currency and rebalance demand; and (3) potential effects from reserve or net foreign asset (NFA) accumulation and capital account policies. The following points were made:

- *Sustainability of rapid growth*. While maintenance of Chinese growth has been a big plus for partners through the global crisis, concerns were expressed about the tail risk of disruption. The concern is that overheating in China could put added pressure on commodity prices and draw short-term capital to the region. Further, continued high investment could, down

the road and absent sufficient progress in rebalancing, create excess capacity, given uncertain demand prospects in advanced economies, thus risking a hard landing that reverberates beyond China.

- *Commodity prices*. Many counterparts cited China's role in pulling up commodity prices—a plus for commodity exporters but not for the rest. China's strong growth and infrastructure investment were expected to sustain such demand, with some moderation as the economy rebalances; insofar as resource intensity is affected by factor cost distortions, addressing the latter could ease demand.

- *Currency adjustment*. While many acknowledged that China's growth had brought benefits, including lower costs and an imperative for firms to raise productivity, some saw an undervalued currency as having displaced employment. Some with floating exchange rates believed, however, that their flexible exchange rate regimes had limited the impact (as their own currencies weakened with the loss in market share). Most stressed the positive spillovers from faster appreciation of the RMB, with some noting that this could facilitate a move up in the currencies of other Asian supply chain countries (Figure 6).

Figure 6. Regional Co-Movement of Currencies

(Bilateral Exchange Rates with US dollar)


Source: International Financial Statistics
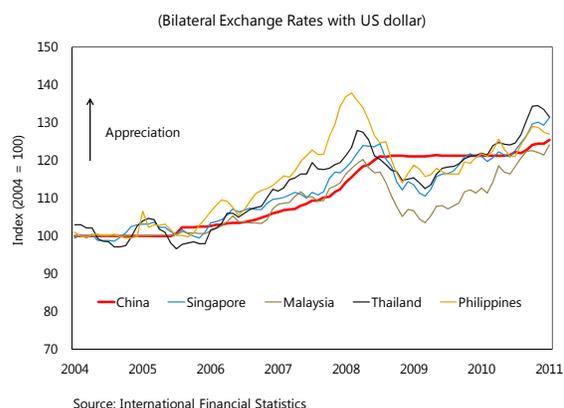
- *Structural policies for rebalancing*. Most partners considered these to be at least as important as currency appreciation. The same policies that facilitate and bottle up high net savings also make for a very low cost of capital relative to productivity; together with other cheap input costs (land, power etc.), these boost China's already high competitiveness. Absent broader reforms to stimulate consumption and raise input costs (see China 2011 Article IV Staff Report), faster currency appreciation yields only marginal benefits.

- *Asset prices and capital flows*. Despite the restricted capital account, China can still affect global asset prices via its large on-going reserve or NFA accumulation—but how large might these effects be? Some officials also thought that a closed capital account could be diverting capital flows from advanced markets to EMs with more open capital accounts.

III.   SPILLOVERS FROM INTERNAL STRESSES

8.   China recently has been an important buffer for the world economy but, in the post-crisis spirit of being less dismissive of tail risks, what happens if the underlying export-and-associated-investment led model were to falter [see background paper, Factor Pricing, Overcapacity, and Sustainability Risks]? Looking at the market shares of countries with sustained booms (Figure 7), China's current trajectory entails unprecedented gains in market share—potentially implying a price or profit squeeze in China's corporate sector and nonperforming loans in banks. Unprecedented market shares may yet occur, but evidence from Chinese industries such as steel, shipbuilding, and machine tools suggests that it will be difficult to accommodate price cuts within existing profit margins and productivity gains. What would be the spillovers if these firms had to reconcile high supply capacity with unexpected demand weakness?

Figure 7. Market Shares of Selected Economies Since Growth Take-off
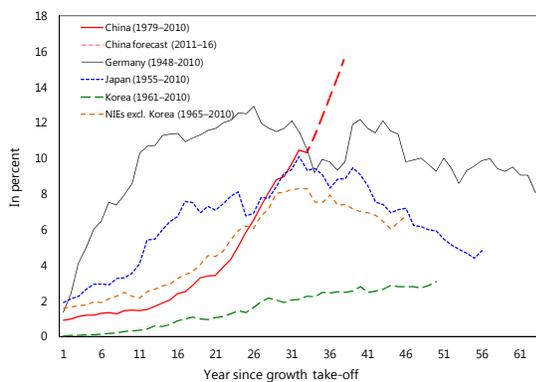
Source: Background paper, "Factor Pricing, Overcapacity, and Sustainability Risks"
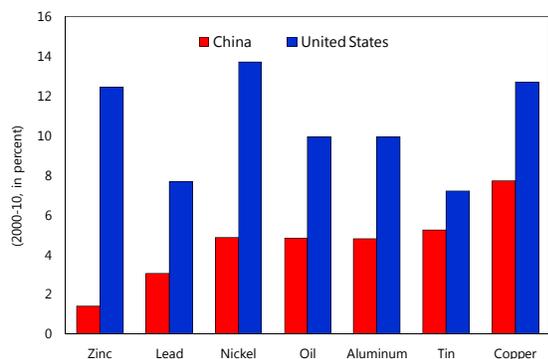
9.   Based on a global model with real and financial variables [see background paper,

China Spillovers: Analysis from a Global VAR], deterioration in the quality of corporate and financial balance sheets could hit many players through trade and investment. For example, an increase in Chinese corporate default probability (from lower expected asset values at each value of debt) of 2 percentage points (a benchmark deterioration seen in U.S. recessions) lowers industrial output by about ¾ percent in emerging Asian economies and ½ percent in commodity exporters; the impact on most advanced economies is generally small (except Japan, where it would be ½ percent); deterioration in China's banking sector produces similar effects.

10.   With China's commodity consumption rising even more rapidly than output, the country has been an important—but hardly sole—driver of higher commodity prices [see background study, China Spillovers: Global Commodity Markets]. Figure 8 shows the contribution of variation in China's demand to variation in commodity prices—a concept that captures the role of China as the marginal consumer moving prices. Figure 9 shows that, in the case of oil, China has accounted for an estimated 20 percent of the price rise since end 2004. While these contributions are high, they do not yet rival that of advanced economies such as the United States, reflecting the latter's size and the persistence of its output shocks. Nevertheless, the impact on commodity exporters of a slowdown in China would be significant, with a 3 percent

reduction in the growth rate of industrial output (1 standard deviation, or 1 percent of GDP) resulting in price declines of 6 percent

for oil and base metals such as copper; the impact on other commodities is low, reflecting much more elastic supplies and demands.

Figure 8. Commodity Price Variance Decomposition

Note: 4-quarter variance decomposition to 1 standard deviation shock in industrial output
Source: Background paper, "China Spillovers: Global Commodity Markets"

Figure 9. Decomposition of Crude Oil Prices
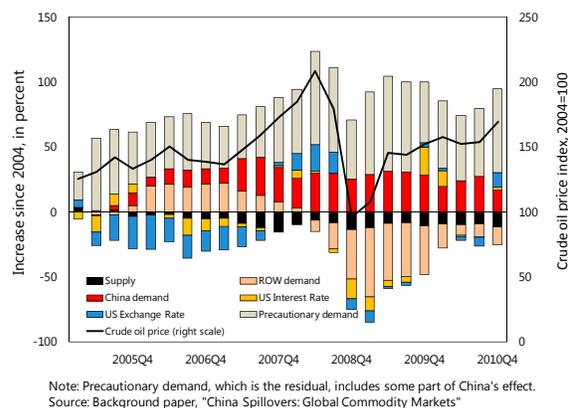
Note: Precautionary demand, which is the residual, includes some part of China's effect.
Source: Background paper, "China Spillovers: Global Commodity Markets"

IV.   CURRENCY ADJUSTMENT AND REBALANCING

11.   On the question of RMB appreciation, China Article IV staff reports have argued that faster correction of an RMB "substantially below the level consistent with medium-term fundamentals" is necessary to rebalance demand and lower the current account surplus. But it is by no means sufficient: other reforms also are needed to reduce savings. From a spillovers perspective, what difference does it make if China only revalues or also implements reforms to reduce savings?

12.   A number of approaches were used to answer this question quantitatively. First, an input-output model combining the production structure with information on trade

connections is used to calculate the immediate short-run impact of appreciation and other rebalancing measures on partners' trade and output [see background paper, China Spillovers: Impact of Rebalancing on the Supply Chain]; relatedly, a trade elasticities methodology estimates the differential effects across sectors [see background paper, Estimating China's Spillovers: A Sectoral Trade Elasticities Approach]. Second, a global vector auto regression models the intermediate-run (peak effects usually occur within a year) interactions across 30 advanced and emerging countries [see background paper, China Spillovers: Analysis from a Global VAR]. Third, the Fund's GIMF model simulates the medium-

term effects (3–5 years) of both a straight RMB appreciation and a comprehensive rebalancing package [see background paper, China Spillovers: GIMF Simulations of Rebalancing and Currency Appreciation]. Purely as an illustration, a real effective appreciation of 20 percent connotes a "substantial" change.

13.   The results in Tables 2–3 suggest that real appreciation would raise partners' output. Large advanced economies experience limited effects, but countries in the Asian supply chain could over time see fairly large increases in output and in current accounts. RMB appreciation benefits final goods producers such as Japan and Korea. Intermediate goods producers in emerging Asia may experience a deterioration in their current account balances initially. Over time, however, as production adjusts to meet Chinese final demand and as market share is gained outside China, their output and current account balances improve.

14.   The main result, however, is that rebalancing policies greatly increase the positive spillover from currency adjustment. If private consumption in China also were to rise with currency appreciation, the growth and trade balance effects more than double. China contracts before production structures adjust but the ultimate impact is mildly positive (which is fine, since the point of rebalancing is not to raise growth in China but to render it sustainable). It bears reiterating that the above is a partial treatment of global imbalances, which requires action by many sides.

Table 2. GDP Impact of Appreciation and Rebalancing (in percent)

	20% Real Appreciation		20% Real Appreciation and Other Reforms for Rebalancing	
	Near term (I-O, GVAR)	Medium term (GIMF) 1/	Near term (I-O, GVAR)	Medium term (GIMF) 1/
China	-2.0 to -3.1	-8.8	-2.0 to -2.3	1.0
U.S.	< 0.05	0.07	< 0.05	0.15
Euro Area	< 0.10	0.12	< 0.10	0.21
Japan	0.10 to 0.30	0.07	0.10 to 0.30	0.22
U.K.	< 0.50	…	< 0.10	…
EM Asia	0.25	0.33	0.25 to 0.30	1.0
Commodity	< 0.30	0.09	< 0.30	0.20

1/ Cumulative effect at peak

Table 3. Current Account Impact of Appreciation and Rebalancing (in percent of GDP)

	20% Real Appreciation		20% Real Appreciation and Other Reforms for Rebalancing	
	Near term (I-O)	Medium term (GIMF) 1/	Near term (I-O)	Medium term (GIMF) 1/
China	-0.69	-2.91	-0.70	-5.17
U.S.	0.02	0.08	0.02	0.25
Euro Area	0.10	0.05	0.10	0.19
Japan	0.11	0.04	0.11	0.04
U.K.	0.05	…	0.11	…
EM Asia	0.30	-0.31	0.31	-0.76
Commodity	-0.02	0.11	-0.01	0.31

1/ 5-years.

15.   The estimated impacts on advanced countries do seem small. However, the results in Tables 2–3 need to be seen in perspective. For one, the effects on advanced countries are many times larger measured against their manufacturing sectors, which are the ones most affected by Chinese competition. More importantly, the effects would be much larger measured against an arguably unsustainable trajectory—an inherently difficult baseline to model; the attenuation of risk, as rebalancing moves the economy to a sustainable path, would also lower risk premiums and magnify the benefits of China's adjustment. Finally, the modeling work here incorporates many countries, thus dispersing the impact of relative price shifts that other models would attribute to one or two country clusters.

V.   FINANCIAL SPILLOVERS

16.   The channels of China's influence on global asset prices are complex. On one hand, that influence is greatly constrained by China's relatively closed capital account. On the other, the sheer size of China's savings (the highest in the world in dollar terms), its rising foreign currency reserves (also the largest), and the composition of those reserves, should all affect asset prices. How to think about these effects?

17.   First, if China accounts for over one-third of global wealth accumulation over the next five years, how might its allocation of savings affect global markets? If the current portfolio "preference" remains, as is likely in the next few years, demand for Chinese assets will push up their price. Relative to the United States, Chinese asset prices would need to rise by 60 percent to equate demand and supply [see background paper, China's Saving: The Impact on Global Financial Conditions]. To arrest this price rise, China's central bank could supply more *domestic* bonds and sterilize the monetary effect by accumulating reserves (buying *foreign* bonds)—in the simulation, $600 billion over the baseline in foreign asset purchases and domestic bond sales is required; in this case, EMs may face upward pressure on their asset prices to the extent that advanced country yields are pushed down by further reserve accumulation, and capital is thus pushed out to EMs. Alternatively, China may liberalize its capital account; in this case,

EM asset prices could go either way (depending on the intensity of Chinese vs. advanced country portfolio reallocations—see background paper for an illustrative scenario). Exchange rate flexibility and steps to reduce saving could alleviate asset price pressures.

18.   Second, what difference does the composition of reserves make to yields in different currencies? Data on the composition of China's reserves are not known, but the general presumption is that at least two-thirds are allocated to U.S. dollar assets. A simple mean-variance portfolio model can be used to estimate the effect of a US$100 billion shift from U.S. to EM treasuries [see background paper, Potential Impact on Global Bond Markets of Reallocating Reserves]. The reallocation, equivalent to about one-quarter of annual reserve accumulation, is assumed to be gradual and orderly—which admittedly abstracts from important market effects that an overt announcement might have. The results in Figure 10 suggest that: (i) U.S. long-term yields would rise by some 12 basis points (as more of these bonds must be absorbed in the market); (ii) yields in advanced countries would rise by about half that figure (these being closer substitutes); and (iii) EM yields could fall sharply, by as much as 50 bps. While these results have been checked for robustness, any static exercise is at best a starting point for discussion, and comes with

important caveats noted in the background paper. For instance, were China to spread its purchases more evenly between advanced and EM bonds, the impact on U.S. and EM yields would be much smaller. Overall, and without claiming too much for this partial analysis, it may be noted that the size of the effect on U.S. yields is similar to those of Warnock and Warnock (2009), but larger than the Gagnon et al (2010) estimate of the impact of U.S. quantitative easing (albeit in stressed and unusual market conditions).

Figure 10. Impact on Yields of Portfolio Reallocation in China
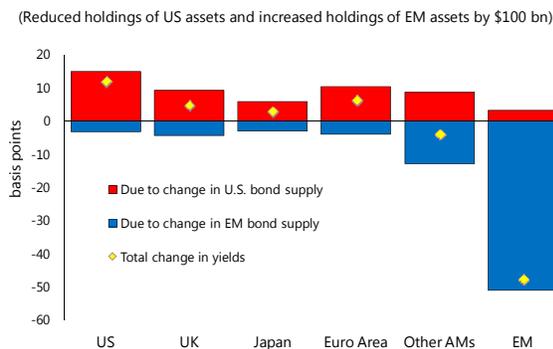
(Reduced holdings of US assets and increased holdings of EM assets by $100 bn)

Source: Background paper, "Potential Impact on Global Bond Markets of Reallocating Reserves"

19.　　Third, how do China's capital controls affect potential outcomes in EMs? Many EMs have faced a surge in capital inflows since the amelioration of the crisis in 2009, reflecting strong fundamentals in these countries as well as easy monetary conditions in advanced economies. But it has been argued that reserve accumulation and capital controls in China also have played a role. This is plausible insofar as reserve accumulation depresses yields in advanced countries, thus pushing capital to EMs. Moreover, capital controls mean that

investors have few avenues to gain direct exposure to one of the world's fastest growing economies, thus diverting capital to others in the asset class. However, evidence on the latter effect is hard to find [background paper, <u>China's Closed Capital Account and Capital Flows to Emerging Markets</u>]:

- In theory, it is unclear which way net flows would go if China were to open up its capital account. Chinese savers currently have few choices between bank deposits (with zero to negative real returns), a volatile domestic stock market, and real estate (whose prices have risen to a degree that the term "bubble" is often employed). Such outflows could exceed the presumed body of capital waiting to pour into China.

- In practice, it is unclear how much is dammed up behind the wall of capital controls. Stocks listed in Hong Kong SAR, where mainland shares are half of market capitalization, tell an ambiguous story. Their performance, either in terms of gross inflows or prices, does not suggest huge demand pressure. On the other hand, the weight to put on this observation is not obvious: it might just be that the stocks listed in Hong Kong SAR are the "wrong ones", e.g., too export oriented (while, going forward, the China growth story seems more about domestic sectors). Indeed, China's FDI abroad quadrupled to US$60 billion during 2007–2010, suggesting desire for outward investment.

VI. AUTHORITIES' REACTIONS

20.   The Chinese authorities welcomed the spillover analysis as adding an important dimension to the discussion of policies of systemic economies. They agreed that, by virtue of the economy's size, China has important spillover effects. They emphasized that maintaining domestic stability is the most important spillover. Policies during the crisis—anchoring demand and regional currencies—illustrate the broad context of China's policy choices. While stable growth in China will continue to support the global recovery, instability elsewhere has complicated the task of rebalancing China's economic structure. The tide of trade complaints attending the global recession and unemployment (Figure 11) also can disrupt the process, and calls into question the commitment to globalization.

Figure 11. Advanced Economy Unemployment Rates and Trade Complaints
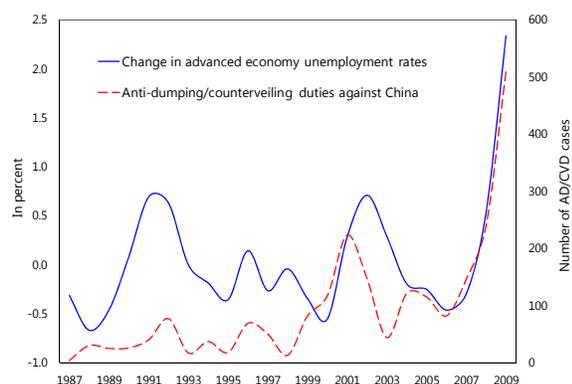
21.   The authorities agreed that China affects the rest of the world primarily through the trade channel. Though the large volume of processing trade may overstate its influence, China is the last link in the supply chain, and its place cannot be easily substituted. As the economy rebalances, its influence will rise. At present, however, the authorities see the United States and European Union as leading sources of global demand.

22.   With China developing rapidly, the authorities expect demand for commodities to continue to rise. But demand also depends on the efficiency of resource use, on which progress is being made and further improvements are envisaged in the 12th Five Year Plan (e.g., in energy use). The authorities cautioned that estimates of China's demand need to account for the effect of processing trade—to the extent that China is bundling goods for consumption by others, estimates of per capita use are overstated. Empirical analyses should control for factors such as speculation and concentrated production. They emphasized that China's effect remains smaller than major advanced economies.

23.   The authorities argued that China's competitiveness rests on structural advantages such as the low cost of labor. Such cost advantages have underpinned the rise of processing trade and market shares, as multinational firms have relocated production to China. High saving has contributed to the low cost of capital. As financial sector reforms

are implemented and rebalancing and structural changes occur (e.g., demographic shifts), saving would fall and the cost of inputs (capital, land, energy, environment) would rise.

24. The authorities regarded the planned rebalancing of growth as good for China and for the world. However, for maximal impact, they considered that this needs to be matched by rebalancing in advanced markets. Otherwise, the latter's overall current account deficits would not shrink (instead, bilateral deficits would simply fall vis-à-vis China and rise against other low-cost producers). They stressed that rebalancing is a long-term process with complex effects. A sudden large appreciation would have large deleterious effects on exporters and the economy, with related negative spillover effects on the output of partners, such as commodity exporters. The importance of processing trade in China's exports suggests that conventional estimates of currency appreciation on the trade balance are overstated. Relatedly, the authorities argued that it is far from clear that Asian supply chain currencies would follow the RMB: the former currencies depreciated while the RMB was stable during the crisis, and caution is warranted in postulating regional behavior.

25. The authorities considered concerns regarding excess capacity and growth

downsides as over stated. High returns on capital suggest the need for further investment, given also China's stage of economic development and infrastructure needs. Much of investment in recent years has been geared to infrastructure, and domestic demand is increasing rapidly. If there is a tail risk of disruption to growth, it comes from protectionist pressures that could interrupt the transition to a rebalanced economy.

26. China's international reserve purchases are seen by the authorities to have a stabilizing role in global financial markets, particularly against the backdrop of fiscal challenges in advanced markets. The saving rate is expected to decline, alleviating pressures on domestic asset prices. Further, a range of macro-prudential tools are available to stabilize asset prices. The authorities noted that large reallocations of net foreign assets are neither realistic (not matching past investment behavior nor accounting for market considerations such as liquidity) nor necessarily in their interest. Finally, they saw no evidence behind the claim that China's capital controls are diverting capital flows to other EMs, which are rather driven by abundant liquidity in advanced markets.

VII. CONCLUDING REMARKS

27.   The main messages that emerge from the discussion are the following:

- China's size and connectedness are such that any economic disruption there would have material adverse consequences for the rest of the world. Insofar as some of the tensions—e.g., excess capacity in parts of manufacturing and rising real estate prices—stem from the current growth model, it is important to the rest of the world that these are addressed quickly by accelerating the rebalancing process.

- Currency revaluation is key to that process, but alone yields only limited benefits to the rest of the world. Positive spillovers hinge more on other reforms to rebalance domestic demand, especially steps to reduce household and corporate savings and, concomitantly, to raise factor prices, especially for capital. Such reforms can also address concerns that China's comparative advantage is unfairly built on low and distorted cost structures, thus reducing trade tensions.

- While the impact on global financial markets is limited by the closed capital account, this will change as the RMB is internationalized and financial opening occurs. The impact on foreign asset prices could be large.

28.   The Chinese authorities welcomed the spillover analysis, noting that their policies have important global spillover effects. They considered that ensuring domestic stability is the most important spillover to the rest of the world. They view rebalancing of China's growth as good for China and for the rest of the world, and agreed that a comprehensive package of currency appreciation and structural reform would yield beneficial results. But they also emphasized that China's rebalancing needs to be matched by rebalancing in other parts of the world for maximum positive effect.

29.   One goal of this spillover report has been to quantify the spillovers from various policies to rebalance demand in China and durably reduce the current account surplus. The payoff to the rest of the world, as it is for China, could be important. However, any disruption in growth arising from a failure to address the tensions implicit in China's export-oriented growth model would yield major *negative* spillovers. The stakes for the world in a smooth transition to a more domestically led growth model are thus significant.

Box 1. China: Spillovers to Low Income Countries

China's commodity demand has materially boosted low income country (LIC) trade performance and a jump in outward FDI and development financing from China would help LICs tap natural resources and develop infrastructure and manufacturing capacity.

- China's share of LIC trade has almost trebled since 2000, reaching 14 percent in 2009, about one-half of the combined shares of the E.U. and the U.S. China is among the top 3 export destinations of nearly 30 percent of LICs, up from 8 percent in 2000.

- At over 80 percent, fuels and other commodities dominate China's imports from LICs (see New Growth Drivers for Low-Income Countries: The Role of BRICs).

LIC Exports to China
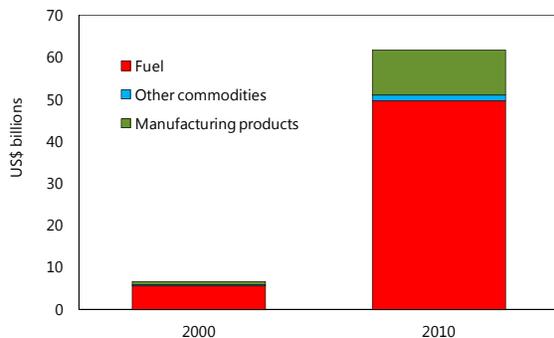
Source: UN Comtrade

- Chinese demand has boosted LIC trade. A 3 percent increase in China's industrial output (or 1 percent of GDP) raises the terms of trade and the trade balance of several LICs by amounts noted in the figure below [see background paper, China Spillovers: Global Commodity Markets].

First-Round Trade Balance Effects of Oil and Base Metal Demand Shocks in China

Change in Trade Balance (in percent of GDP)
- > 1
- 0.5 to 1
- 0 to 0.5
- -0.5 to 0
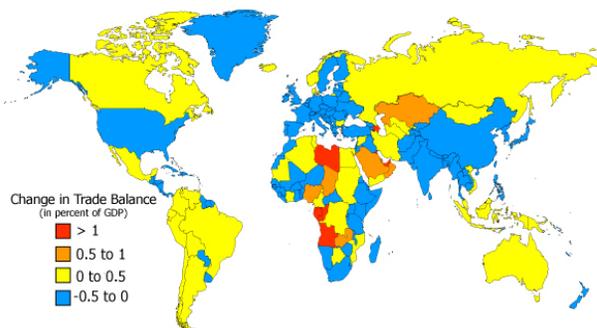
- Although Chinese FDI to LICs is still a small fraction of total FDI inflows to LICs, it has increased more than ten-fold between 2003 and 2009. Large state-owned firms investing in natural resource sectors and infrastructure dominate Chinese FDI.

Chinese FDI in LICs
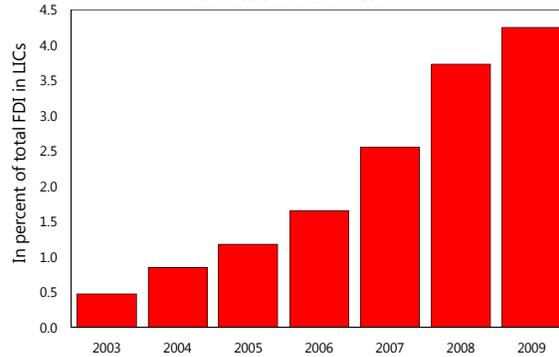
Sources: UNCTAD data; Bulletin of China's Outward Foreign Direct Investment, 2009

- Overall development financing is small relative to traditional donors, and concentrated in infrastructure. China's infrastructure spending in Sub-Saharan Africa (SSA) is, on average, double the IDA/IBRD sectoral allocation for infrastructure.

- Concessional financing commitments from China amounted to about $3 billion in 2007 (compared to $90 billion from traditional donors). This is expected to be scaled up—there are plans for a further $10 billion to SSA over the 2010–12 period.

- Financing is significantly higher once non-concessional resources are included. China's development financing often involves multi-year packages of grants, loans, and lines of credit.

Some have called for greater disclosure on the destination and terms of China's financing flows, and for the need to take into account LIC debt sustainability, including cooperative approaches to debt resolution. Closer involvement with other donors and international lenders would also help ensure a coordinated approach.

INTERNATIONAL MONETARY FUND

PEOPLE'S REPUBLIC OF CHINA

2011 SPILLOVER REPORT—SELECTED ISSUES

June 28, 2011

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I.   CHINA'S EVOLVING ROLE IN GLOBAL TRADE[1]

China's export-oriented growth model has resulted in a large expansion of China's trade and a rapid move up the value-added chain. This has had significant implications for the global supply chain: China's reliance on processing trade, while large, is on a declining trend. From a network perspective, China is now the world's most "central" trader, with the largest and most important connections to other major trading nations; it has become a dominant importer of commodities and exporter of capital goods and intermediate products. While China remains a key conduit for the transmission of real shocks, but three factors—its size, trade centrality, and shares of domestic demand and value added—mean that the impact of shocks <u>originating</u> in China is increasing.

1.   *Export-oriented growth*. The export-oriented growth model—comprising in the main an exchange rate policy and supportive investment, financial, and trade policies—has resulted in a large expansion of exports. China's share of exports has nearly quadrupled over the past 15 years, rising from around 3 percent in 1995 to about 12 percent in 2009; its share has doubled since WTO accession in 2002. The structure of exports has changed, with a rapid increase in the proportion of capital goods exported. At the same time, processing still accounts for nearly one half of China's trade, which means that the standard trade figures overstate the economic impact of China trade, but its share is declining.

2.   *Increasing value added*. China has been moving rapidly up the value-added chain (Figures 1 and 2). Its comparative advantage, as measured by its export share of a product group relative to the world, is increasingly in capital goods, alongside consumer goods. As a result, the share of intermediate inputs has declined.

3.   *Global supply chain*. The growth and transformation of China's trade has had important implications for the global and, in particular, the regional supply chain.

- *Commodities.* China has moved from being a material supplier to a very large importer, with new links emerging (e.g., with Australia, Brazil, and Saudi Arabia).

- *Intermediate goods.* The rise up the value chain is reflected in new and expanded markets for its intermediate good exports (e.g., in the region, U.S., and Euro Area).

- *Capital goods.* China has expanded its market share for exports of capital goods. Its demand for capital goods is increasingly met within the region.

- *Consumption goods.* As domestic consumption strengthens, important supply links are developing—from the Euro Area, Korea, Japan, and the U.S.

4.   *Central role*. Applying metrics of centrality from network theory, China is found to be most *central* to the global trading system, surpassing even the U.S. and the Euro Area. This is a significant change from a decade ago. On final consumption and capital goods, China has become the most central, and also very central to intermediate goods trade.

---

[1] Prepared by Papa N'Diaye (APD) and Nathan Porter (SPR), with inputs from Jarkko Turunen (SPR).

Centrality in Global Exports
(Rank, with 1 being the most central; measured by eigenvector centrality 1/)

	Total Trade		Capital Goods		Consumption Goods		Intermediate Goods		Raw materials	
	2000	2008	2000	2008	2000	2008	2000	2008	2000	2008
Australia	16	13	16	18	17	16	13	14	7	6
Brazil	15	12	14	15	15	17	9	9	8	5
China	**4**	**1**	**5**	**1**	**1**	**1**	**5**	**3**	**9**	**10**
Euro Area	**1**	**2**	**3**	**3**	**2**	**2**	**1**	**1**	**6**	**8**
Hong Kong, China	17	20	13	13	10	18	17	18	17	18
India	19	15	17	16	14	9	10	10	13	11
Indonesia	14	16	15	14	9	12	12	13	10	9
Japan	**3**	**4**	**1**	**2**	**3**	**4**	**4**	**4**	**16**	**16**
Korea, Rep.	7	6	8	5	7	6	7	6	20	20
Malaysia	9	11	9	8	12	11	15	15	15	14
Mexico	6	10	6	7	6	8	11	11	2	3
New Zealand	21	21	19	20	21	21	19	19	12	15
Philippines	18	18	11	12	18	20	20	20	19	17
Russian Federation	10	8	18	19	13	7	6	7	5	2
Saudi Arabia	12	9	21	21	20	19	18	17	1	1
Singapore	11	17	10	11	16	14	16	12	21	21
Taiwan, China	8	7	4	6	8	10	8	8	18	19
Thailand	13	14	12	10	11	13	14	16	11	13
United Kingdom	5	5	7	9	5	3	3	5	4	7
United States	**2**	**3**	**2**	**4**	**4**	**5**	**2**	**2**	**3**	**4**
Vietnam	20	19	20	17	19	15	21	21	14	12

1/ Eigenvector centrality weighs the size of exports with linkages to other large players.

5.   ***Spillovers***. China's central role in global trade makes it an important *conduit* for the transmission—and increasingly *a source*—of shocks. Domestic demand is contributing a growing part of the value added of its trading partners (see Appendix I for a technical discussion). This contribution was small about a decade ago, reflecting the low import content of consumption, but it is currently estimated to be larger than Japan and the U.K., and smaller only when compared to the Euro Area and the U.S. As demonstrated during the financial crisis, China can attenuate the effects of global shocks down the supply chain. Its expanded domestic demand during the crisis raised imports for commodities and capital goods. However, its central role in trade also means that an adverse shock *originating* in China could have a much larger and wider impact than in the past.

Contributions of Countries' Final Demand to Partners' GDP
(Weighted average across major trading partners)
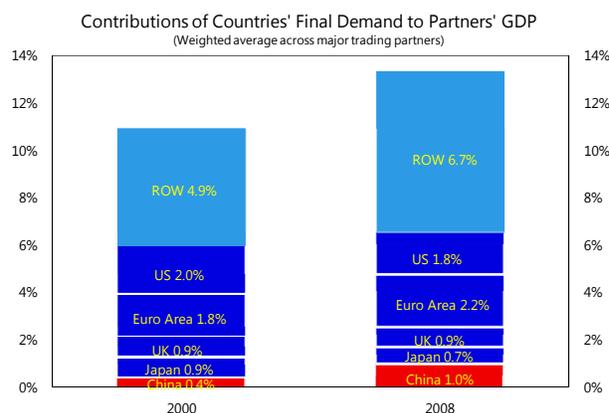
6.   ***Rebalancing policies***. Looking ahead, rebalancing growth in China toward domestic private consumption can have significant spillovers on the supply chain (see, for instance, Chapters II and VI). This increased demand would need to be measured against the impact of potentially reduced demand from the U.S. (owing to increased saving) and given the different sets of consumption goods imported by the Chinese and the Americans (Figure 3). Moreover, since China and the Asian region export a different set of consumption goods, changes in product mixes and/or consumer preferences would need to accompany such demand changes, if the impact of the changes is to extend beyond the Asian supply chain.

Figure 1. China's Trade Structure

Main Message: China is a dominant trade house, moving up the value added chain.

China has become a dominant trading nation.

Share in World
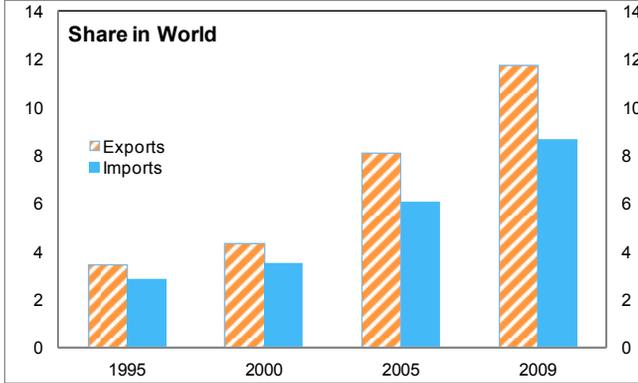
It produces consumption and, increasingly, capital goods...

Export Structure
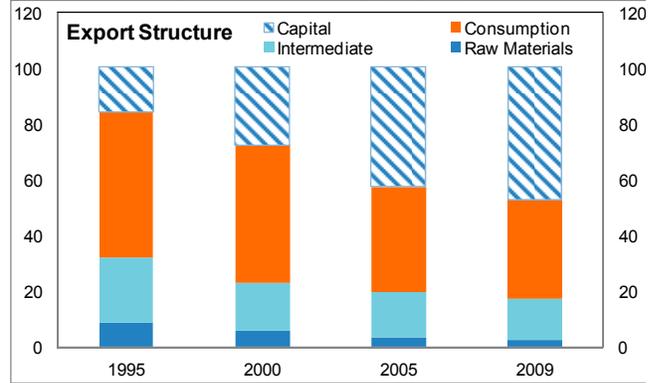
...relying increasingly on imports of raw materials and capital goods, while consumer goods continue to be small.

Import Structure
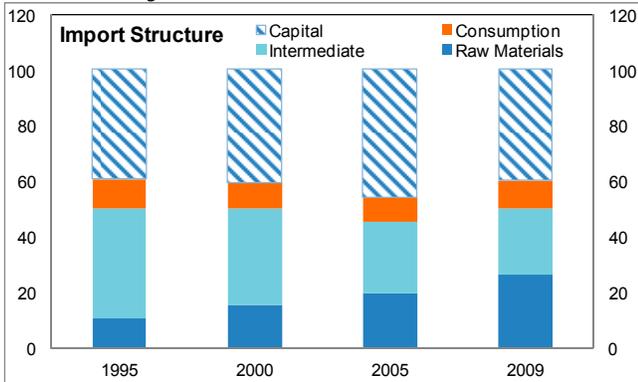
China is moving up the value added chain....

Processing Trade
(In percent of total trade)
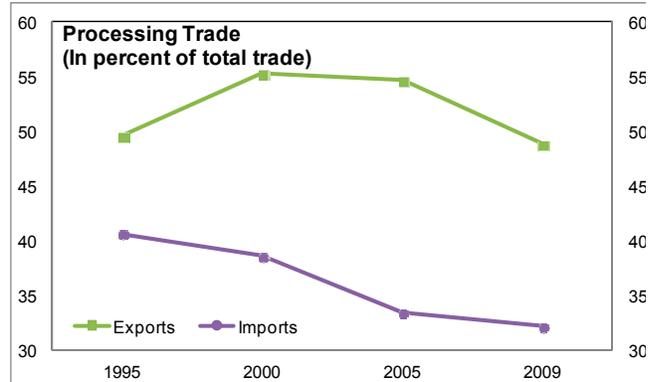
... with foreign enterprises playing a major role.

Foreign Invested EnterpriseTrade
(In percent of total trade)
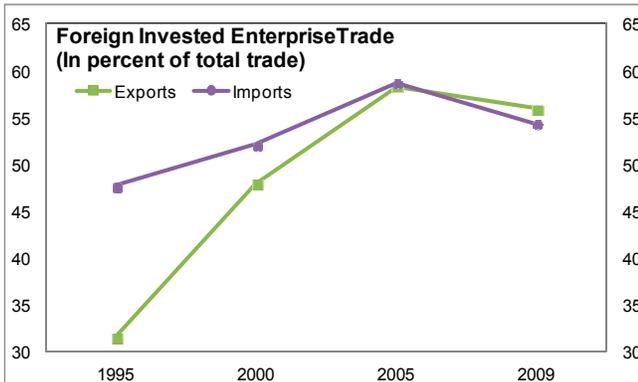
China maintains a comparative advantage in capital and consumer goods, although the advantage in consumer goods has declined.

Revealed Comparative Advantage
(Export share relative to the world)
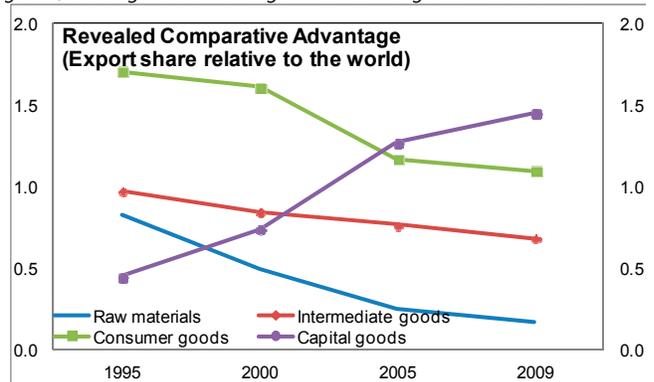
Source: Comtrade; CEIC Data Ltd.

Figure 2. China's Changing Trade Patterns

Chinese manufacturing and electronics exports (main export sector) have become more similar to exports of advanced European countries as well as Brazil and India, ...
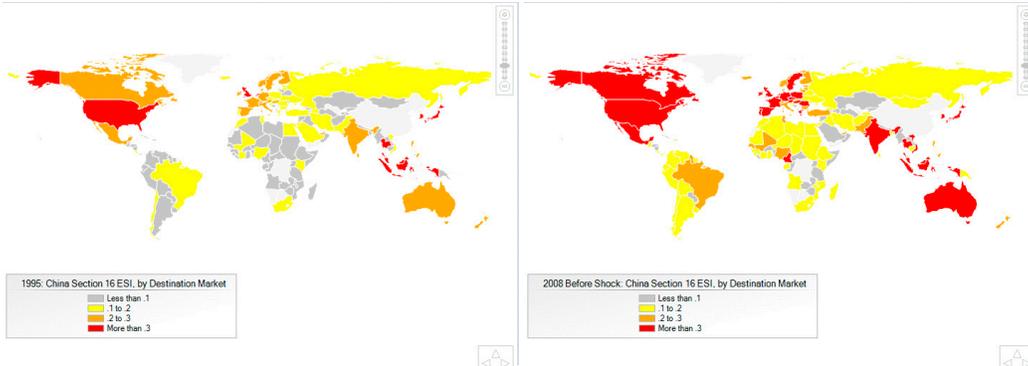
...although adjusting exports to exclude foreign content lowers the share of high technology exports
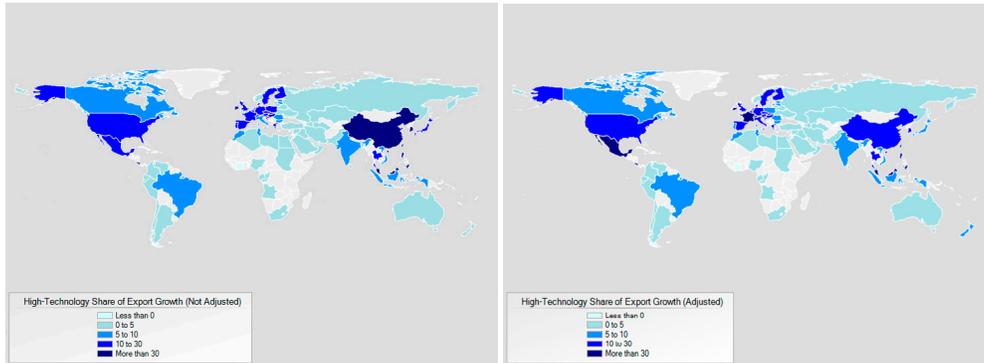
China is well integrated in the Asian supply chain, with Japan, Taiwan Province of China and Korea providing the largest foreign contributions to value-added in Chinese exports. The Asian supply chain extends across several countries, with goods-in-process crossing borders several times.
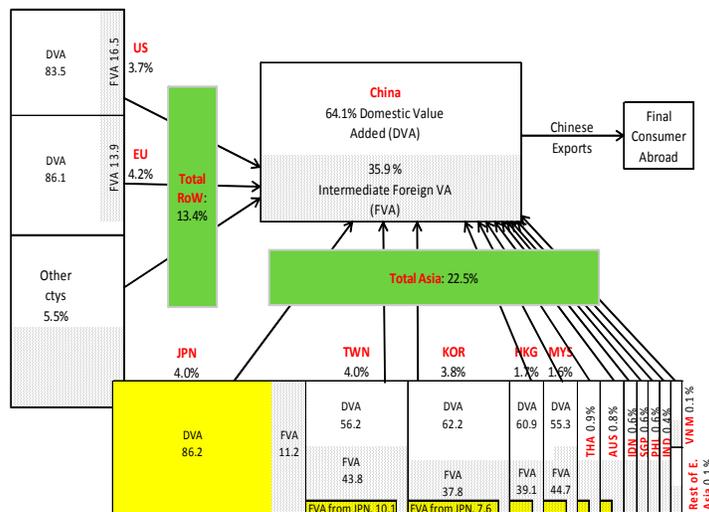
Source: Koopman et al. (2010), "Give Credit Where Credit is Due: Tracing Value Added in Global Production Chains," NBER WP 16426
Note: DVA refers to Domestic Value Added, while FVA refers to intermediate Foreign Value Added.

Figure 3. China Trade Direction and Similarity

Main Message: China trades mostly with U.S., E.U., and Asia, but there is little similarity in consumer products

Exports remain largely regional, ...
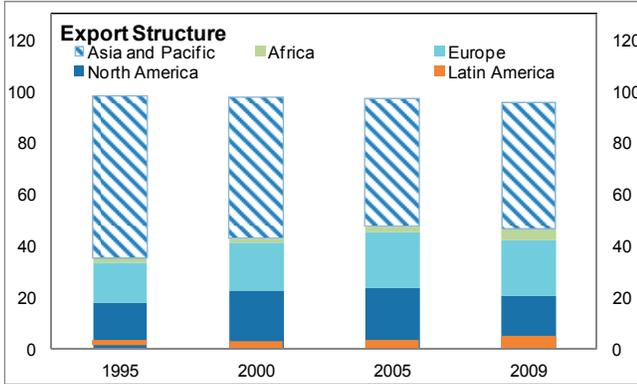
...as do imports, although Latin America and Africa have gained in market share relative to Europe and North America.
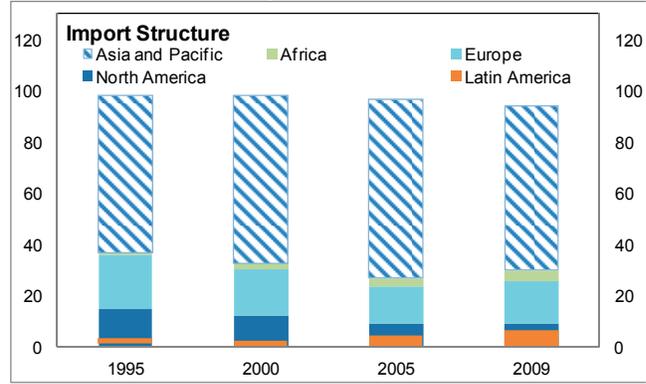
China produces distinctly different consumer goods, particularly durables, than partners outside the region,...

Source: UN Comtrade data base; IMF staff calculations
Note: Based on 303 SITC 5-digit line items for durable, semi-durable and other consumer goods.
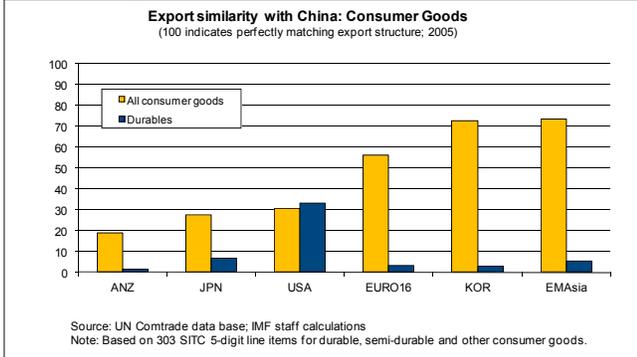
... and the similarity has not changed much over time.

Source: UN Comtrade data base; IMF staff calculations
Note: Based on 303 SITC 5-digit line items for durable, semi-durable and other consumer goods.
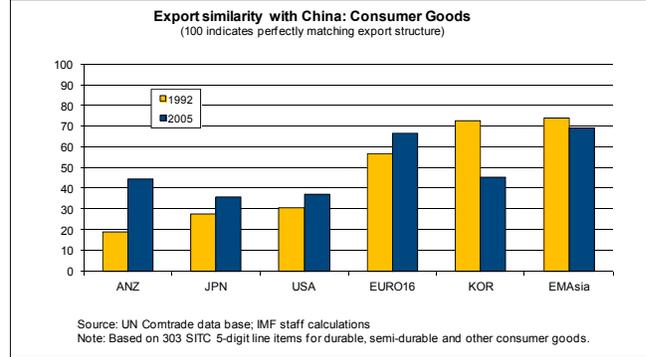
China also imports different consumption goods, ...

Source: UN Comtrade data base; IMF staff calculations
Note: Based on 303 SITC 5-digit line items for durable, semi-durable and other consumer goods.
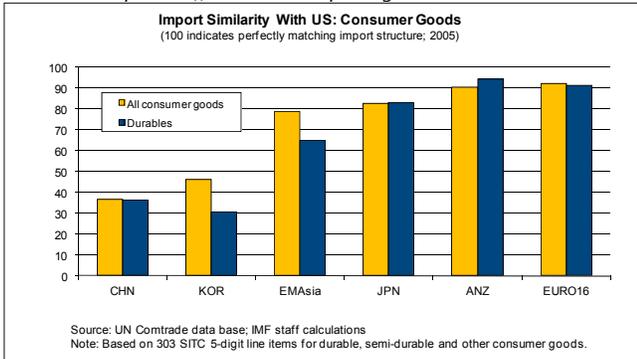
... a pattern that has also not changed substantially over time.

Source: UN Comtrade data base; IMF staff calculations
Note: Based on 303 SITC 5-digit line items for durable, semi-durable and other consumer goods.
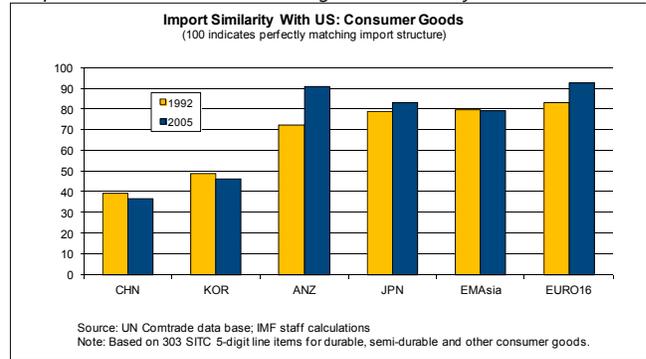
Source: Comtrade; CEIC Data Ltd.

Appendix I. The Decomposition of Value Added

1. ***Input-output analysis***. This appendix presents the details of the input-output analysis needed to calculate the contribution of China's (and others') domestic demand to the value added of partner countries. The analysis builds on Asian regional Input-Output tables for 2000 and 2008 from Mohommad and others (2010). These I-O tables show the detailed production structure for 10 economies—Indonesia, Malaysia, Philippines, Singapore, Thailand, China, Taiwan Province of China, Korea, Japan, and the U.S.—with 7 sectors in each economy.[1]

2. ***Production structure***. Figure 1 summarizes the production structure of each economy, which comprises an intermediate demand block (the "A" matrix) and a final demand block (the "F" matrix). The A and F matrices show (reading down the column) the number of units of intermediate (in the A matrix) and final (F matrix) inputs required to produce one unit of output. The inputs include domestic and imported intermediate goods from upstream supplier, as well as final goods. The diagonal shaded blocks show the domestic goods for intermediate and final use.

Figure 1. Production Structure
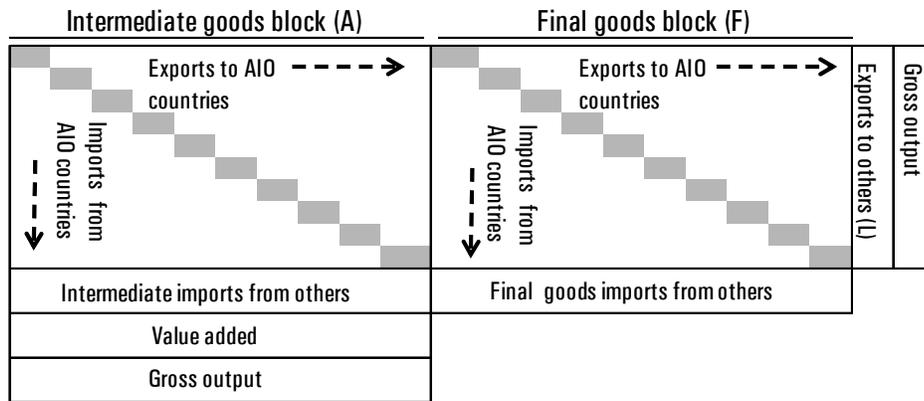
3. ***Country coverage***. To broaden country coverage, the following key economies were added to the selected ones above: Australia, Brazil, the Euro Area, Russia, India, Saudi Arabia, and the U.K. The I-O tables for these economies for 2008 were constructed using I-O tables for year 2000 published by the OECD and information on trade and output growth. This involved mainly the following 3 steps:

- For each new country (and each in the Euro Area), a domestic input-output matrix is identified from the OECD input-output database. Typically, these were for the year 2000. For 2008, the value added inputs were updated using GDP data from the WEO database,

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[1] Our use of COMTRADE HS classification data is in line with that by Mohommad, Adil, Papa N'Diaye, and Olaf Unteroberdoerster, "Does Asia Need Rebalancing?" *Regional Economic Outlook: Asia and Pacific*, April 2010, pp. 43-66 (International Monetary Fund: Washington, D.C.) and Pula, Gabor, and Tuomas Peltonen, 2009, "Has Emerging Asia Decoupled?" ECB Working Paper 993 (European Central Bank: Frankfurt).

and domestic intermediate input requirements were updated assuming a constant relation to value added.

- Imports of intermediate and final goods were calculated using COMTRADE data based on the BEC classification. Raw materials and intermediate goods trade were assumed to feed into the production process at the intermediate level (matrix A), while trade in capital and consumption goods were taken to be for final use in each country (F matrix). Trade data were then used to complete the "off diagonal" blocks of the A and F matrices.

- The domestic final demand was calculated as the residual from output net of intermediate use and exports in each economy to ensure consistency with the I-O framework presented in Figure 1.

4.   ***Calculating spillovers***. In the I-O framework, gross output (X) solves the following equation:

$$X = AX + F = (I - A)^{-1}F$$

where $B = (I - A)^{-1}$ is the Leontief matrix. Each block (B_{ij}) in this matrix shows the number of units of production in country i (supply country) to produce one unit of gross output in j, the demand country. The impact of final demand in economy j on other economies is determined through the following equation:

$$IFv^j = vBF^j$$

where *v* is a diagonal matrix of the vector of value added.

II. CHINA SPILLOVERS: IMPACT OF REBALANCING ON THE SUPPLY CHAIN[1]

This chapter assesses quantitatively the short-run effect of rebalancing growth in China on its trading partners. Using an input-output framework and detailed trade information, and holding short-term production patterns unchanged, it finds that rebalancing—with higher private consumption and a real appreciation of the RMB—would substantially raise GDP in the regional supply chain. The impact on advanced partners would be small initially, but should become larger as production patterns change.

1.   ***Rebalancing policies***. As discussed in Chapter I, China's export-oriented growth strategy has had important effects on trading partners and competitors. Going forward, its policies to rebalance the economy—such as in the 12th Five Year Plan—are expected to have significant effects on the global supply chain as China's imports rise and its production becomes more domestically oriented. These policies include re-aligning relative prices (e.g., cost of capital, land, and pollution), gradually adjusting the exchange rate, and changing the savings behavior of households and corporations (e.g., through reforms to social safety nets).

2.   ***The exercise***. This note uses an input-output framework—which takes as given the production structure of inputs and output in an economy and relates changes in final demand across countries to changes in output and value added (see *Regional Economic Outlook: Asia and Pacific,* IMF, April 2010)—to assess quantitatively the instantaneous or short-run effect on partner countries of a fall in savings that raises private consumption (by 5 percent of GDP) and lowers the share of investment in GDP, and a real effective exchange rate (REER) appreciation (of 10 percent). The calibration of the increase in private consumption by 5 percent follows the study of Guo and N'Diaye (2010). The REER appreciation of 10 percent is ad hoc and illustrative, and not based on any assessment of RMB undervaluation. *In the near term*, it is taken as part of an overall rebalancing package, which includes measures to promote private consumption.

3.   ***Rising private consumption***. Rebalancing that raises Chinese consumption would raise growth universally and reduce China's trade surplus significantly (Figure 1):

- *Growth*. Chinese GDP would increase by around 2 percent. Regional trading partners would be the significant beneficiaries. For instance, GDP in Malaysia and in Taiwan Province of China would rise by around ½ percent. However, advanced economies would benefit substantially less. Japan's GDP would rise by 0.1 percent, while the U.S. and the Euro Area would see even smaller rises. (By comparison, a 5 percent increase in U.S. consumption has larger effects outside Asia than it does in Asia.)

- *Trade balance*. China's trade surplus would be reduced by about ½ percent of GDP. The trade balance in all trading partners would improve, contributing to raising GDP.

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[1] Prepared by Papa N'Diaye (APD) and Nathan Porter (SPR).

4.   ***REER appreciation***. An appreciation of the REER would lower China's trade balance and also its GDP, but most trading partners would benefit (Figure 2).

- *China*. A 10 percent REER appreciation could reduce China's GDP by around 1 percent. The initial direct impact could be larger, close to 1¾ percent; however, the appreciation would also raise private consumption that offsets this direct impact. China's trade surplus would narrow by more than ⅓ percent of baseline GDP.

- *Regional supply chain*. Most trading partners would benefit from a real appreciation of the renminbi, especially regional partners. This changes if other countries in the regional supply chain also appreciate.

- *Commodities' producers*. Some raw material suppliers, however, could have slightly lower GDP, reflecting a decline in the demand for inputs. Nonetheless, the rise in Chinese consumption (due to the appreciation) boosts GDP in all partners.

- *Advanced partners*. Advanced trading partners benefit only marginally from the appreciation. The largest beneficiary is the Euro Area, probably reflecting Germany's role as a significant supplier to China.

5.   ***Best of both worlds***. Combining the 10 percent REER appreciation with rebalancing toward private consumption (rising 5 percent of GDP in total) leaves China's GDP relatively unchanged, while China's trade surplus narrows (Figure 3). Trading partners benefit from both the appreciation and stronger demand. The impact of the stronger consumption also tends to ameliorate the impact of trading partner appreciation.

6.   ***Caveats***. The strength of input-output analysis is that it is built on detailed trade and production patterns. However, the economic structure is relatively static, with limited substitution possibilities. The simulation results should, therefore, be interpreted as short-term impacts. The scenarios may understate the impact of an appreciating renminbi, with only trade in final goods directly affected by the appreciation. Trade in intermediate goods is affected only through second round effects.

Figure 1. Input-Output Analysis: Impact of Rising Consumption on Trading Partners
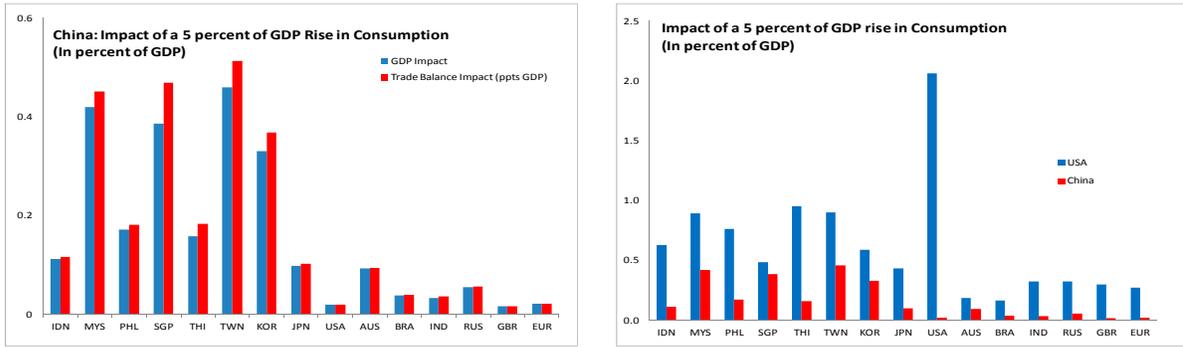

Figure 2. Input-Output Analysis: Impact of Real RMB Appreciation

GDP and Trade Balance
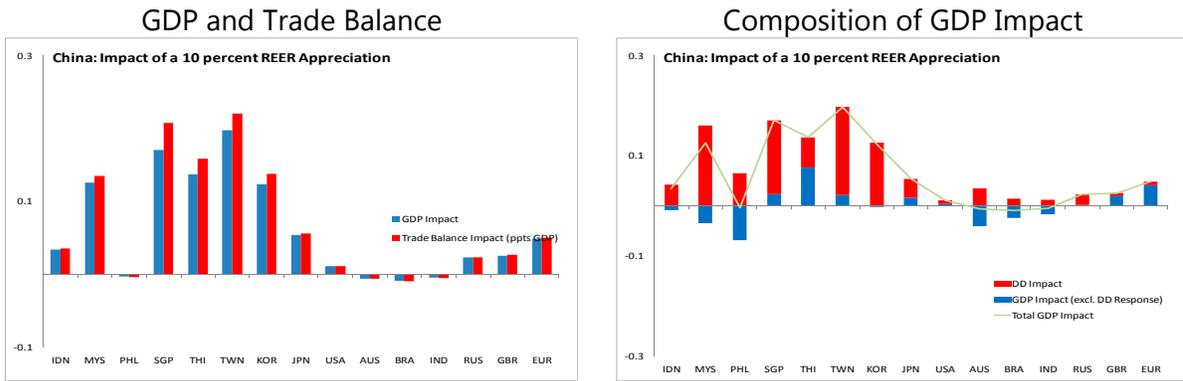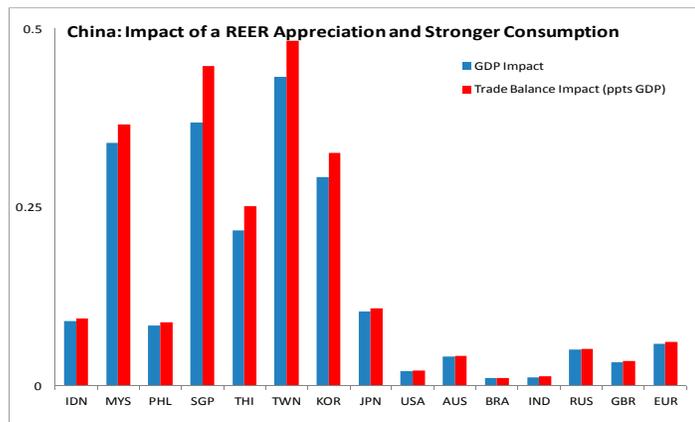
Composition of GDP Impact

Figure 3. Input-Output Analysis: Impact of Rising Consumption and Real Appreciation

III. ESTIMATING CHINA'S SPILLOVERS: A SECTORAL TRADE ELASTICITIES APPROACH[1]

This chapter assesses the potential impact of an exchange rate appreciation on sectoral trade at a high level of disaggregation. Given the significant information requirements for highly disaggregated data, a partial equilibrium exercise is conducted and the long-run effects examined. The results suggest that a change in relative prices consistent with an appreciation of the RMB would, over time, facilitate a rebalancing of the economy and re-orient exports more toward regional partners and high-technology products.

1.   Sectoral-level analysis. The impact of currency appreciation is often examined at the level of the overall economy or for highly aggregated sectors. This note analyzes the response of trade flows at the product level (HS2002, 6-digit) to changes in relative prices. Differences in import demand and substitution elasticities, and differences in the amount of imported intermediate goods in production, result in changes to the structure of trade.

2.   Approach taken. The information requirements for a high level of disaggregation necessitate taking a simple approach. Complex interactions across products, sectors, and other variables (such as income) would compound the number of variables (e.g., elasticities) to be estimated, raising the data requirements even more. So instead, a partial equilibrium set up is used, with information from input-output tables (for a detailed description of the methodology and additional results, see *Changing Patterns of Global Trade*, IMF). A two-step approach is taken. The first step focuses on the import market of each economy. Changes in relative prices result in demand responses and shifts in the structure of trade at the product level that reflect differences in import demand and substitution elasticities as well as in the amount of imported intermediate inputs used in producing exports. An analysis of input-output tables shows in particular that the foreign content of Chinese exports has increased and is large for high and medium-high technology exports (Figure 1).[2] The second step uses the input-output tables to determine the composition of import demand as a result of the shift in the structure of exports (as determined in the first step).

3.   Simulation. The simulation reflects an increase (decrease) in the relative price of Chinese exports (imports) that could stem from a 10 percent appreciation in the currency. For simplicity, full pass-through of nominal exchange rate changes to import prices in partner countries is

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[1] Prepared by Jarkko Turunen (SPR).

[2] Foreign value added (FVA) share in gross exports is calculated as: FVA share in exports $= u \cdot A_M \cdot L \cdot \frac{E}{E_k}$ where u is a row vector of ones, A_M is the imported inputs coefficients matrix, L is the Leontief matrix, E is a column vector of gross exports in each sector, and E_k is the total exports. By multiplying the column vector of gross exports E by the Leontief matrix, $(I - A_D)^{-1}$ where I is the identity matrix and A_D is the domestic input coefficient matrix, the gross output needed to produce those exports is computed. By multiplying this by import inputs coefficients, the total foreign inputs contained in gross exports is computed. Finally, by dividing it by total exports, the foreign value added content share of gross exports is calculated. The main source of data is the input-output tables from STAN/OECD, available for 36 emerging and advanced countries.

assumed, although in practice exporting firms are likely to adjust profit margins, mitigating the impact on trade.

- **Sectoral effects**. The simulation points to significant changes in the structure of sectoral trade. High technology exports decline less than low technology exports, owing to the significant contribution of imported intermediate inputs (Figure 2). Among the largest export sectors, the share of machinery and electrical equipment (a high technology sector) increases, whereas the share of textiles (a low technology sector) declines marginally. Thus, an appreciation would support a continued upgrading of Chinese exports in terms of technological content. Reflecting China's relative downstream position in the supply chain, imports of intermediate goods fall (while other imports increase) as overall exports decline in response to the appreciation (Figure 3).

- **Supply chain effects**. Trade with Asian trade partners is less sensitive to changes in relative prices, consistent with significant regional integration (Figure 4). Exports to the main Asian export destinations (Hong Kong SAR, Korea, and Taiwan Province of China) decline less, while exports to European countries (mainly to Italy, U.K., France, and Germany) decline more. This is consistent with both significant high technology exports to Asian countries and China's integration within the Asian production chain.

- **Aggregate effects**. The effects on each sector can be aggregated and the effect on rebalancing computed. In total, Chinese exports would fall by about 11 percent and imports increase by 2 percent. Overall, the simulations suggest that the trade surplus could fall by more than 3 percentage points. However, these results need to be interpreted with caution owing to the partial equilibrium nature of the exercise.

Figure 1. China: Foreign Content in Gross Exports

(billion U.S. dollars)
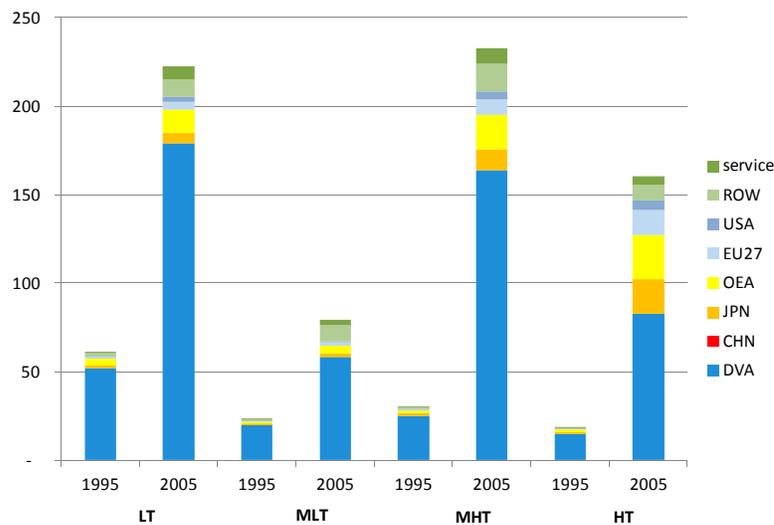
Note: LT: Low Technology; MLT: Medium-Low Technology; MHT: Medium-High Technology; HT: High Technology. Technology classification is based on OECD (2005). DVA: Domestic value added. OEA: Other East Asian countries.
Source: IMF staff estimates using OECD Input-Output tables, COMTRADE and OECD STAN.

Figure 2. Exports by Technology Content: Simulation of Appreciation
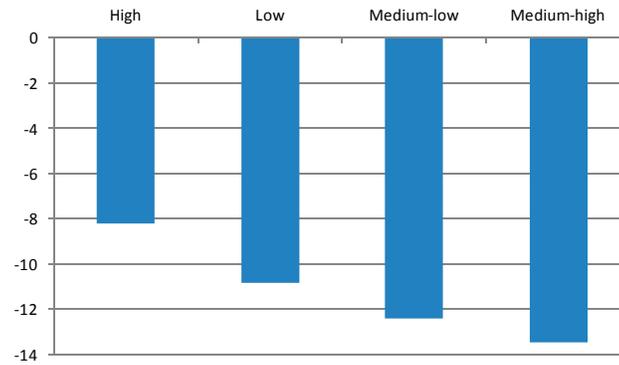
Note: High technology (machinery and electrical equipment; instruments, e.g., medical). Low technology (animal and vegetable products; foodstuffs; hides and skins; wood products; paper products; textiles; footwear; precious and semi-precious stones; misc. manufactures). Medium-low technology (mineral products; plastics and rubber; stone, plaster, cement; base metals). Medium-high technology (chemical products; transportation equipment; arms and ammunition).

Figure 3. Imports by Use: Simulation of Appreciation
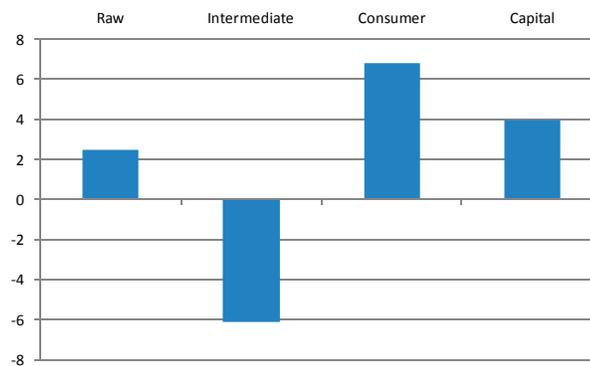
Figure 4. Exports to the Supply Chain: Simulation of Appreciation
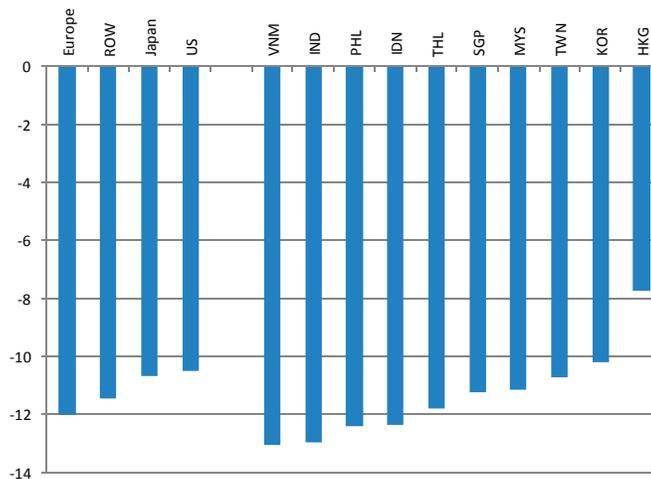
IV. FACTOR PRICING, OVERCAPACITY, AND SUSTAINABILITY RISKS[1]

This chapter examines the argument that distortions in factor markets effectively subsidize China's tradables investment. It finds that distortions in capital costs are substantial and have increased over time. Moreover, the export-oriented growth model looks increasingly unsustainable. Delays in reform pose the risk of significant spillovers in the interim.

A. Factor Pricing

1. ***Factor costs***. In addition to an undervalued exchange rate, China's export-oriented growth model has relied on a combination of distorted factor prices. Distortions to capital, labor, land, energy, and environmental prices have been suggested in the literature (e.g. Huang, 2010). Huang and Kunyu (2010) suggest the estimated extent of aggregate distortions have declined from a peak of around 12 percent of GDP in 2006 to around 9½ percent in 2009. More directly, the extent of the potential distortion can be seen from the gap between Chinese interest rates and growth, and the relatively low price of gasoline.
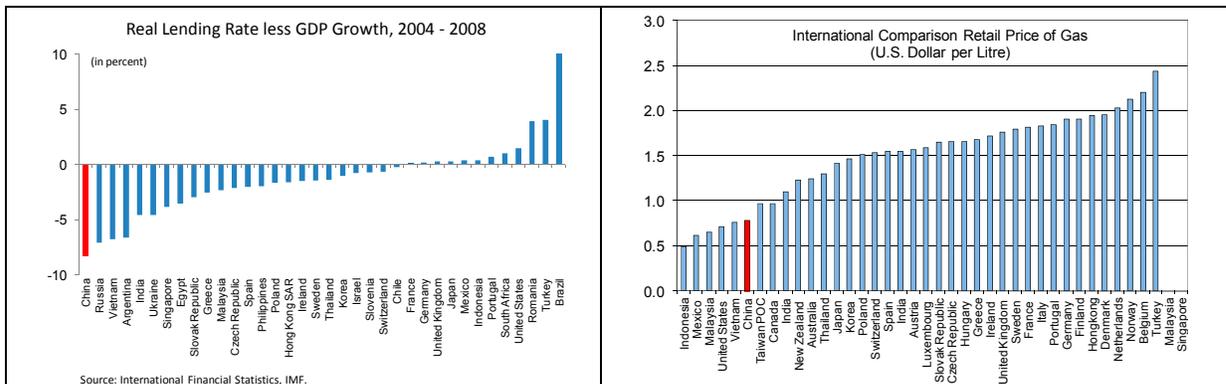
2. ***Aggregate estimate***. A measure of the aggregate factor cost distortions can be constructed from aggregate production and income data.[2] Applying the methodology of Aziz (2006) to China, the implied tax on capital is significantly negative over much of the period since 1990 and has become more negative over the past decade, suggesting distortions amounting to substantial subsidies to capital over this period. Many other countries effectively tax capital or have smaller implicit subsidies, particularly since 2000. Given the undervalued exchange rate and

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[1] Prepared by Kai Guo (SPR) and Nathan Porter (SPR) with helpful inputs from Papa N'Diaye (APD).

[2] Aziz (2006) uses growth accounting to calculate the implicit tax (or subsidy, if negative) on investment such that aggregate productivity, factor use, and consumption are consistent with a model-based benchmark. Since this essentially measures the distortion in the cost of capital required to account for the difference between economic behavior described in the aggregate data and a distortion-free benchmark, it provides a single measure of all distortions. In particular, it can be used to track changes in aggregate distortions over time.

the capital intensity of the tradables sector, new investment spending has been largely concentrated in tradables.

Imputed Tax/Subsidy on Capital Costs

In percent of the marginal product of capital

Other S5 Range

Non-China Asia Range 1/

China

1/ Includes Indonesia, Korea, Singapore, and Taiwan Province of China.

Sectoral Fixed Asset Investment
(In percent of Fixed Asset Investment Spending)

Manufacturing   Tertiary ex real estate and infrastructure
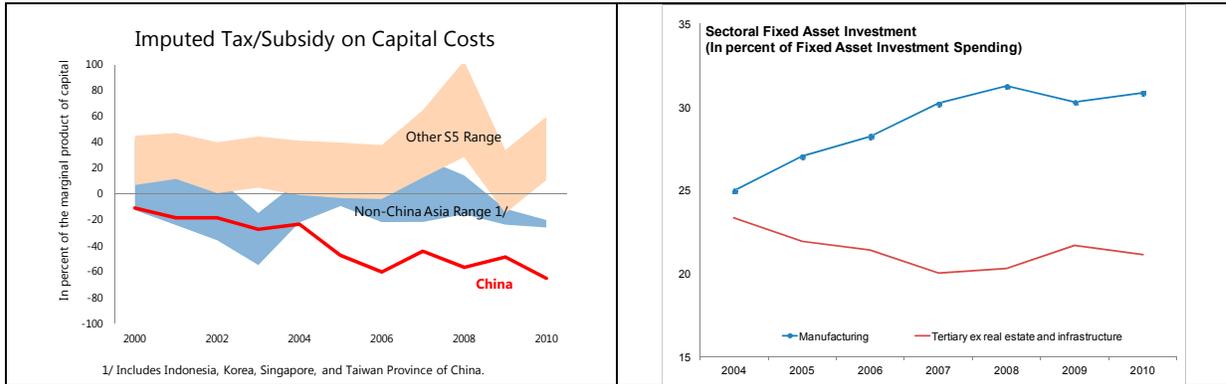
B. Sustainability and Competitiveness

3.   *Unsustainable?* China's current growth pattern, without rebalancing, would require continued gains in market share in the global market. Absent substantial productivity growth or further subsidies with undesirable distortions, large price cuts (and an associated squeeze of profit margins) could be unavoidable to gain the required market share.

Market Shares of Selected Economies since Growth Take-off

China (1979–2010)
China forecast (2011–16)
Germany (1948-2010)
Japan (1955–2010)
Korea (1961–2010)
NIEs excl. Korea (1965–2010)

In percent

Year since growth take-off

4.   *Illustration*. An illustrative scenario in Guo and N'Diaye (2010) suggests that key industries could see their profit margins evaporate in a few years in order to gain the required market shares, particularly those with thin profit margins and large capacities (e.g., steel). The mismatch between the buildup of tradable manufacturing capacity in China and the lack of strong external demand could have significant implications for the balance sheets of the corporate and banking sectors.

5.   *Spillovers*. Based on the estimates from a global vector autoregression (GVAR, see Chapter VI), a deterioration in the quality of non-financial corporate and financial balance sheets in China would have substantial negative effects on the rest of the world, particularly on the regional supply chain and commodity exporters.

• *Corporates.* An increase in Chinese corporate default probabilities (a measure of balance sheet deterioration) by 10 percentage points could lower industrial output in other economies by as much as 3⅓ percent among emerging Asian economies and 2 percent of GDP in commodity exporters.
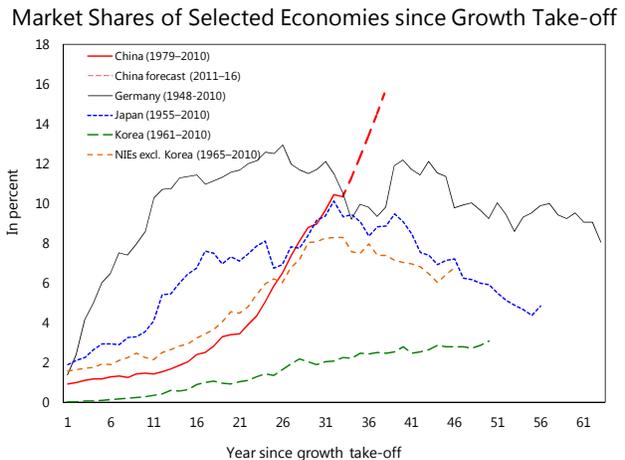
- *Banks.* A similar deterioration in bank balance sheets would have somewhat larger impacts. An increase in Chinese banks' default probability by 10 percentage points could lower industrial output in Japan and emerging Asia by about 3⅓ percent. U.K. industrial output would also be lower by about 5 percent. Many other economies, such as in the Euro Area, could also experience some decline in industrial production.

- *Caveat*: The measure of financial stress is indicative of problems in balance sheets that would affect real activity, at least until policies are implemented to either resolve the problems directly or to transfer them out of the banks' balance sheets and, as some expect, onto the balance sheet of the public sector.

6. ***Historical default rates***. Historical evidence from China and the U.S. suggest that a significant hike in the default probability could occur following the booms, particularly investment driven ones. The default probability of the Chinese banking sector increased by more than 200 bps following the credit boom in the early 2000's. In the U.S., corporate default rates also increased by a similar magnitude during the 1990–1991 recession and after the crash of the dot-com bubble (Maurer, Nguyen, Sarkar and Wei, 2008). Historically, the U.S. has experienced even higher (double-digit) corporate default rates after large booms, e.g. 13 percent in the Great Depression, and 36 percent after the bursting of the railroad investment bubble (Giesecke, Longstaff, Schaefer and Strebulaev, 2010).

China: Credit Growth (y/y) and Banks 1-Year Ahead Default Probability
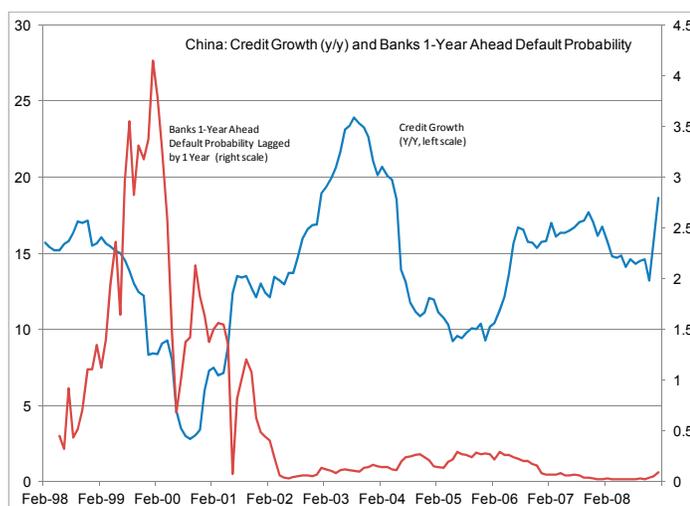
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Maurer, Samuel, Luu Nguyen, Asani Sarkar, and Chenyang Wei, 2008, "Financial innovation and corporate default rates," Proceedings of the IFC Conference, BIS.

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Table 1. Illustrative Conditions to Sustain China's Growth Strategy

	2007	Baseline 2011–2020
Production volume		
Steel (in percent of world production)	35.5	53.6 1/
Ship building	18.4	61.7 1/
Machine tools	15.0	30.2
Excess capacity utilization rate (in percent)		
Steel	18.5	-84.2
Ship building		
Machine tools		
Annual investment growth		
Steel	12.3 2/	9.4
Ship building		8.5
Machine tools	34.7	15.0
Annual average profit margin		
Steel	5.5	
Ship building	9.6	
Machine tools	6.4	
Scenario: Annual average export growth		
Steel	66.6 2/	18.3
Of which:		
Annual average world demand		14.0
Cumulative required price change		-24.4
Ship building	31.5	18.3
Of which:		
Annual average world demand		17.8
Cumulative required price change		-12.8
Machinery	14.7	18.3
Of which:		
Annual average world demand		15.8
Cumulative required price change		-14.5

1/ end of period.
2/ Average 2005–2007.

V.   IMPACT OF CHINA'S COMPETITION: BRAZIL AND MEXICO[1]

This chapter assesses the impact of China's competition on the main export market shares of Brazil and Mexico. It finds some evidence that these countries lost competitiveness vis-à-vis China, but the impact is moderate. A portion of the loss can be attributed to exchange rate valuations, particularly for Mexico, whose export structure is more similar to China's.

1.   ***Context***. There has been concern that China's competitiveness in export markets, while built on structural advantages such as the low cost of labor, has been boosted by a distorted exchange rate and other factor costs, such as the cost of capital. The claim is that this competitiveness has adversely impacted the ability of other developing and emerging market countries to compete in third markets. This paper assesses the claim by looking at the impact of China's competition on two Latin American emerging markets, Brazil and Mexico. In particular, it looks at how these countries have been affected in their largest markets, the U.S. and European Union for Brazil and the U.S. for Mexico.

2.   ***Exports in third markets***. Brazil and Mexico gained market shares in their respective main markets, but this process stopped in the 2000s, with somewhat different timings for each. For Brazil, it stopped in the mid-2000s, but for Mexico, it was 2001, around the time China entered the WTO. Excluding China's exports reveals higher market shares in remaining exports, suggesting competition with China may have led to losses in market share.

Brazil: Market Share in the U.S.
(2001 = 100)

Brazil: Market Share in the E.U.
(2001 = 100)

Mexico: Market share in the U.S.

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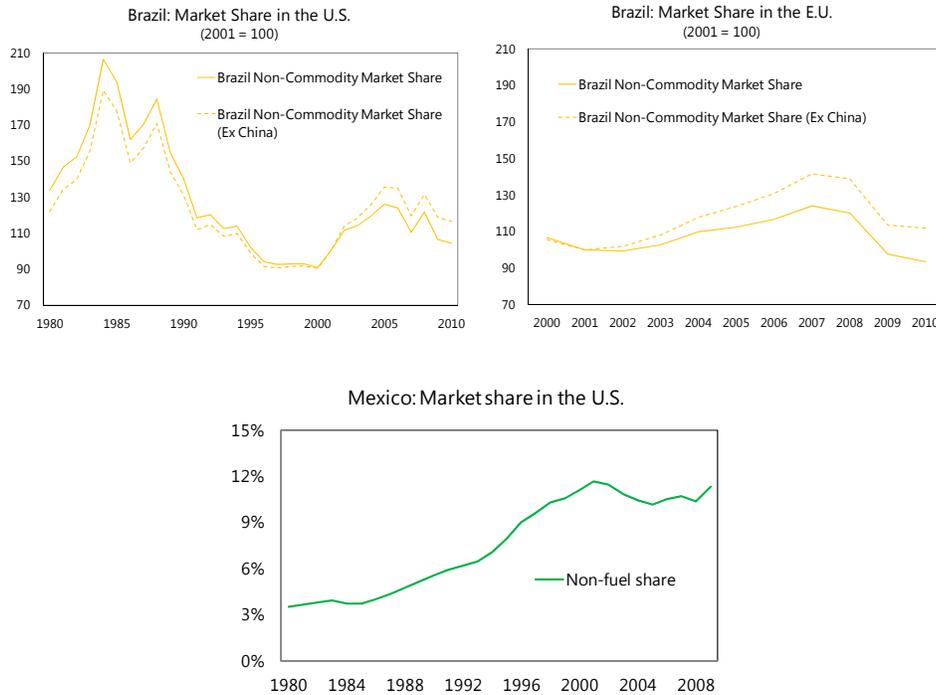
[1] Prepared by Roberto Benelli (SPR) and Kai Guo (SPR).

3.   ***Competitiveness gain index***. To measure more precisely the impact of China's competition on Brazil's and Mexico's competitiveness, the first step was to construct a "competitiveness gain" index using constant market share analysis (CMS) at a 4-digit SITC product level (see Appendix I). The index was constructed with and without China for both the U.S. and the European Union markets in the case of Brazil and for the U.S. market in the case of Mexico. The index shows that, in both the U.S. and European Union markets, Brazil experienced competitiveness gains in the first part of the 2000s, but suffered losses in competitiveness in the last part of the decade (see charts below); these losses were especially strong in the U.S. market. For Mexico, the loss of competitiveness started in 2001 after gaining for 15 years. Repeating the exercise for China shows it continuously gaining competitiveness since the mid-1980s, with a boost taking place after its entry into the WTO.

Competitiveness Gain in the U.S.
(In percent of exports to the U.S.)

Competitiveness Gain in the E.U.
(In percent of exports to the E.U.)

Competitiveness Gain in the U.S.
(In percent of exports to the U.S.)
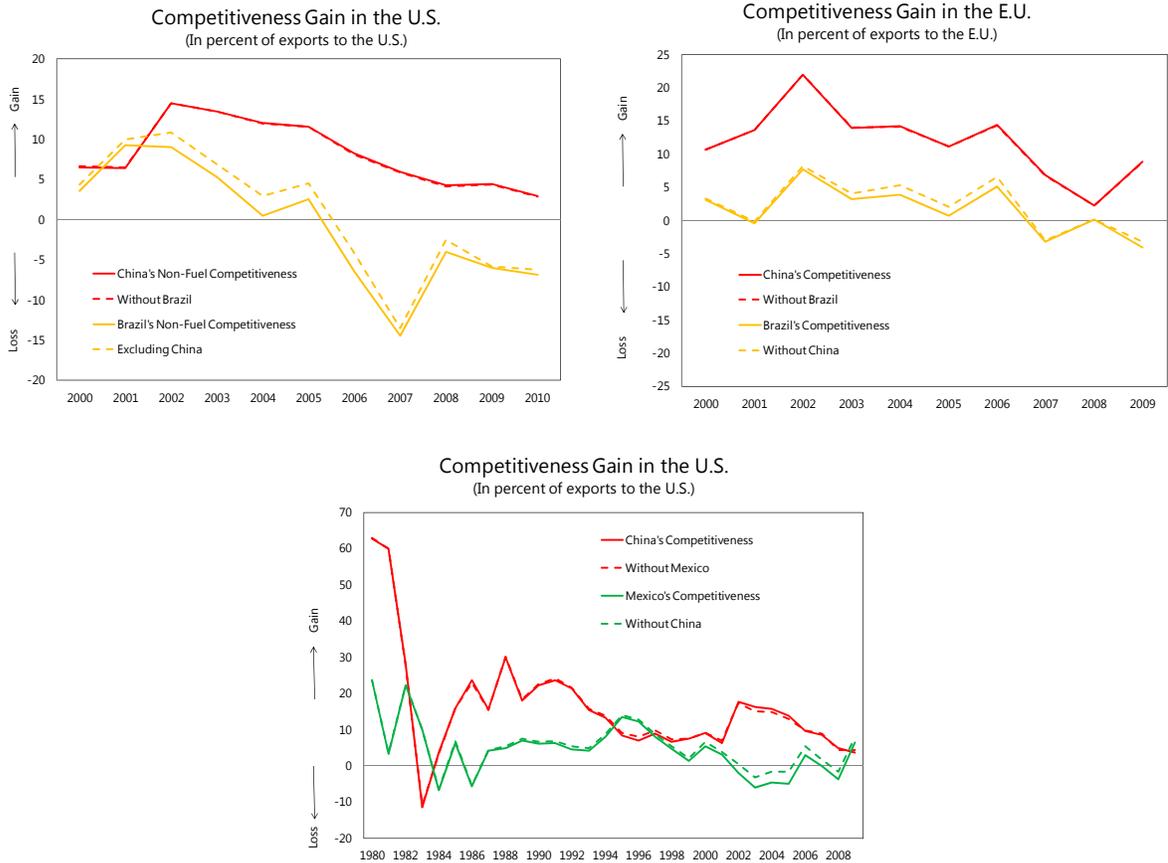
4.   ***China effect***. These competitiveness gain indices can in turn form the basis for constructing a counterfactual: what would have happened to Brazil's and Mexico's competitiveness in third markets had China not been active in these markets? This was done by first calculating competitiveness gains of Brazil and Mexico with and without China in a third market (solid line and dash line, respectively, in the charts on competitiveness gain shown above), and then by taking the difference between these two indices. The difference can be thought of as a measure of a pure "China effect" on Brazil or Mexico. The same exercise was repeated for China by including and excluding Brazil's or Mexico's exports to construct a Brazil or Mexico effect (for China). Finally, a China effect was constructed for a few other countries. The following facts emerge (see charts below):

- The China effect on Brazil and Mexico has almost always been negative in the third market. On the other hand, the Brazil or Mexico effects have been fairly small.

- The China effect was small before 2001 but widened afterwards. The large negative impact appears to be diminishing after 2005, following the appreciation of the RMB.

- The overall magnitude of the China effect does not appear to be very large. The peak impacts on Brazil and Mexico, both of which occurred in 2005, are about 2 percent and 3 percent of their exports to the U.S. (slightly less in the E.U. market for Brazil).

This analysis thus suggests a role for a China effect on Brazil's and Mexico's manufacturing market share in third markets, but this effect appears to be moderate. Other factors, such as potentially internal competitiveness factors and the shift of the supply chain, could play a key role in driving the dynamism of the manufacturing tradable sector in Brazil or Mexico.

The China Effect and the Brazil Effect
(In percent of exports to the U.S.)

The China Effect and the Brazil Effect
(In percent of exports to the E.U.)

The China Effect
(In percent of exports to the U.S.)

Competition with China and Loss in Market Share

The China effect on Mexico's exports
(in percent of exports to the U.S.)
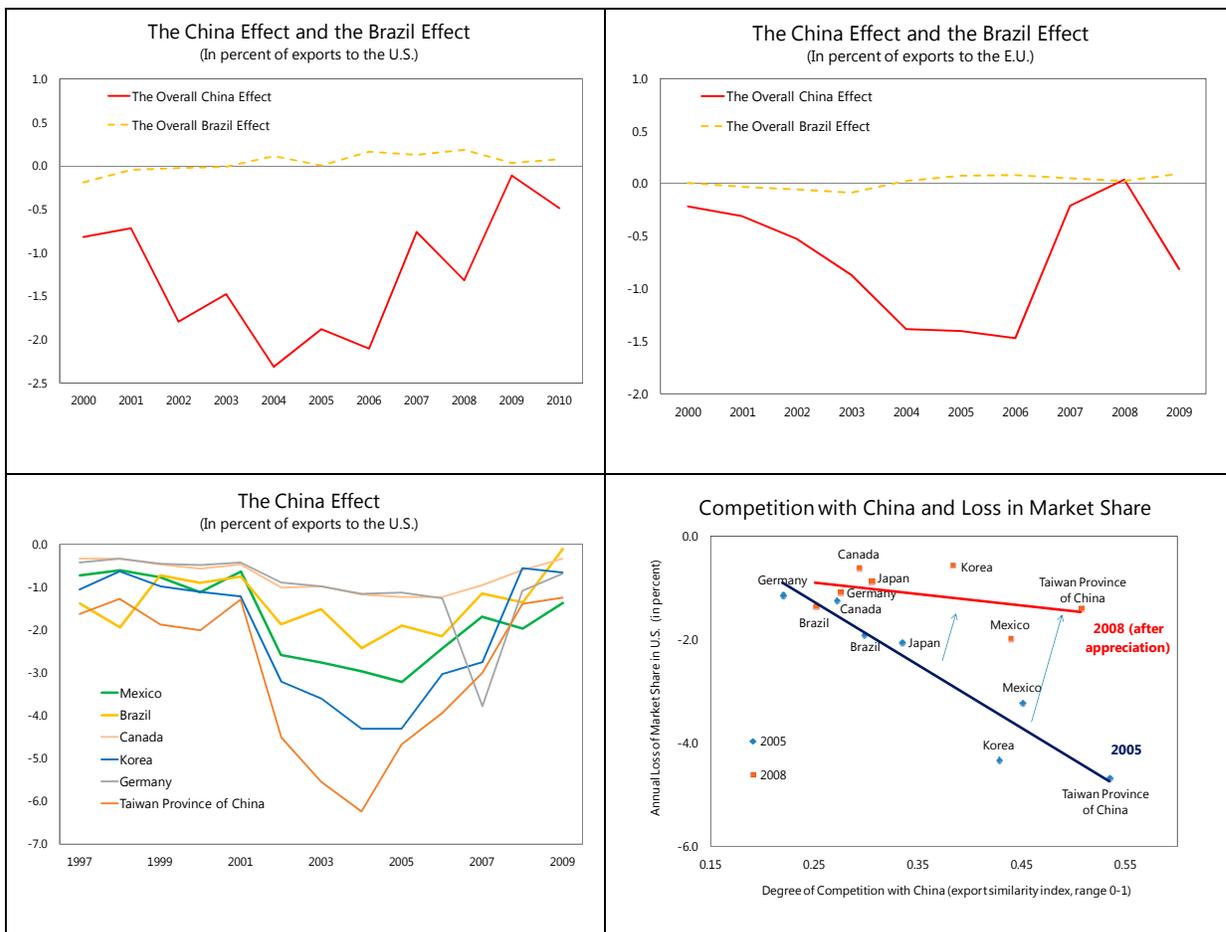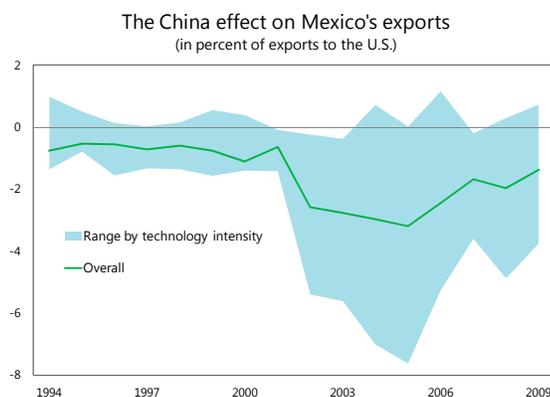
5.   ***Exchange rates***. The flexibility of exchange rates in Brazil and Mexico and the relatively rapid appreciation of the renminbi against the U.S. dollar during 2005–2008 generated significant variations in both the bilateral nominal and real exchange rates between China and Brazil or Mexico. These variations can be used to estimate the impact of China's exchange rate on Brazil's or Mexico's competitiveness.

6.   ***Results***. Regression analysis shows that exchange rates played a role in determining Brazil's or Mexico's competitiveness. In these regressions, the China effect (whose increase indicates that Brazil's competitiveness improves) was regressed on the annual change in the bilateral nominal and real exchange rates (subject to the usual caveat that these regressions capture correlations and not causality). The main results are as follows:

- The regression was first estimated by pooling together all the products (first table below, first column for Mexico; second table below for Brazil). As expected, an appreciation of the real or the peso is estimated to push the China effect more into negative territory— that is, it reduces Brazil's or Mexico's competitiveness. Every 10 p.p. depreciation of the renminbi against the real or the peso would reduce Mexico's exports by around 0.5 p.p. The effect on Brazil's exports is smaller (about one-quarter of the effect on Mexico).

- Results for sub-groups of products reveal that the effect of the exchange rate has been stronger and statistically significant on products where Brazil and Mexico have traditionally enjoyed a comparative advantage over China, medium-low and medium-high technology goods, while the effect on resource-based, low-technology and high-technology good is either weak or statistically less significant (first table below, second through fifth column, for Mexico; third table below for Brazil). This finding thus lends support to the view that undervaluation in China's currency may be contributing to eroding competitiveness in those goods where Brazil or Mexico and China are increasingly competing, medium-tech goods.

Mexico: Exchange Rate and the China Effect (2002-2009) 1/

	All Products	Resource-based low tech	Low-tech	Medium-tech	High-tech
CPI-Based REER	-0.050 ***	0.023	-0.048**	-0.060**	-0.032
	(0.017)	(0.052)	(0.024)	(0.027)	(0.061)
Constant	-0.184*	0.087	-0.209	-4.715	-0.312
	(0.097)	(0.198)	(0.153)	(3.856)	(0.326)
Fixed Effect	Y	Y	Y	Y	Y
OBS	3543	164	1338	1762	266
R-Sq	0.08	0.13	0.16	0.05	0.05

Source: UN COMTRADE; Fund staff estimates.

1/ An increase in the REER indicates an appreciation of the peso against the renminbi; thus, a negative sign for the exchange rate coefficient means that Mexico gains competitiveness when the peso depreciates against the renmimbi. Robust standard error reported in parentheses. ***, **, *, represent 1 percent, 5 percent, and 10 percent signficance levels, respectively.

Brazil: Exchange Rate and the Overall China Effect

	USA	EU	USA	EU
Nominal exchange rate	-0.006	-0.015***		
	(0.004)	(0.003)		
Bilateral real exchange rate \1			-0.008**	-0.013***
			(0.004)	(0.003)
Constant	-0.417***	-0.360***	-0.422***	-0.261***
	(0.016)	(0.005)	(0.016)	(0.013)
Fixed Effect	Y	Y	Y	Y
OBS	5950	5976	5950	5976
R^2	0.002	0.0063	0.001	0.006

\1 Bilateral nominal and real exchange rates are used in the regressions; increases in the exchange rate denote an appreciation of the real against the renminbi. Thus, a negative sign for the coefficients indicates that Brazil gains competitiveness when the real depreciates against the renminbi.

Brazil: Panel Regressions of China Effect by Product on Brazil's Exchange Rates -- By Product Subgroup

	United States					European Union				
	Resource-based/low tech	Low-tech	Medium-low tech	Medium-high tech	High-tech	Resource-based/low tech	Low-tech	Medium-low tech	Medium-high tech	High-tech
Nominal exchange rate \1	-0.029	-0.004	-0.008**	-0.005	-.003	-0.029	-0.011***	-0.013***	-0.018***	-0.016
	(0.030)	(0.007)	(0.004)	(0.007)	(0.004)	(0.026)	(0.0038)	(0.004)	(0.007)	0.019
Constant	-0.562***	-0.516***	-0.276***	-0.339***	-0.203***	-0.429	-0.382***	-0.381***	-0.302***	-0.40***
	(0.080)	(0.029)	(0.021)	(0.038)	(0.0192)	(0.018)	(0.007)	(0.011)	(0.016)	(0.015)
Fixed Effect	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
OBS	407	2228	1606	1199	340	390	2264	1622	1210	340
R^2	0.008	0.001	0.002	0.006	0.007	0.0112	0.004	0.009	0.006	0.010
	Resource-based/low tech	Low-tech	Medium-low tech	Medium-high tech	High-tech	Resource-based/low tech	Low-tech	Medium-low tech	Medium-high tech	High-tech
Bilateral real exchange rate \1	-0.003	-0.004	-0.010**	-0.011	-0.001	-0.0343413	-0.006**	-0.013***	-0.016**	-0.01805
	(0.006)	(0.006)	(0.004)	(0.007)	(0.040)	(0.029)	(0.003)	(0.005)	(0.007)	(0.022)
Constant	-0.526***	-0.526***	-0.259***	-0.383***	-0.240***	-0.241**	-0.313***	-0.263***	-0.199***	-0.278***
	(0.028)	(0.028)	(0.023)	(0.034)	(0.021)	(0.090)	(0.013)	(0.023)	(0.034)	(0.068)
Fixed Effect	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
OBS	407	2228	1606	1199	340	390	2264	1622	1210	340
R^2	0.009	0.001	0.002	0.007	0.011	0.012	0.003	0.010	0.006	0.010

\1 Bilateral nominal and real exchange rates are used in the regressions; increases in the exchange rate denotes an appreciation of the real against the renminbi. Thus, a negative sign for the coefficients indicates that Brazil gains competitiveness when the real depreciates against the renminbi.

Appendix I. The Competitiveness Gains Index

1. *Calculation*. For a given product, the index denotes whether competitiveness is increasing or decreasing: it is computed as the difference between a country's export of this product to a particular market in a given year relative to what would have been expected if this country had maintained the same market share for the product in this market as in the previous year and given its total imports of this product. A positive value indicates that the country's competitiveness is increasing in this product. The sum across all products (normalized by the country's total exports in the previous year) gives a summary index of the overall competitiveness gains. The methodology controls for two effects that change a country's export share in global markets without underlying changes in competitiveness. The first is the terms of trade effect: if the prices of the products exported change, it is likely that the exporter's market share may also change regardless of its "competitiveness". The second is the composition effect: if a country specializes in goods that are in strong demand, its export market share may rise even without any gains in productivity.

VI. CHINA SPILLOVERS: ANALYSIS FROM A GLOBAL VAR[1]

This chapter analyzes the spillovers from China using a global vector autoregression that allows for complex interactions among a large number of economies. The impact of cyclical factors, such as worsening credit quality, is assessed, along with exchange rate appreciation and structural reforms for rebalancing demand. Deteriorating credit portfolios would adversely impact trading partners, particularly those in the Asian supply chain. On the other hand, the benefit to trading partners of Chinese structural reforms and real appreciation depends on their location in the supply chain.

1.   ***Global VAR***. A global vector autoregression (GVAR) provides a dynamic multi-country framework suitable for the analysis of interdependence and international transmission of shocks. In this note, a GVAR model comprising 30 countries—21 advanced and 9 emerging—is used, based on Chen et al. (2010, IMF Working Paper WP/10/124; see Appendix I). The model has real and financial variables: industrial production (a proxy for GDP), real effective exchange rate, real money market rate, real share prices, and a measure of potential financial stress (the asset-weighted average expected default frequency of banks and nonfinancial corporates). The latter captures the role of credit in the transmission of financial and real sector shocks. Monthly data are used (Jan 1996–Dec 2008).

2.   ***Spillovers***. The model is used to analyze the spillover effects of policies or shocks from China. Given China's rapidly changing economic structure, an estimated model like the one used here cannot speak to the long-term impact of changing policies or shocks. Conjunctural concerns regarding the pace and quality of credit growth are assessed by examining the effects of deteriorating balance sheets. Balance sheet quality is captured through estimated default probabilities (EDFs); these have predictive power on the strength of credit growth one year ahead (the unconditional correlation between credit growth and one-year lagged EDF is around -0.5), even though credit is highly influenced by official actions in China. Structural reforms in support of rebalancing the economy, such as financial sector reforms that help to level the playing field in production, would be expected to increase Chinese productivity. Only the aggregate impacts of such reforms and of exchange rate appreciation are assessed (it is not feasible to report standard errors, given that weighted maximum impulse responses are reported).

3.   ***Financial shocks***. A deterioration in the quality of non-financial corporate as well as financial balance sheets in China would have substantial negative effects on the rest of the world, highlighting China's increasingly important role, including in the global supply chain.

- *Corporates.* An increase in Chinese corporate default probabilities by 1 pp could lower industrial output in other economies by as much as 1/3 percent among emerging Asian economies and 1/5 percent of GDP in commodity exporting economies. Declining equity prices would have a qualitatively similar impact (see figure below).

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[1] Prepared by Papa N'Diaye (APD) and Nathan Porter (SPR).

- *Banks.* A similar deterioration in bank balance sheets would have a somewhat larger impact. An increase in Chinese banks' default probability by 1 pp could lower industrial output in Japan and emerging Asia by about 1/3 percent. U.K. industrial output would also be low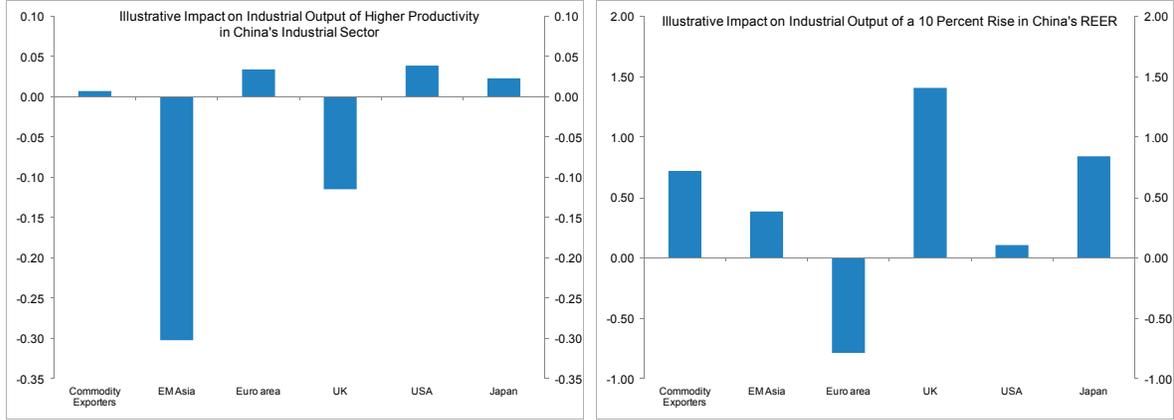er by about ½ percent. Many other economies, such as in the Euro Area, could also experience some decline in their industrial production (see figure below).

- *Robustness.* Note that the measure of financial stress is indicative of problems in balance sheets that would affect real activity, at least until policies are implemented to resolve the problems directly or to transfer them out of the banks' balance sheets and, as some expect, onto the balance sheet of the public sector. A financial stress scenario performed in the context of a structural macroeconometric model of the G20 (Vitek, 2010, IMF Working Paper WP/10/152) yields broadly similar results.

Illustrative Impact on Industrial Output of a Deterioration in Chinese Corporate Balance Sheets (1 p.p. increase in default probabilities)

Illustrative Impact on Industrial Output of a Deterioration in Chinese Bank Balance Sheets (1 p.p. increase in default probabilities)
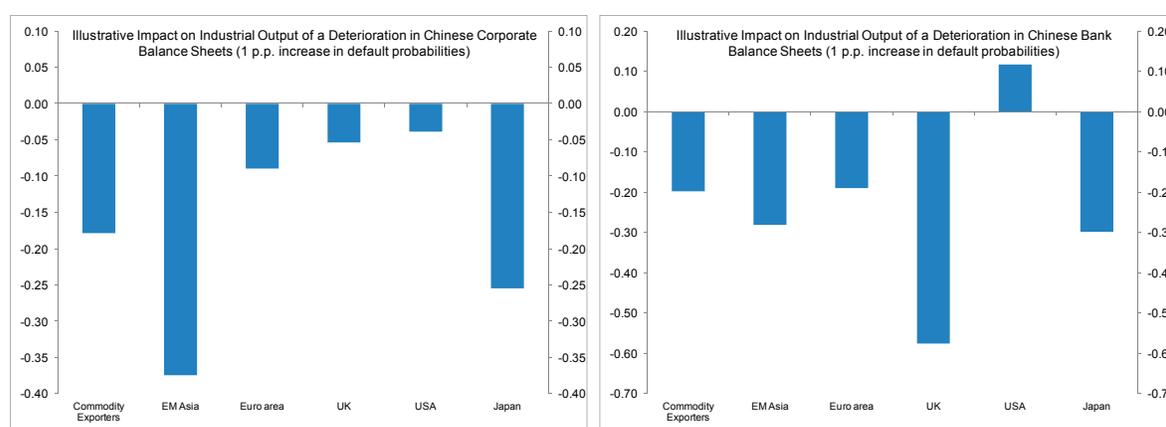
4. **Rebalancing**. Structural reforms would be expected to boost productivity in manufacturing, which accompanied by greater import substitution would generally have an important impact on the supply chain. Economies upstream would benefit from higher output in China at lower cost, while the demand for inputs from suppliers would decline. A rise in industrial output by 1 pp would raise output by about 0.05 percent in economies at the end of the supply chain, such as advanced economies (see figure below). The impact downstream (mainly, emerging Asia) is estimated to be negative, albeit small, owing to increased capacity in China.

5. **Appreciation**. RMB real effective appreciation would lower output in China but have positive spillovers for most economies, especially commodity (e.g., Latin America) and producers of intermediate goods (e.g., emerging Asia). A 10 percent real effective appreciation could raise output by close to 1 percent in many advanced economies (e.g., Japan, U.K.) but less so in the U.S. (see figure below). Such an appreciation would also lower output in China. Symmetrically, a real effective depreciation boosts growth in China, at the expense of many partners.

Illustrative Impact on Industrial Output of Higher Productivity in China's Industrial Sector

Illustrative Impact on Industrial Output of a 10 Percent Rise in China's REER

Appendix I. The GVAR Model

Structure of the GVAR Model

The structure of the GVAR model can be summarized as the follows. Consider $N+1$ economies, indexed by $i = 0, 1, 2, ..., N$, and a vector $\mathbf{x}_{it}$ of k_i domestic variables for each economy. Stacking the vectors of country-specific variables,

$$\mathbf{x}_t = \left(\mathbf{x}_{0t}', \quad \mathbf{x}_{1t}', \quad ..., \quad \mathbf{x}_{Nt}' \right), \tag{1}$$

a VAR in $\mathbf{x}_t$ would contain too many parameters to be estimated if the time dimension T of the data is not much larger than the number of economy N. Instead of regressing $\mathbf{x}_{i,t}$ on

$$\mathbf{x}_{-i,t} = \left(\mathbf{x}_{0t}', \quad \mathbf{x}_{1t}', \quad ,..., \quad \mathbf{x}_{i-1,t}', \quad \mathbf{x}_{i+1,t}', \quad ,..., \quad \mathbf{x}_{N,t}' \right), \tag{2}$$

without any restriction, GVAR links $\mathbf{x}_{i,t}$ to a $k_i^* \times 1$ vector $\mathbf{x}_{i,t}^*$, where

$$x_{\ell it}^* = \sum_{j=0}^{N} \omega_{\ell ij} x_{\ell jt}, \quad \ell = 1, 2, ..., k_i^*. \tag{3}$$

The weight ω_{lij} captures the spillover effect of variable l of foreign economy j on variable l of domestic economy i. Since ω_{lij} measures the relative importance of economy j to economy i, the spillover effect of variable l is in proportion to the weight chosen to measure the relative importance. Therefore, each economy's component of GVAR is given as a VARX* (p_i, q_i):

$$\mathbf{x}_{it} = \mathbf{a}_{io} + \mathbf{a}_{i1} \cdot t + \sum_{s=1}^{p_i} \boldsymbol{\Phi}_{is} \mathbf{x}_{i,t-s} + \sum_{s=0}^{q_i} \boldsymbol{\Lambda}_{is} \mathbf{x}_{i,t-s}^* + \sum_{s=0}^{r_i} \boldsymbol{\Psi}_{is} \mathbf{d}_{t-s} + \mathbf{u}_{it} \tag{4}$$

with $u_{it} \overset{iid}{\sim} \left(0, \sum_i \right)$,

where $\mathbf{d}_{t-s}$ is the observed common factor of $q \times 1$ dimension and $\boldsymbol{\varepsilon}_{it}$ is iid across time. Country-specific vector $\mathbf{x}_{i,t-s}^*$ reflects interdependence among economies and serves as a proxy for the

unobserved common effects across economies. The country-specific foreign variables and common factors are treated as weakly exogenous (if confirmed by statistical tests), i.e., they are "long-run forcing" country-specific domestic variables. The term "long-run forcing" means that in the equations for foreign variables, the coefficients on the error-correction terms are set to zero. The dynamics of foreign variables are not influenced by deviations from the long-run equilibrium path, in contrast to the dynamics of domestic variables.

The VARX* can be estimated economy by economy using the ordinary least squares (OLS) method or rank-reduced approach if the cross-dependence of the idiosyncratic shock is sufficiently small, that is:

$$\sum_{j=0}^{N} Cov\left(\varepsilon_{\ell it}, \varepsilon_{sjt}\right) / N \to 0, \tag{5}$$

all $i \neq j$, l and s.

From equation (3), it can be seen that

$$\mathbf{z}_{it} = \mathbf{W}_i \mathbf{x}_t \qquad i = 1, 2, \ldots, N \tag{6}$$

Where $\mathbf{z}_{it} = \left(\mathbf{x}'_{it} \quad \mathbf{x}^{*'}_{it}\right)$ and $\mathbf{W}_i$ is an appropriately defined weighting scheme. Thus, stacking (4) across i, the endogenous variables can be solved for in a global system:

$$\mathbf{G}\mathbf{x}_t = \mathbf{a}_{i0} + \mathbf{a}_{i1} \cdot t + \sum_{s=1}^{p} \mathbf{\Phi}_s \mathbf{x}_{t-s} + \sum_{s=0}^{r} \mathbf{\Psi}_s \mathbf{d}_{t-s} + \mathbf{u}_t \tag{7}$$

thus

$$\mathbf{x}_t = \mathbf{G}^{-1}\mathbf{a}_{i0} + \mathbf{G}^{-1}\mathbf{a}_{i1} \cdot t + \mathbf{G}^{-1}\sum_{s=1}^{p} \mathbf{\Phi}_s \mathbf{x}_{t-s} + \mathbf{G}^{-1}\sum_{s=0}^{r} \mathbf{\Psi}_s \mathbf{d}_{t-s} + \mathbf{G}^{-1}\mathbf{u}_t \tag{8}$$

Where $p = \max\{p_i, q_i\}$, $r = \max\{r_i\}$, and

$$G = \begin{pmatrix} A_0 W_0 \\ A_1 W_1 \\ \vdots \\ A_N W_N \end{pmatrix}, \quad H_s = \begin{pmatrix} B_{s,0} W_0 \\ B_{s,1} W_1 \\ \vdots \\ B_{s,N} W_N \end{pmatrix}, \quad u_t = \begin{pmatrix} u_{0,t} \\ u_{1,t} \\ \vdots \\ u_{N,t} \end{pmatrix}. \tag{9}$$

Equation (8) is a VAR for the complete set of domestic variables for all economies.

The advantage of the GVAR model is that it makes the estimation of (8) feasible by accounting for interdependence among economies and then estimating the partial system on a economy-by-economy basis, which implies allowing for modeling a large number of economies. The impulse response is computed based on (8).

The vector for domestic variables is given by:

$$\mathbf{x}_{it} = \left(edfb_{it} \quad edfn_{it} \quad r_{it} \quad y_{it} \quad p^s_{it} \quad q_{it}\right)' \tag{10}$$

where $edfb_{it}$ denotes the logarithm of asset-weighted average expected default frequency (EDF) of banks and $edfn_{it}$ for (nonfinancial) corporates, r_{it} is the real money market rate, y_{it} is the logarithm of industrial production, p_{it}^s the logarithm of real share price index, and q_{it} is the logarithm of the real effective exchange rate.

The vector for foreign variables for each economy except the United States is given by:

$$\mathbf{x}^*_{it} = \left(edfb^*_{it} \quad edfn^*_{it} \quad r^*_{it} \quad y^*_{it} \quad p^{s*}_{it} \right)' \tag{11}$$

We do not construct foreign effective exchange rates to minimize the number of parameters to be estimated, since information about foreign economies' currency is captured in the (trade-weighted) real effective exchange rate q_{it}.

The foreign variable for the United States is constructed as:

$$\mathbf{x}^*_{us,t} = y^*_{us,t} \tag{12}$$

Given the large influence of the U.S. financial variables on global markets, the U.S. foreign financial variables are less likely to be weakly exogenous for the U.S. domestic variables. That is the main reason we do not include the U.S. foreign financial variables in the equations for the United States.

The spot oil price is included as a common factor d_{t-s} to remove the common component in the reduced form residuals. Another candidate for inclusion as a common factor could be the index of global stock price volatility VIX, to ensure that the EDF shocks are purely idiosyncratic. However, because the VIX is driven by volatility in U.S. share prices, it is not weakly exogenous to the U.S. variables. Adding it separately will not augment the information content of the model.

Equations (3) and (4) show that the spillover effect of a foreign variable on a domestic variable is proportional to the weight ω_{lij}, which measures the relative importance of economy i to economy j in the transmission. Since the transmission channels for financial variables are likely to be different from the transmission channels for the variables measuring real activity, we use financial weights to construct foreign financial variables—EDFs, real money market rate, share price index and real effective exchange rate—and trade weights for industrial production.

Impulse Responses

Given the short sample period, the study focuses on short-run dynamics. The model is estimated in first differences as the macroeconomic and financial data are found to be integrated of order 1. Identifying the complete set of shocks in equation (8) and computing the impulse response functions in a GVAR model is not straightforward. It requires imposing an enormous amount of identification restrictions due to the large number of economies covered in the study. Therefore, we identify shocks following the approach in Dees, Di Mauro, Pesaran and Smith (2007) and Binder, Chen and Zhang (2009).

After identifying the EDF shocks, we compute impulse responses of the other variables in the global solution in equation (8) based on correlations between the reduced form shock of each variable and the identified structural shock of the EDF. Such an identification scheme means that zero correlation between the structural EDF shocks and other domestic variables in each economy need not be imposed and the transmission of the shock is determined without any additional restrictions.

Data Description

Variable	Description	Source	Notes
edfb	Asset weighted one year ahead expected default probability of (broadly defined) financial firms	Moody's KMV	Data for China from March 1996 to April 1997 are not available, and are interpolated in a linear manner.
edfn	Asset weighted one year ahead expected default probability of non-(broadly defined) financials firms	Moody's KMV	Missing data for October 1996 is interpolated.
y	Logarithm of industrial production index	GDS for Australia and New Zealand; CEIC for Brazil, China, Hong Kong SAR, Indonesia, Malaysia, Philippines, Singapore and South Africa; IFS for all other economies.	Data for China is the value added of industry, which to our knowledge the closest available measure of the industrial production. The series is spliced with the implied value from the year on year growth value from 1995 January onwards. All data from CEIC and for India are available in seasonally unadjusted form and adjusted using Census X12 in EViews.
r	Money market rate deflated by consumer price index (CPI)	Money market rates are from IFS and CEIC. Consumer price indices for Australia and New Zealand are from GDS, while the rest economies are from IFS. The 7 day weighted average CHIBOR is used for China.	Data for Sweden from December 2004 onwards are not available in the IFS, and the policy-related interest rate from the GDS is taken instead. Missing data for September 1992 is interpolated.
p^s	Logarithm of share price index deflated by CPI	IFS	
q	Logarithm of real effective exchange rate	Data for Hong Kong SAR, Indonesia, Mexico and Turkey are from CEIC, while the rest are from IFS.	
p^o	Logarithm of world spot petroleum price	IFS	

VII. CHINA SPILLOVERS: GIMF SIMULATIONS OF REBALANCING AND APPRECIATION[1]

This chapter applies the Global Integrated Monetary and Fiscal (GIMF) model to study the spillovers from China rebalancing. The GIMF model permits an assessment of changes to fiscal, exchange rate, and structural policies in both the near and longer terms. The model's simulations point to significant spillovers from rebalancing. Benefits are larger if rebalancing comes through a comprehensive package of structural, fiscal, and exchange rate reforms rather than exchange rate appreciation alone.

1. **Policies**. The set of policies considered for rebalancing demand and reallocating resources across sectors include a real appreciation of the exchange rate by about 20 percent over five years, financial sector reform comprising among others interest rate liberalization and increased access to financial services by households and SMEs, higher public social spending, and a stronger social safety net. All these policies support rebalancing demand toward private consumption. They are broadly consistent with the medium-term reform plans already being implemented or envisaged by the Chinese authorities. The real effective exchange rate appreciation of 20 percent over 5 years serves purely as an illustration so as to model a "substantial" change in the exchange rate over the medium term.

2. **Model**. To analyze the spillover effects of these policies, the multi-country dynamic general equilibrium GIMF model is used. The model allows for dynamic interaction across a broad range of countries and sectors, and permits an analysis of fiscal as well as exchange rate and structural policies (see Kumhof and Laxton, 2010). The GIMF model used for this chapter comprises 8 regions: 5 Asian blocks, namely, China (CN), Emerging Asia (AS—which includes Hong Kong SAR, Indonesia, Malaysia, Philippines, Singapore, and Thailand), Japan (JA), South Korea (KO), and Australia and New Zealand (AZ); the U.S. (US), Euro Area (EU), and the rest of the world. Financial sector variables operate mainly through a financial accelerator mechanism. There are several layers of production, with distinctions between manufacturing of intermediate goods, distribution of intermediate goods to domestic and foreign assemblers, and final production of consumption and investment goods. The model thus captures the direct and indirect transmission channels of shocks as well as spillover effects from rebalancing.

3. **Scenarios**. Two scenarios are considered: (i) a comprehensive rebalancing scenario that assumes (a) structural reforms to raise productivity in the services sector, which would be accompanied by a shift in households' preferences toward non-tradable goods; (b) fiscal reforms aimed at reducing individual uncertainties and precautionary savings; (c) financial sector reforms to liberalize interest rates and develop further the domestic capital market; and (d) a gradual appreciation of the RMB—20 percent over 5 years; and (ii) a real effective exchange rate (REER) appreciation scenario only—20 percent over 5 years.

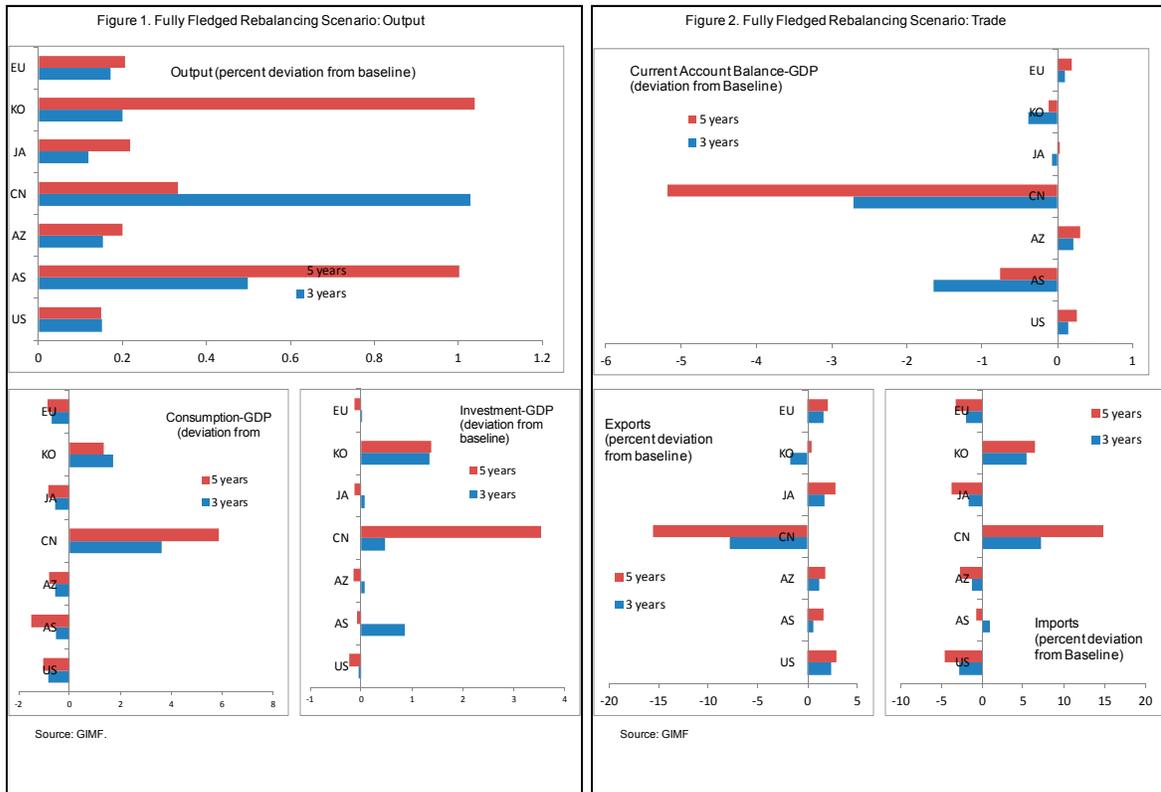[1] Prepared by Papa N'Diaye (APD) and Nathan Porter (SPR).

4.   ***Comprehensive rebalancing***. A successful rebalancing of China's growth toward private consumption would have a significant impact on China's trading partners (see Figures 1–3).
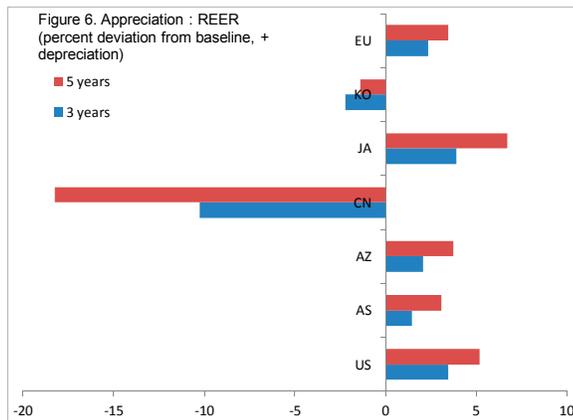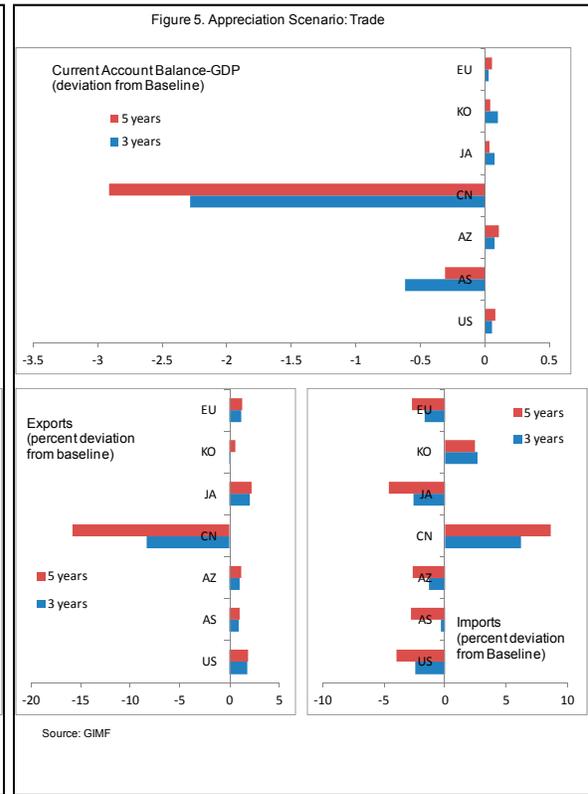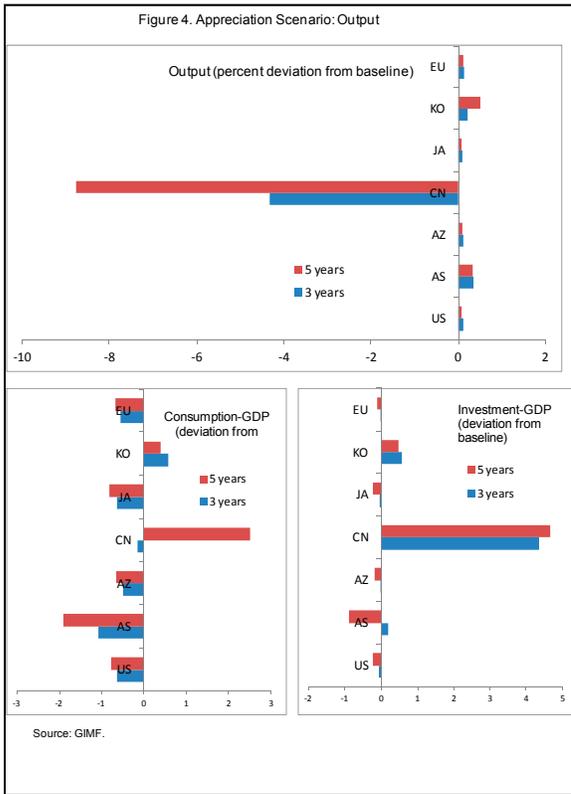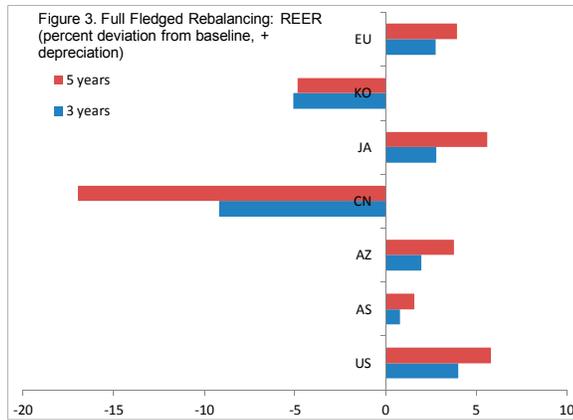
- Output rises in all regions, including China, with the largest gains among partners being in the Asian economies.

- Investment rises throughout Asia (ex Japan), but falls in U.S. and Euro Area.

  - In China, investment rises primarily in the non tradable sector because structural reforms raise productivity and profits. This increase is offset in the short term by lower investment in tradables, given the rising cost of capital and appreciating exchange rate. The overall impact on total investment depends on how quickly capacity rises in the non tradable sector and on the payoffs from reforms.

  - In Korea, emerging Asia, and to a lesser extent Australia and New Zealand, investment rises in relation to GDP in the short run as these economies benefit from stronger demand from China. But as China's demand for imported goods moves away from intermediate inputs and toward final goods and as production shifts toward catering to the domestic market, the benefits for intermediate goods exporters is reduced.

  - In the U.S. and the Euro Area, total investment falls in relation to GDP as the non-tradable sector shrinks with the real depreciation of the dollar and the euro. However, the depreciation supports the manufacturing sector.

- Private consumption rises in relation to GDP in China and Korea, but falls in the other partner economies.

  - In China, the higher share reflects the impact of fiscal and financial sector reforms that provide better access to finance for households and small private firms, reduce the need for precautionary savings, and raise labor income.

  - In Korea, the rise in consumption stems from higher income as firms hire more labor to satisfy the demand from China, as well as wealth effects from lower payments (through both lower interest rates and an appreciating currency) on foreign liabilities (the valuation effects from currency changes would be somewhat overstated to the extent that most foreign liabilities are hedged, as would be the case for Australia and New Zealand.).

  - Consumption falls in relation to GDP in Japan, emerging Asia, the United States, Euro Area, and Australia and New Zealand, as the real depreciation of their currencies limits spending and results in a rise in saving. This increase in saving mirrors the decline in China's saving rate.

- Current account balances are lower in China (reflecting stronger domestic demand and an appreciating currency) and in emerging Asia. Balances are higher in the U.S., Euro Area, and Australia and New Zealand owing to stronger import demand from China.

5. **REER appreciation**. A 20 percent appreciation of China's REER would lower output in China and shift its composition toward domestic demand (Figures 4–6). Such a shift would be accompanied by a rise in import demand from the rest of the world, which would generate positive spillovers. At the same time, the appreciation reduces China's exports, lowering the current account surplus. Current account balances rise modestly in most regions because of stronger exports to China, but fall in emerging Asia owing to a reduction in China's demand for intermediate goods.

6. **Conclusion**. Rebalancing through the exchange rate alone would be less beneficial to other countries and more costly to China compared to the case where rebalancing is brought about by a comprehensive package of polices. A lack of rebalancing owing to a non-appreciation, or a real effective depreciation, benefits China at the expense of the world. But a comprehensive rebalancing would bring mutually beneficial outcomes.

Figure 1. Fully Fledged Rebalancing Scenario: Output

Figure 2. Fully Fledged Rebalancing Scenario: Trade

Source: GIMF.

Source: GIMF

Figure 3. Full Fledged Rebalancing: REER (percent deviation from baseline, + depreciation)

Figure 4. Appreciation Scenario: Output

Source: GIMF.

Figure 5. Appreciation Scenario: Trade

Source: GIMF

Figure 6. Appreciation : REER (percent deviation from baseline, + depreciation)

VIII.   CHINA SPILLOVERS: GLOBAL COMMODITY MARKETS[1]

China's role in global commodity markets is increasing rapidly. Potentially the most important spillover over the medium term could come from a rebalancing of economic growth toward private consumption. This could reduce China's demand growth for some raw materials used in processing and investment (e.g., base metals), although historical experience suggests that total energy consumption will still rise by similar rates to GDP growth. Short-run shocks to real activity in China have an increasingly large commodity price effect; for example, a 3 percent shock to industrial production growth (1 standard deviation, or nearly 1 percent of GDP) causes crude oil and copper prices to rise by 6 percent. This would have widespread global terms of trade effects.

1.   **Role**. China is a large consumer of a broad range of primary commodities. Its market shares have increased sharply since 2000, reflecting rapid economic growth but also the economic structure, notably rapid growth of exports and large-scale fixed asset investment. China has come to play a dominant role in base metals markets and, to a somewhat lesser extent, agricultural raw material markets. In contrast, China has not yet assumed a large role in global food and energy markets, although its share of world imports is rising.

Figure 1. China's Share of Global Commodity Trade
(net imports as a percent of world imports)
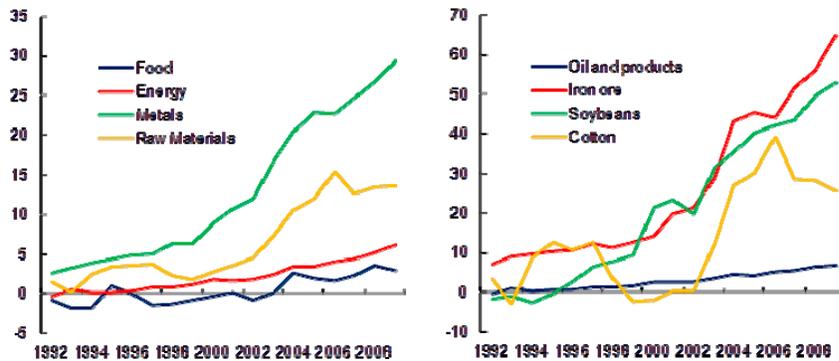
2.   **Rebalancing**. Realignments in the structure of China's economy over the medium term (e.g., a lower contribution to growth from fixed asset investment and exports of tradables) may change the nature of China's participation in world commodity markets. In particular, while relatively high economic growth rates should lead to ongoing increases in commodity consumption, China may experience a decline in "commodity

Figure 2. Intensity of Base Metals Consumption
(Kilograms per capita)

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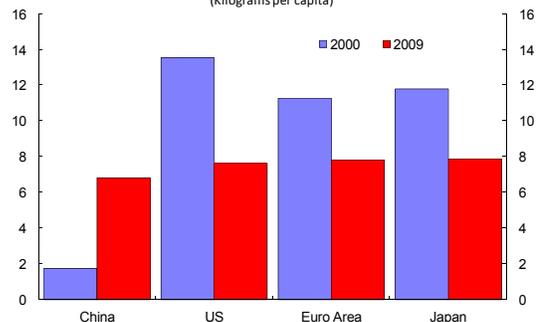
[1] Prepared by Shaun Roache (RES). Based on a forthcoming working paper.

intensity", which—as Figure 2 shows—for China is particularly high given its income level.

3.   ***Quantitative effect***. How big is China's effect in global commodity markets? The main near-term policy spillover from China to global commodity m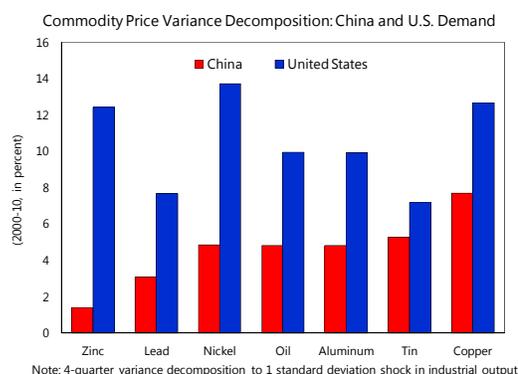arkets is from measures that affect the level of real activity or the accumulation of physical inventory. To analyze the effects of shocks to the growth rate of real activity on some important global commodities—namely, crude oil, copper, and other base metals such as aluminum—global supply-demand models are estimated:

- *Specification*. A vector autoregression (VAR) with 5 variables is estimated using monthly data from January 2000 through October 2010: the primary production of the commodity; advanced economy industrial production; Chinese industrial production; the real renminbi-U.S. dollar exchange rate; and the real commodity price. A recursive identification scheme is used, based on Killian (2009) with the variables ordered as above.

- *Results*. Real activity shocks have large and statistically significant effects on global commodity prices. The attached figure shows the variation decomposition of commodity prices arising from Chinese demand. In particular, a one standard deviation shock to the trend monthly growth rate of China's industrial production (about 2¾ percent, or nearly 1 percent of GDP) leads to:

  Commodity Price Variance Decomposition: China and U.S. Demand

  Note: 4-quarter variance decomposition to 1 standard deviation shock in industrial output

  - *Crude oil*. A rise in crude oil prices of about 6 percent (equivalent to about US$6.50/ bbl at current prices) after six months. This effect has a persistent effect on the level of oil prices, largely because of a weak supply response.

  - *Copper*. A rise in copper prices of about 6 percent after six months, with the effect largely persisting due again to a weak supply response.

  - *Other base metal* prices rise by less and, in some cases (e.g., zinc), there is no statistically significant effect of a price effect. There is no significant effect on aluminum prices, reflecting a relatively large supply response. In contrast to other base metals, China has significant bauxite deposits and aluminum refining capacity that can respond quickly to increased demand.

- *Reserves*. It is difficult to identify demand shocks caused by changes in state reserve holdings, for lack of data. At a global level, precautionary demand shocks are modeled as unexpected changes in prices and are shown to have large and persistent price effects.

4.   *Global terms of trade effects*. Material shocks to real activity growth in China have significant global terms of trade effects. Using the global supply-demand model estimated above, the first-round trade balance impacts are presented by country and region of higher prices for crude oil and 5 base metals following a China demand shock (Table 1). Iron ore is also included owing to its importance as a factor of production (limited data availability and the prevalence of long-term contract pricing before 2010 preclude an empirical estimate of the 12-month impact on prices; the change in prices is set to the average of the other 5 base metals, which equates to 1 percentage point increase for a 1 percentage point demand growth shock). The 12-month change in prices is applied to full year imports and exports.

- *Overall.* Many commodity exporting emerging economies experience a positive terms of trade effect as the value of exports increase. Their trade balances improve, while those of advanced markets and other commodity importers deteriorate slightly.

- *Middle East.* The largest effect is seen in the Middle East where oil exporters see a 3.3 percent improvement in trade balances as a percent of GDP.

- *Other commodity exporting regions.* Africa, the Commonwealth of Independent States, and Latin America also experience improved trade balances.

- *Commodity importers.* This increase is offset globally by small deteriorations in the trade balances of advanced economies, emerging Asia (including China), and emerging Europe.

Table 1. First-Round Trade Balance Effects of Oil and Metal Demand Shocks
in the U.S. and China
(change in trade balance, percent of GDP) 1/

	Unit demand shock		Standard deviation demand shock	
	U.S.	China	U.S.	China
Middle East	4.0	0.7	3.2	1.6
Africa	1.4	0.2	1.2	0.6
Latin America	0.4	0.1	0.3	0.2
United States	-0.2	0.0	-0.2	-0.1
Euro Area	-0.3	0.0	-0.2	-0.1
Emerging Europe	-0.3	-0.1	-0.2	-0.1
Japan	-0.3	-0.1	-0.2	-0.1
Emerging Asia	-0.4	-0.1	-0.3	-0.2
China	-0.4	-0.1	-0.3	-0.2

1/ Commodity price changes estimated from the 12-month cumulative impulse response of crude oil and base metals prices to an industrial production growth shock. Change in baseline 2011 trade balance as a percent of 2009 GDP. Import and export weights are average trade shares from 2005-08.

- *Summary.* China's impact on commodity markets, while significant, remains smaller than that of the U.S. This reflects a smaller share of world consumption for some commodities, such as for crude oil. More broadly, this is the result of the dynamics of real activity growth shocks in the U.S., which tend to be more persistent domestically and have larger effects on the rest of the world than shocks that originate in China.

5.   ***China's increasing role***. Recursive estimations show that, in general, the impact of China on global commodity prices has been steadily increasing over the last 5 years and that estimates based on historical samples may be underestimating China's current impact (Figure 3). The spike in the estimated impulse responses during the final quarter of 2008 is caused by the significant declines in commodity prices during the post-Lehman Brothers bankruptcy period. Recursive estimations that include separate dummy variables for October, November, and December 2008 smoothed out the evolution of the impulse responses, but the results were qualitatively and quantitatively similar.

Figure 3. Recursively Estimated 4-quarter Commodity Price Impulse Reponses to a China Demand Shock (cumulative log change) 1/
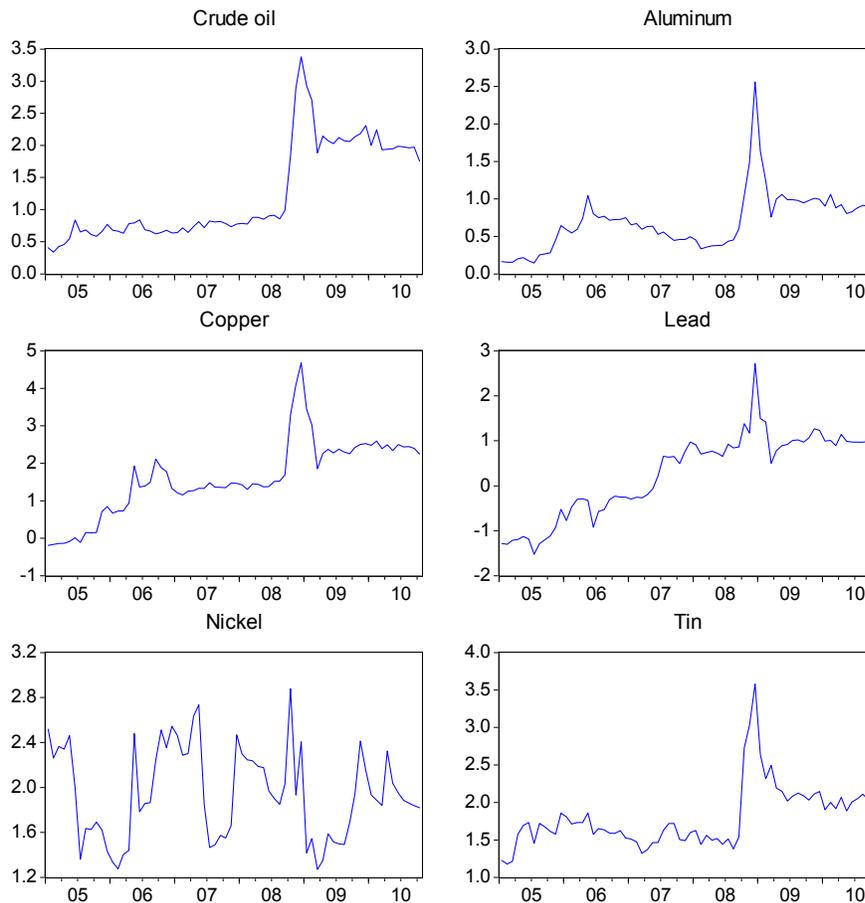

1/ Dates along the horizontal axis refer to the end date of the sample period. All sample periods begin January 2000. Zinc is not shown.

6. ***Commodity price decomposition***. How important has Chinese demand been for commodity price developments during the last 10 years? To some extent, this is shown by the variance decompositions above. An alternative perspective is to assess the contribution of each of the variables to commodity price changes for each quarter, based on the model estimates (Figure 4).

- One notable result is the important role played by precautionary demand (or commodity "price shocks" as defined in the VAR). In particular, during early 2009 the recovery in commodity prices was largely driven by precautionary demand. This is likely to be a "China effect" that is not captured by the demand shock because the State Reserve Bureau reportedly began

Figure 4. Crude Oil Prices

Note: Precautionary demand, which is the residual, includes some part of China's effect.

stockpiling commodities in advance of the fiscal stimulus that was implemented later that year and into 2010. During the early stages of the price recovery, explicitly identified China demand shocks provided a positive but small contribution to price changes.

- A second notable result is the contribution of U.S. interest rates to price changes. Some caution should be exercised with respect to the interest rate contributions as they are based on changes in the real Federal Funds rate. During this period, U.S. inflation was unusually volatile, in part reflecting the pass-through of international commodity prices and, as interest rates approached their zero lower bound, much of the effect can be ascribed to changing inflation.

- Perhaps the most striking result is the relative size of the effect of changes in the value of the U.S. dollar on commodity prices. Dollar appreciation exacerbated the demand-driven price downturn in 2008 and contributed to the price rebound in 2009. The effects of recent depreciation—occurring through the second half of 2010, during which the U.S. Federal Reserve announced a second round of quantitative easing (QE2) of monetary policy—have been significant. Although the lagged effects of a stronger dollar in the midst of the Euro Area problems was still weighing on commodity prices during Q3, the final three months of 2010 saw dollar depreciation contributing significantly to commodity price changes. The extent to which QE2 contributed to the loss of value of the dollar is still subject to debate and there remains insufficient evidence to claim that QE2 affected commodity prices significantly.
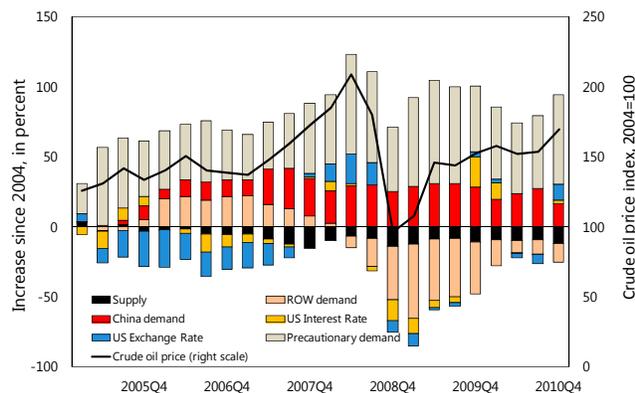
IX.   CHINA'S CLOSED CAPITAL ACCOUNT AND CAPITAL FLOWS TO EMERGING MARKETS[1]

There is a view that China's closed capital account has exacerbated the recent surge of capital flows to other emerging markets (EMs). It is hypothesized that the inability of investors to have direct exposures to portfolio investment in China led them to look for substitutes in other EMs, which in turn contributed to the inflows elsewhere. While this is plausible, the evidence below is ambiguous.

1.   *Closed capital account*. China's capital account is tightly controlled and remains largely closed to portfolio flows. The controls are comprehensive, effective, and binding in both directions. Thus, portfolio flows account for a small fraction of capital flows. This is in contrast to other EMs with open capital accounts, where portfolio flows are of greater importance, as evidenced in various episodes of surging capital flows.
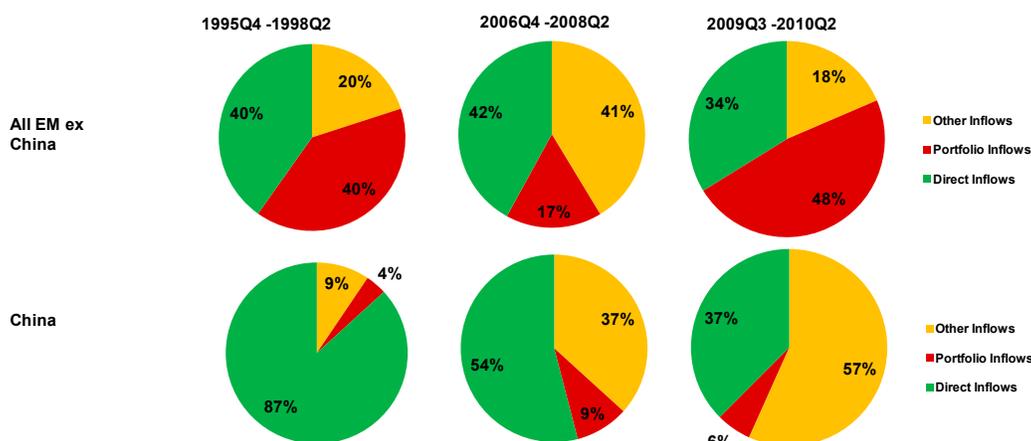
2.   *Capital inflows*. China is the single largest recipient of capital inflows among all EMs. During the period 2009Q3–2010Q2, 29 percent of the inflows to EMs ended up in China, while China's GDP is about 31 percent of the same group of countries. While the aggregate inflows to China do not appear to be distinctly small, it should be noted that in other large countries their share of flows is larger than their share of GDP.
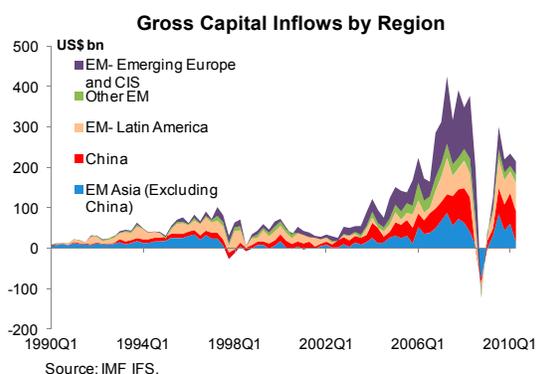
3.   *Hong Kong SAR listed firms*. Investors could gain direct exposures to Chinese portfolio assets by buying Chinese stocks listed in Hong Kong SAR. H-share (mainland companies listed in Hong Kong SAR) and red-chip (companies with main business in the mainland) stocks account for around 50 percent of market capitalization of HKSE (about US$2.7 trillion). If capital flows were being diverted from China, Hong Kong SAR would be a natural place to receive such flows

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[1] Prepared by Kai Guo (SPR) with helpful inputs from Yanliang Miao (SPR) and Mali Chivakul (SPR).

and one would expect to see large inflows and a surge in equity prices in Hong Kong SAR under its linked exchange rate regime. However, there has been no evidence of large inflows into the Hong Kong SAR stock market (even some outflows in the most recent quarters). In addition, the performance of the Hong Kong SAR stock market is decisively in the middle of the pack compared to regional peers.

Hong Kong SAR: Gross Portfolio Inflows

Selected Markets: Stock Market Performance
(Index, Jan 2009 = 100)
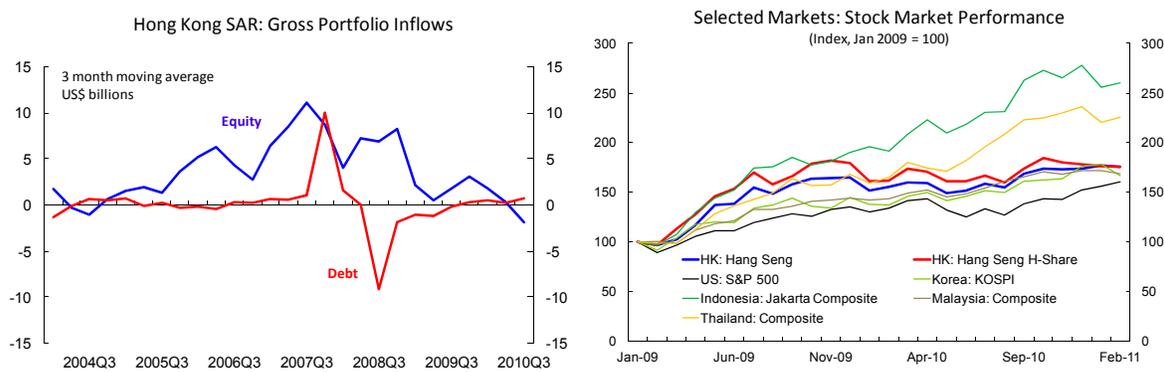
4.   ***Regression analysis***. Empirical analysis of how overall flows and the composition of flows would change as a result of an opening of China's capital account is hindered by the lack of variation in the data on the degree of openness over time of China's capital account. Such analyses would need to rely on differences in the openness across other EMs' capital accounts to make inferences, but given China's size and importance it is difficult to draw firm conclusions for China from such an exercise. In a regression that includes pull and push factors of capital flows as well as a measure of capital account openness, a country's own capital account openness is found to have a significant impact on capital flows into itself (details about the regression are provided in *Recent Experiences in Managing Capital Inflows—Cross-Cutting Themes and Possible Policy Framework*). But there is no clear evidence that partner countries' capital account openness matters for its capital inflows, or alternatively stated that the closed capital account of one country contributed to additional inflows to other countries (Table 1).

5.   ***Further results***. The regressions also suggest that additional portfolio inflows into China may not be large were China to open its capital account. A standard gravity equation using CPIS data suggests that multiple pull and push factors could affect portfolio investments between any pair of countries (Table 2). Financial openness, as measured by the Chinn-Ito index, is only marginally significant after controlling for other factors. Quantitatively, portfolio investment in Chinese equities, where capital account openness appears to matter most, would be about 30 percent higher than the current level if China's capital account were as open as that of Brazil.

6.   ***Caveats***. The above tests suffer from low power. Therefore, caution is needed in interpreting the results (since, among other things, currency undervaluation and financial repression would be expected to shift asset allocations). China is not an average EM, given its robust growth and size. The regressions results reflect experiences from average EMs, and it is unlikely that an opening of China's capital account would be seen as an average EM opening its capital account. General equilibrium effects of such an event are not captured by the analysis above but may well exist in reality.

Table 1. Determinants of Gross Capital Inflows

	All	Debt	Equity	Direct Investment	Other
US 10-year yield	-0.0972***	-0.213**	-0.141	-0.145***	-0.010
VIX (Log)	-0.250***	0.005	-0.611***	-0.066	-0.100
Trade openness	0.318	-0.556	-0.622	0.103	0.308
Inflation	-0.000235*	-0.000170*	-0.000282	-0.000227***	0.0000733
Growth	0.0397***	0.0505*	0.0595***	0.0330***	0.0395***
Average Size (Log GDP)	0.128	0.307	-0.401	0.216	0.304**
Capital Account Openess	0.547***	0.719*	0.809*	0.208	0.783***
Partner's KA Openess	1.265***	0.906	0.785	2.291***	0.646**
Constant	5.220***	3.518**	7.066***	3.349***	3.129***
Country dummies	Yes	Yes	Yes	Yes	Yes
Time dummies	No	No	No	No	No
Observations	2791	1444	1514	3145	2173

Notes: The table presents panel fixed-effects regressions on factors affecting gross capital inflows and their composition over 48 emerging market economies between 1990Q1 and 2010Q2. Dependent variables are the log level of total inflows and their different components. Trade openness is the sum of exports and imports divided by GDP and average size proxied by the logarithm of average GDP in the first and the second decade of the sample. ***, ** & * denote statistical significance at the 1%, 5% and 10% level of confidence.

Table 2. Determinants of Bilateral Invesments

	Debt	Equity	BIS bank claims
Log GDP	0.733***	1.128***	0.682***
Log GDP per capita	0.238**	0.463***	0.131
Log distance	-0.203*	-0.385***	-0.573***
Log exports from recipient	0.0224	0.0681***	0.202***
Measure of market depth 1/	0.453***	0.300***	0.410***
Time difference	-0.141***	-0.0158	0.0441
Chinn-Ito financial openness measure 2/	0.092	0.106**	-0.0901*
Common legal system	0.447***	0.261**	0.230*
Common currency	0.910***	0.328*	0.0497
Common language	0.729***	0.713***	0.627***
Bilateral real exchange rate volatility	-0.153**	-0.00158	0.0255
EUREM dummy	-1.170***	-0.688***	-0.634***
Western Hem EM dummy	-0.939***	-0.104	-0.092
Asian EM dummy	-1.092***	1.068***	-0.497
Other EM dummy	-1.632***	-0.2	-0.955***
Financial center dummy	0.156	1.449***	1.497***
Constant	4.542***	0.412	6.135***
Observations	742	1023	911
R-squared	0.786	0.802	0.744

Note: ***, ** & * denote statistical significance at the 1%, 5% and 10% level of confidence.

1/ Measures of market depth are: Total domestic and international debt securities to GDP for debt regression, stock market capitalization to GDP for equity regression and banking system's private sector credit to GDP for the BIS claims regression.

2/ Chinn-Ito financial openness measure is derived from the IMF's AREAER. We use the latest indices from 2008.

# X. CHINA'S SAVING: THE IMPACT ON GLOBAL FINANCIAL CONDITIONS[1]

China's annual saving is the largest in the world—even in dollars. During 2010–15, China is projected to contribute more than 1/3rd of global net wealth accumulation, which will impact domestic and external financial conditions. This chapter estimates the impact of this saving on asset prices. China's closed capital account implies that the saving will significantly raise domestic valuations relative to the rest of the world. Should the authorities seek to alleviate mounting inflationary pressure on domestic asset prices by selling Chinese bonds (and sterilizing with foreign asset purchases), external valuations could also rise. An orderly opening of the capital account that results in net flows into China could lead to declining asset valuations elsewhere, particularly in non-S5 countries.

1.   *Large saving*. On account of its large annual saving, China is projected to contribute more than 1/3rd of global net wealth accumulation between 2010 and 2015 (measured as net investment plus increase in net foreign assets). China's allocation of this new wealth should have increasingly important, if gradual, implications for domestic and global financial markets.

Global Net Wealth Accumulation (2010-2015, in trillions of US$)

Source: World Economic Outlook and staff estimate.
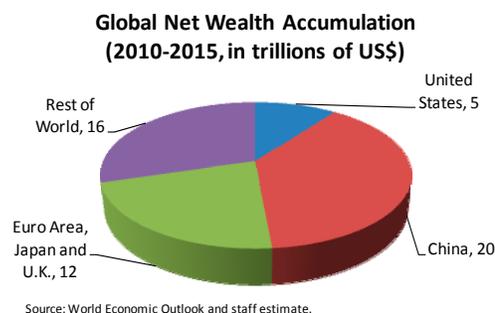
2.   *Analytical framework*. To assess the implications of China's growing influence on global financial markets under current policies, a set of asset market clearing conditions is used (see Appendix I). Relative valuations needed to clear asset markets are calculated for portfolio allocations across regions. An increase in demand for a country's asset results in an increase in its valuation, under a given path for the exchange rate. (Consistent with the WEO, a constant REER exchange rate path is assumed, which also determines the saving and investment balances.)

3.   *Rising domestic asset prices*. Given capital controls and an undervalued currency, among other factors, China's non-reserve asset holdings reveal a high degree of home-bias. If, as is likely, capital controls remain in place for the coming years and the managed appreciation of the currency is gradual, the current configuration of asset holdings would likely persist into the medium term. This portfolio "preference", together with high saving rates, would translate into high demand for Chinese assets that outpaces its supply, resulting in significant domestic asset price inflation. The chart shows the asset price changes (under the given exchange rate path) required to clear markets.

Asset Price Change (relative to US, in percent)

Sources: World Economic Outlook and staff estimates.

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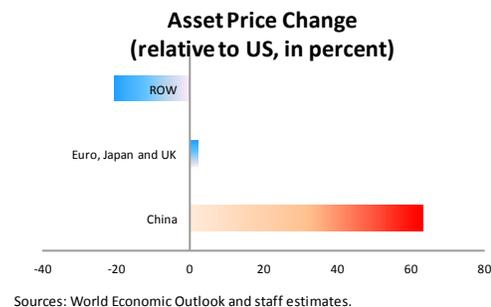
[1] Prepared by Kai Guo (SPR).

4.   ***Changing portfolios***. In the absence of rebalancing policies to slow savings, the authorities may seek to control asset inflation by purchasing foreign assets and selling RMB assets. Such operations reallocate saving toward net foreign assets. A further accumulation of US$600 billion in reserves between 2011 and 2015 would be needed, on top of the baseline increase in reserves (US$2 trillion), to keep real asset inflation at the same rate as in the U.S.

5.   ***Impact on foreign asset prices***. Purchases of foreign assets would result in noticeable asset inflation elsewhere over the 2011-15 period. The impact on non-S5 countries could be larger, should China choose to incrementally hold more of their assets.[2] This would be particularly true if more outward direct investment is encouraged as an alternative to reserve accumulation, since 95 percent of China's FDI goes to non-S5 countries.

Asset price response to more reserve accumulation from China (in percent)
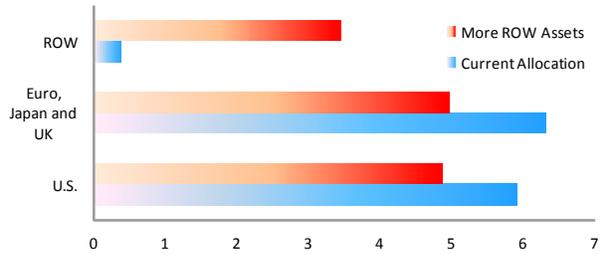
Sources: World Economic Outlook and staff estimates.

6.   ***Capital account liberalization***. The gradual opening of China's capital account would have an ambiguous impact on domestic and global financial markets. Liberalization would bring two offsetting forces: investment into China from abroad, and more Chinese investment in the ROW. The relative strength of these two forces will depend, among other things, on the sequencing and timing of reforms. The chart illustrates a scenario in which even relatively large outflows from China (6 percent of assets reallocated to the U.S., other S5, and the ROW in equal proportions) will not offset a small reallocation of global assets from non-S5 countries to China (to the tune of 1 percent of their assets). The result would be asset disinflation in non-S5 countries.

Asset price response to opening capital account in China (in percent)
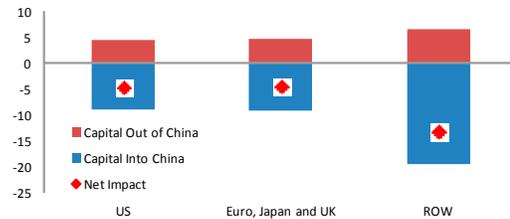
Source: Staff estimates.

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[2] The S5 or "Systemic 5" economies are China, the Euro Area, Japan, the U.K., and the U.S. The assumptions are that China will allocate half of the reserve accumulation to the rest of the world (ROW), or about US$ 1.2 trillion. Of the remaining half, 2/3rd goes to the U.S. and 1/3rd to the other S3.

Appendix I. Methodology

1. ***Analytical framework***. The impact of China's portfolio allocation on global financial markets is analyzed in a set of market-clearing conditions. The underlying assumption is that the asset price has to adjust to clear the market, once the portfolio preferences of all investors are given. The following conditions must be satisfied at any moment of time for country i

$$\frac{X_i}{E_i} = \sum_{j=1}^{n} a_{ij}W_j + B_{ij}$$

$$\frac{X_i}{E_i} + F_i + B_i = W_i$$

$$\sum_{i=1}^{n} a_{ij} = 1$$

$$\sum_{i=1}^{n} (F_i + B_i) = 0$$

where X_i is the value of assets in country i; E_i is the exchange rate of the currency in country i against a numeraire currency, which is assumed to be the U.S. dollar. So, $\frac{X_i}{E_i}$ is the value of assets in country i measured in U.S. dollars. W_j is the total net wealth of country j denominated in U.S. dollars, a_{ij} is the portfolio share of country i's asset in country j's portfolio, F_i is country i's non-reserve net foreign assets denominated in U.S. dollars, and B_{ij} is country j's reserve held in country i's asset. For countries other than China, reserves and non-reserve net foreign asset are treated as a single net foreign asset.

2. ***Comparative statics***. If the demand for a country's asset increases, i.e., if $\sum_{j=1}^{n} a_{ij}W_j$ increases, $\frac{X_i}{E_i}$ will have to go up as a response. This means either the currency appreciates or the asset price increases, or there is a trade-off between exchange rate appreciation and asset price inflation in the face of rising demand for a country's asset. The above conditions can pin down a unique set of $\frac{X_i}{E_i}$ for given a_{ij}, F_i and W_i. That is, the asset prices in all countries can be determined, once net foreign asset positions, portfolio preferences, and the net wealth of each country are given. To study the impact of changes to certain parameter values, such as a_{ij} or W_i, on the asset value, $\frac{X_i}{E_i}$, comparative statistics can be applied.

3. ***Calibration***. To calibrate parameter values with actual data, the world is divided into four major blocks: the U.S., China, the other S5 (Japan, Euro Area, and U.K.), and the rest of the world (ROW).

- F_i, namely, the net foreign asset position, is taken from Lane and Milesi-Ferretti's dataset. When possible, these data were checked against official flow of funds data and official IIP data. These three datasets are largely consistent for Japan, the Euro Area, and the U.K. For the U.S. and China, the official IIP and Milesi-Ferretti data are very similar. The ROW is taken as the residual.

- X_i, or domestic assets, is the domestic capital stock. Since all cross holdings of assets and liabilities among different domestic sectors will be netted out in the aggregate, the capital stock is the relevant asset for the purpose of this exercise. Capital stock data for the U.S, Japan, Euro Area, and U.K. are taken from the OECD. For China and ROW, a capital/output ratio of 2 is used to back out the capital stock.

- a_{ij}, or the portfolio allocation: to calibrate a_{ij}, first, foreign assets were divided into portfolio investment and FDI. For countries other than China, portfolio investment data are from CPIS and FDI from OECD. Intra Euro Area investment was netted out. For China, the FDI data are from the official Chinese statistics, which break down the stock of FDI by country. For portfolio investment, official data are used from the U.S. and Japan, along with some CPIS data, and a few assumptions were made to back out the geographical allocation. Then, the weighted average of portfolio investment and FDI and the net holding of domestic asset were used to calculate a_{ij}. For countries other than China, reserves were treated as part of foreign assets, as they are generally small compared to a country's overall foreign assets. Therefore, for all countries except China, a_{ij} also reflects reserve holdings and B_i is subsumed into F_i. However, for China, reserves are treated separately and a_{ij} is calculated by excluding reserves, given the scale and dominance of reserves. All calibrations are based on end-2009 data and all nominal variables are converted into 2009 U.S. dollars.

4.   ***Summary calibrations***. The following is a summary of main input to the scenario.

- *Portfolio allocation matrix*. The rows signify the country or region whose net wealth is distributed geographically according to the columns. So, China holds 96 percent of its net wealth domestically, 2 percent of its non-reserve foreign assets in the U.S., and the remainder equally across the other S5 and the rest of the world.

Portfolio Allocation Matrix				
	US	China	S3	ROW
US	0.75	0.00	0.12	0.13
China 1/	0.02	0.96	0.01	0.01
S3	0.11	0.00	0.71	0.17
ROW	0.11	0.02	0.18	0.70

Sources: Staff Calculation
1/ Excluding reserve assets.

- *Domestic asset and net wealth*

Domestic Asset and Net Wealth				
(in trillions of US dollar)				
	US	China	S3	ROW
Domestic Asset	31.5	10.0	56.3	38.2
Net Wealth 1/	28.4	9.2	56.3	39.7

Sources: Staff Calculation
1/ Excluding reserve assets for China.

- *China's foreign reserves*

China's Foreign Reserves (end 2009)			
(in billions of US dollar)			
US	S3	ROW	Total
1247	812	392	2451

5. ***Change in net wealth during 2010-15***. To calculate the increase in net wealth, WEO projections are used. Investment between 2010-2015 net of 4 percent annual depreciation of existing capital stock provides the increase in domestic asset. The cumulative current account balance between 2010 and 2015 yields the change in net foreign assets. For China, the change in net foreign assets is further broken down into changes in non-reserve assets and reserves, with reserves allocated to each region based on existing allocation. Portfolio preferences are assumed to be fixed. The following are the results:

Change in Domestic Asset			
(in trillions of 2009 US dollar)			
US	China	S3	ROW
8.2	17.2	11.1	16.3

Sources: Staff Calculation

Change in Net Foreign Asset			
(in trillions of US dollar)			
US	China 1/	S3	ROW
-2.9	1.1	0.6	-0.8

1/ Excluding reserve accumulation.

China: Reserve Accumulation			
(in billions of US dollar)			
US	S3	ROW	Total
1017	663	320	2000

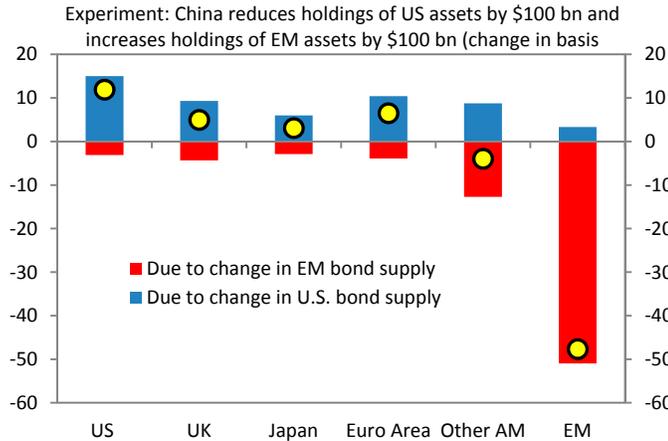# XI. POTENTIAL IMPACT ON GLOBAL BOND MARKETS OF REALLOCATING RESERVES[1]

This chapter derives the global bond market implications of shifts in China's reserve allocation using a simple static mean-variance framework. It provides an example where a reallocation of China's holdings of U.S. reserve assets to emerging market (EM) assets by, say, US$100 billion could increase U.S. yields by 12 bps and reduce EM yields by about 48 bps. Yields on other advanced market (AM) debt, which are close substitutes of U.S. debt, would also increase. In this framework, the quantitative results are linear and can be scaled. Given the many uncertainties involved in this estimation, the results need to be interpreted with caution. In practice, the effect of such a reallocation would also depend on the speed of its reallocation, an effect that is not possible to assess in the simple model employed here.

1.   China's reserves. At over $3 trillion and rising, China's international reserves are by far the largest in the world. The portfolio composition of these reserves is not known, but is widely believed to be mainly in U.S. dollar assets, given the size and depth of U.S. financial markets. Senior Chinese policy makers have publicly ruled out a rapid change in the composition of China's reserves. However, concerns expressed by them on the value of the dollar and the strength of U.S. policies, measures taken to promote the use of the renminbi in cross-border trade settlements, and calls for a more diverse international reserve currency system have fueled speculation that gradual diversification may occur.

2.   Methodology. This chapter analyzes the potential impact on global yields of a shift in China's reserve portfolio away from U.S. assets and into EM assets under a variety of scenarios and assumptions. In a baseline experiment, it is assumed that China reduces its holdings of U.S. reserves by $100 billon and increases its holdings of EM assets by the same amount. This reshuffling increases the stock of U.S. debt available in the market while reducing the stock of available EM debt. In equilibrium, these changes need to be absorbed by a representative global bond investor through changes in bond yields. This investor requires to be compensated for the required portfolio shift, as this affects the mean-variance characteristics of his portfolio (see Appendix I).

3.   Results. Simulation results for a reallocation of China's reserves from U.S. government bonds to EM government bonds by $100 billion are as follows (Figure).

- First, increasing the market supply of U.S. debt increases yields by about 12 basis points. This effect is similar to the estimates of Warnock and Warnock (2009), who found that foreign purchases of U.S. Treasuries of 1 percent of GDP were associated with a 19 bps reduction in long rates. At 2009 GDP, this would correspond to an impact of 13 bps for a purchase of US$100 billion. On the other hand, the effect is larger than available estimates of the effect of U.S. quantitative easing. For instance, Gagnon, Raskin,

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[1] Prepared by Roberto Benelli (SPR).

Remache, and Sack (2010) estimated that Federal Reserve purchases between December 2008 and March 2010 of US$1.7 trillion of longer-term agency debt and mortgage-backed securities lowered longer term yields by 30–100 bps.

- It also increases the yields on U.K., Euro Area and Japan debt by between around 20 and 35 basis points, while it reduces EM yields significantly (by some 200 points).

Experiment: China reduces holdings of US assets by $100 bn and increases holdings of EM assets by $100 bn (change in basis

4. **Robustness**. To check the robustness of the results, a number of sensitivity analyses are undertaken, including: changes in risk aversion parameters; inclusion of U.S. agency debt in the pool of debt affected by the reallocation; consideration of alternative re-allocation scenarios; and estimation of yield means and variances over alternative sample periods.

Sensitivity Analysis (basis points)
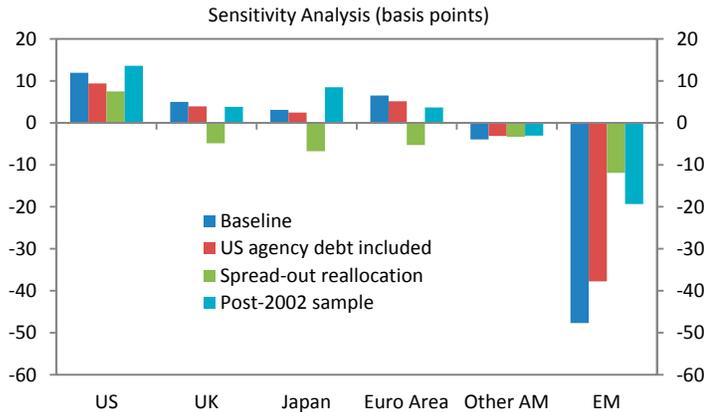
- *Risk aversion*. As would be expected, the magnitudes change slightly.

- *U.S. reserve assets*. In the baseline, only U.S. government debt was considered as part of U.S. reserve assets. U.S. agency debt has long been considered a close substitute for U.S. government debt, given the implicit (and, more recently, explicit) government guarantee. If agency debt (around US$8 trillion at end 2009) is included in the global pool of public debt, then a US$100 billion shift by China out of U.S. debt represents a smaller portion of the global debt market, and as such it generates a smaller impact on yields (the impact is some 20 percent smaller).

- *Broader re-allocation*. If, instead of investing entirely in EM debt, China were to spread its purchases equally across the U.K., Japan, the Euro Area, other AMs, and EMs (by US$20 billion each), then the impact of shifting out of China is smaller on both the U.S. and EM debt. (The impact on U.S. yields is lower because the market supply of debt that is closely substitutable for U.S. debt is reduced, causing demand for the latter to increase in the ensuing portfolio reallocation.) Yields on non-U.S., non-EM debt also fall in this experiment, given their reduced supply.

- *Shorter sample period*. If expected returns and covariances are calculated with a shorter sample (post 2002 only), then the impact of the baseline portfolio shift is larger on U.S. and Japan yields and smaller on EM yields (and basically unchanged for others). This is because the 1990s were a turbulent period for many EMs, while the latter part of the sample has been relatively more turbulent for AMs (in relation to the longer sample). Thus, EM debt is perceived as less risky in a shorter sample, with the opposite being the case for AM debt.

- *Market debt*. As discussed above, one of the assumptions underlying this exercise is that all the public debt that is not held as official reserves is considered as "being in the market" and priced according to the mean-variance framework. This may not be the case to the extent that a portion of the outstanding debt is held by financial institutions that follow passive investment strategies and hold their debt to maturity. Moreover, a portion of outstanding debt may not available to global investors (e.g., because of limited liquidity or other constraints). In this framework, the share of the debt that is not truly available in the market could be subtracted from the world stock of marketable securities, implying that a given nominal shift in China's holdings would require a bigger re-shuffling in terms of portfolio shares (given the smaller base), and in turn proportionally higher yield adjustments.

5.   ***Caveats***. These results are subject to a number of caveats, including: the model's focus, which is limited to mean-variance trade-offs; the sensitivity of the results to the estimation period; limited data availability; the model's high-level approach, which abstracts from finer asset differences; and the static nature of the exercise, which does not allow for assessing the effect of more gradual shifts over time:

- The mean-variance framework requires exogenous factors to account for the *level* of current global bond holdings. Under the reasonable assumption that these factors are stable, this framework can be used to assess the implications of *changes* in the stock of different debt securities. The model is less able to account for the level of yields themselves.

- The results are sensitive to the estimation of expected value of returns and their covariance matrix. The sample includes in particular the last global crisis, a period of large and volatile changes in yields. Going forward, it is not clear in principle whether the sample means and variances over this period will be a benchmark for pricing.

- Because of data constraints, EM bond market behavior is modeled on the EMBI segment. By construction, this is the most liquid segment of EM external debt. This may lead to underestimation of the impact of global shocks on EM bond markets, given the trend in recent years of increased foreign participation in domestic local currency debt markets, where liquidity may be lower and unevenly distributed across different segments.

- There are also a number of issues involved in the calculation of the relevant stocks of outstanding bonds, for instance, whether private securities (such as corporate bonds) could be considered as close substitute of government securities.

- In practice, the effect of such a reallocation of reserves would depend on more factors than simply the outstanding stock of securities. These factors, which are not included in the simple model considered here, include the speed of implementation, how this is communicated (or not) to the market, and how other official holders of U.S. dollar securities would react.

Appendix I. Methodology

1.   *Mean-variance framework*. In a mean-variance framework, portfolio shares are chosen to maximize a quadratic utility function (see Neely, 2010):

$$\mu w - \frac{\gamma}{2} w'Vw, \qquad (1)$$

where μ and V are the vector of expected (excess) returns and covariance matrix of returns, respectively; γ is a parameter of risk aversion; and w is the vector of portfolio allocations (as a share of total wealth). These shares are not constrained to sum to one because the portfolio constraint is met by investment/disinvestment in a risk-free asset.

2.   *Portfolio maximization* yields the following relation between expected returns, their covariance matrix, and the optimal portfolio weights:

$$\mu = \gamma Vw. \qquad (2)$$

In equilibrium, this solution links expected returns to risk preferences (as summarized by γ), risk (as captured by V), and the supply of the risky assets included in the market portfolio (summarize by their shares, w). This relation is the basis for the simulations conducted this note in which the relative supplies of different bonds are affected by China's decisions to reshuffle its holdings of reserve assets among different bonds.

3.   *Risk aversion*. It is useful to relate the parameter γ to the standard *Arrow-Pratt measure of relative risk-aversion, R(W)*. Simple algebra yields

$$R(W) = \frac{\gamma W}{1 - \gamma W}, \qquad (3)$$

where W is the wealth level at which risk aversion is evaluated, normalized to one in what follows. With this normalization, equation (3) determines a relationship between γ and R that allows for a calibration of γ for a range of values of relative risk aversion R, for which there is available

empirical evidence. Results are presented for relative risk aversion ranging between 1 and 7, with 4 regarded as the "central" scenario.

4. **_Application to bond yields_**. In the simulations considered in this note, it is assumed that China reallocates its reserve assets by reducing its holdings of U.S. assets and purchasing EM assets. For a given bond k, equation (1) then implies that the change in real monthly return can be written as follows:

$$\Delta\mu_k = \gamma v_{k,US}\Delta w_{US} + \gamma \sum_{j\neq US} v_{j,k}\Delta w_j, \quad (4)$$

where $v_{j,k}$ denotes the covariance in monthly real returns between country j and k; $\Delta\mu_k$ is the change in equilibrium return for bond k; and Δw_j is the change in the supply of asset j available in the market as a percentage of total wealth in the market.
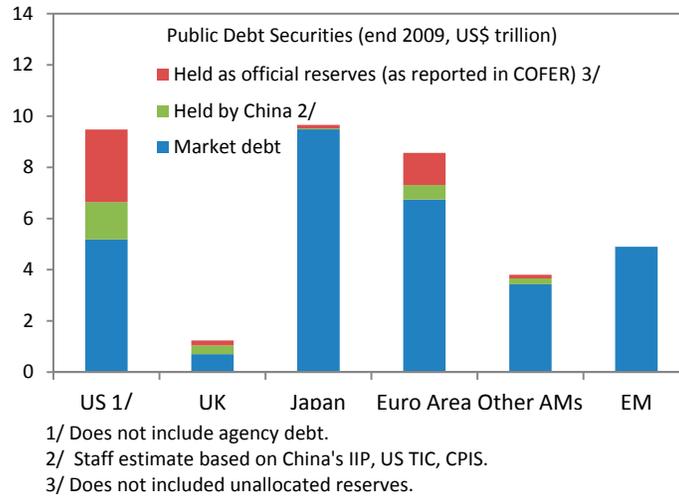
For illustrative purposes, the term corresponding to U.S. bonds has been separated from the other countries. For example, equation (4) implies that an increase in the supply of U.S. bonds available in the market ($\Delta w_{US} > 0$) will raise (reduce) the returns on those bonds whose returns are positively (negatively) correlated with U.S. returns, $v_{k,US} > 0$ ($v_{k,US} < 0$). The total impact is proportional to the change in the supply of U.S. bonds, the strength of the comovement between bond returns, and the parameter of risk aversion. Finally, changes in monthly real returns are translated into changes in annual yields by assuming that these changes are permanent.

5. **_Data and estimation_**. μ and V, the vector of expected (excess) returns and covariance matrix of returns, are calculated from total bond return indices for the countries or regions included in the exercise. For indices in U.S. dollars (the U.S. long-term bond and EM indices, for which the JPMorgan EMBI indices are used), a monthly real return is calculated by subtracting the U.S. monthly CPI inflation rate. For the indices in local currency (Germany for the Euro Area, Japan, United Kingdom, and Canada for other AMs), monthly nominal returns are first converted into U.S. returns using the monthly change in bilateral exchange rates. Finally, excess real returns are calculated by subtracting the U.S. short term rate. For the baseline calculations, the sample starts in 1991 for AM returns and 1995 for the EM index; the Middle East begins in 1998.

In principle, the equilibrium summarized in equation (2) applies to the stocks of financial assets that are outstanding in the market at a given point in time, expressed as a percentage of the world's financial wealth that is allocated to different assets according to the mean-variance framework. Two assumptions were made to operationalize this approach. First, there is a representative world bond investor that decides global government bond allocations according to mean variance preferences _defined over bond returns only_. Second, reserve assets held by central banks are excluded from the pool of bonds whose returns are allocated according to the mean variance framework. The rationale for the latter is that reserve accumulation decisions by central banks are not made primarily according to the risk-return features of their reserve assets.

Data on outstanding stocks for public debt securities as of end 2009 were obtained from the Global Financial Stability Report, October 2010, Statistical Appendix, Table 3. This was combined with COFER data on the currency composition of world reserve assets, and with staff estimates of

China's net portfolio asset holdings (with the additional assumption that the latter reflect mostly holdings of official reserves). This yields the breakdown of public debt securities by issuer and market availability is presented in the chart below.

Public Debt Securities (end 2009, US$ trillion)
- Held as official reserves (as reported in COFER) 3/
- Held by China 2/
- Market debt

1/ Does not include agency debt.
2/ Staff estimate based on China's IIP, US TIC, CPIS.
3/ Does not included unallocated reserves.

References

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