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Towards Recoupling?

Assessing the Global Impact of a Chinese Hard Landing through Trade and Commodity Price Channels*

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Résumé

La croissance rapide de la Chine durant la dernière décennie a été l'un des principaux moteurs de l'augmentation de la demande et des prix des matières premières minérales. Alors que la soutenabilité du modèle de croissance chinois soulève des interrogations, ce papier étudie l'impact potentiel d'un fort ralentissement de l'économie chinoise sur les autres pays, avec une attention particulière aux canaux des prix des matières premières et du commerce. Après une revue des principaux arguments pointant vers un fort ralentissement – précédents historiques de rééquilibrage, surinvestissement, dynamique de la dette, possible bulle immobilière – nous nous concentrons sur un échantillon de 36 pays et utilisons un modèle global VAR adapté aux prévisions conditionnelles afin de simuler l'impact d'un fort ralentissement de l'économie chinoise. Nous modélisons les marchés des métaux et du pétrole séparément pour tenir compte du rôle différencié de la Chine sur ces marchés, et nous identifions trois canaux de transmission affectant les exportateurs de matières premières : volume d'exports, effet revenu (via les prix des matières premières), et investissement (une chute des prix réduisant les incitations à investir dans les secteurs minier et énergétique). Nous analysons aussi le rôle d'amortisseur joué par le taux de change. D'après nos estimations, les pays émergents (hors Chine) seraient les plus fortement impactés avec une perte cumulée de croissance sur 5 ans d'environ 7,5%, notamment en Asie du Sud-Est mais aussi dans les régions exportatrices de matières premières comme l'Amérique latine ; les pays avancés seraient moins affectés. L'écart de croissance entre pays émergents et avancés se réduirait considérablement, conduisant à un *recouplage partiel.*

Mots-clés : Chine, ralentissement économique, spillovers, global VAR, prévision conditionnelle, matières premières, recouplage

Codes JEL: C32, F44, E32, E17, F47, Q02

Abstract

China's rapid growth over the past decade has been one of the main drivers of the rise in mineral commodity demand and prices. At a time when concerns about the sustainability of China's growth model are rising, this paper assesses to what extent a hard landing in China would impact other countries, with a focus on trade and commodity price channels. After reviewing the main arguments pointing to a hard landing scenario – historical rebalancing precedents, overinvestment, unsustainable debt trends, and a growing real estate bubble – we focus on a sample of 36 countries, and use a global VAR methodology adapted to conditional forecasting to simulate the impact of a Chinese hard landing. We model metal and oil markets separately to account for their different end-use patterns and consumption intensity in China, and we identify three specific transmission channels to net commodity exporters: through real exports, through income effects (related to commodity prices), and through investment (a fall in commodity prices reducing incentives to invest in the mining and energy sectors); we also look at the role played by the exchange rate as a shock absorber. According to our estimates, emerging economies (ex. China) would be hardest hit – with a 7.5 percent cumulated growth loss after five years –, in particular in South-East Asia but also in commodity-exporting regions such as Latin America; advanced economies would be less affected. The "growth gap" between emerging and advanced economies would be considerably reduced, leading to *partial recoupling.*

Keywords: China, hard landing, spillovers, global VAR, conditional forecast, commodities, recoupling

JEL Classification: C32, F44, E32, E17, F47, Q02

Non-technical summary

China has enjoyed high growth over the past thirty years. This rapid development has been strongly biased towards investment, and as such, has been highly commodity-intensive: in 2011 China represented around 11 percent of global oil consumption, 41 percent of global copper consumption and 54 percent of global iron ore consumption. High investment levels and the urbanization process have indeed significantly boosted China's demand for metals; while coal is the main energy source in the country, the empirical literature provide some evidence that China's demand also contributed to the strong rise in oil prices over the past decade. This has benefited commodity exporting countries, particularly in Latin America, Sub-Saharan Africa, the Community of Independent States, and the Middle-East.

However, China's growth model seems to have reached its limits, as shown by a continuous growth deceleration since the beginning of 2011. Vulnerabilities are mounting, due to overinvestment, excess capacities, a strong rise in the credit-to-GDP ratio – especially when taking into account shadow banking – and a probable real estate bubble. Although the Chinese authorities are committed to rebalancing the economy towards greater private consumption, they have not been successful so far, with an investment-to-GDP ratio still at record high levels. In this context, rebalancing may occur through a "hard landing" scenario, i.e. a prolonged period of slow growth led by a sharp deceleration in investment – with consumption remaining more resilient –. Indeed, historical precedents of rebalancing following investment-led growth in other countries were systematically associated with significantly lower growth than in the pre-rebalancing period. Accordingly, a number of recent empirical works highlight the risks of a sharp growth slowdown in China.

The aim of this paper is to assess the potential spillovers of a Chinese hard landing on the global economy, with a particular focus on commodity exporters and the commodity price channel. To this purpose, we rely on the Global VAR methodology. Our sample includes 36 countries, both advanced and emerging, and net commodity exporters as well as importers, representing about 88 percent of the global economy. To compare the effects of a hard landing scenario to those under the baseline soft landing, we perform conditional forecasting. Commodity markets are embedded in the GVAR framework by adding two "commodity blocks", respectively for metals and energy, each block including price, production and inventory variables.

In our hard landing scenario (in which Chinese growth slows down markedly and stabilizes at 3 percent per year, while investment nearly stagnates), we find a strong impact on the metal price index, and a somewhat milder (although still sizable) impact on the oil price, consistent with what should be expected. Net commodity exporters would be affected through a number of distinct channels. First, lower commodity prices would affect the value of exports, fiscal revenues, and would imply more generally a lower level of national income. Second, export volumes would also decrease, although this effect is found to be less important for commodity exporters than for China's geographical neighbors in Asia. Third, investment would be hardly hit, both because of lower incentives to invest in the extractive sector and because of lower public investment – reflecting constraints arising

from lower fiscal revenues –. Fourth, indirect trade linkages would also play a role through "neighborhood" effects: in Latin America for example, while the average country is a net commodity exporter, its neighbors are also likely to be net commodity exporters, hence a compounding effect on the whole region. Finally, to the extent that it remains flexible, the real effective exchange rate may act as a buffer in some commodity exporting countries; on the contrary, countries whose exchange rates are pegged to the US dollar would suffer from its real appreciation.

As a result, the regions that we find to be most impacted by a Chinese "hard landing" are regions that are either geographically close to and deeply integrated with China – with a cumulated GDP loss after five years of 9.4 percent in ASEAN –, or that are large net commodity exporters – such as Latin America, with a cumulated GDP loss of 7.5 percent –. Conversely, advanced economies would be less affected (-2.8 percent after five years), because the overwhelming majority of them are net commodity importers and tend to trade predominantly with each other. As a consequence, the "growth gap" between emerging and advanced economies would be significantly reduced, from 6 percent in the years 2007-09 to less than 1 percent from 2017 onwards; this would lead to some form of "partial recoupling".

Retrospectively, our results may help shed some light on the "decoupling" episode that started at the beginning of the 2000s. Decoupling could indeed be reinterpreted as the consequence of China's emergence as a major economy, its highly unbalanced growth pattern – with an excessive reliance on commodity-intensive investment –, and the implied spillovers on commodity exporters. In this context, a "hard landing" in China may bring to an end both the "commodity supercycle" and the period of high growth in emerging economies over the past ten to fifteen years.

1 Introduction

China's rapid growth over the past decade has been one of the main drivers of the rise in energy and mineral commodity demand and prices: over the last ten years, 133 percent of the increase in global copper consumption has been driven by China, 108 percent for nickel, 85 percent for iron ore, 85 percent for coal, and 42 percent for oil (see figures A.8 to A.10). This may have benefited commodity exporting countries, particularly in Latin America, Sub-Saharan Africa, the Community of Independent States, and the Middle-East.[1] However, China's growth has been slowing down in the last few years, and concerns have been mounting about the sustainability of its growth model (Eichengreen et al. 2012, IMF 2013b, RGE 2013). While a majority of analysts still view a soft landing as their baseline scenario, several reasons can be put forward to justify a more pronounced slowdown: historical rebalancing precedents, overinvestment,[2] unsustainable debt trends, and the bursting of a real estate bubble. The rebalancing process itself, with China's growth switching progressively from commodity-intensive investment to private consumption, may already have sizable consequences on energy and mineral commodity demand and prices, and hence on exporting countries; if this rebalancing were to occur through a significant deceleration in growth, that is, a hard landing scenario in which investment would slow sharply, effects on commodity exporters would be amplified accordingly.

The aim of this paper is to assess the potential spillovers of a Chinese hard landing on the global economy, with a particular focus on commodity exporters and the commodity price channel. To this purpose, we rely on the Global VAR methodology developed by Dees et al. (2007). Our sample includes 36 countries, both advanced and emerging, and net commodity exporters as well as importers, representing about 88 percent of the global economy; we use quarterly data over the period 1995Q1-2014Q3. To compare the effects of a hard landing scenario to those under the baseline soft landing, we adapt the procedure initially proposed by Pesaran et al. (2007) for counterfactual analysis, in order to perform conditional forecasting. Commodity markets are embedded in the GVAR framework by adding two "commodity blocks", respectively for metals and energy, each block including price, production and inventory variables. The specification of our Global VAR model allows for three specific transmission channels to net commodity exporters: through real exports, through income effects (related to commodity prices), and through investment (a fall in commodity prices reducing incentives to invest in the mining and energy sectors); we also look at the role played by the exchange rate as a shock absorber.

In our hard landing scenario (in which Chinese growth slows down markedly and stabilizes at 3 percent per year, while investment nearly stagnates), we find a strong impact on the metal price index, and a somewhat milder (although still sizable) impact on the oil price, consistent with what should be expected (oil being more consumption-related than metals, especially for China; see RGE 2012b). The regions that we find to be most

[1]See for example Jenkins et al. (2008) for a review of both direct and indirect impacts of the rapid growth of China on Latin America and the Caribbean region.

[2]See Lee et al. (2012) for a cross-country comparison of investment-to-GDP ratios, or Shi & Huang (2014) for evidence of overinvestment in western Chinese provinces.

affected are ASEAN and Latin America, for which the cumulated GDP loss after five years are respectively 9.4 and 7.5 percent;[3] advanced economies would be less affected (-2.8 percent after five years). Consequently, the "growth gap" between emerging and advanced economies would be significantly reduced, from 6 percent in the years 2007-09 to less than 1 percent from 2017 onwards, leading to what could be called *partial recoupling*.

This paper contributes to the existing literature in the following ways. First, we provide a brief analysis of the Chinese growth model, highlighting the links between high growth and imbalances, the role of factor price distortions, and the recent rise in vulnerabilities. Second, while counterfactual analysis is not fundamentally different from conditional forecast, few papers so far have explicitly performed conditional forecast in a global VAR framework:[4] apart from a previous version of this paper (Gauvin & Rebillard 2013), we are only aware of IDB (2014), Gruss (2014), and Chudik et al. (2014). Third, while in GVAR models commodity prices are usually considered as endogenous to one particular country (generally, the United States), we add two "commodity blocks" to our GVAR specification in order to reflect the countries' consumption shares of each commodity (metals and oil); the use of such auxiliary models for commodities in GVAR frameworks has developed only recently, and in very few cases so far (Georgiadis 2015, Gauvin & Rebillard 2013, Gruss 2014). Finally, from an economic point of view, our results shed light on possible reasons behind the decoupling between emerging and advanced economies observed in the 2000s: to a large extent, it may have resulted from high and imbalanced growth in China, along with its effects on commodity markets (the so-called "commodity supercycle").[5] Given the unsustainable nature of Chinese growth, decoupling may be a temporary phenomenon rather than a "new normal".

The remainder of the paper is organized as follows. Section 2 presents China's growth prospects and the main arguments pointing to a hard landing scenario, before turning to some stylized facts and a literature review on the impact of China on commodity markets and exporters. Section 3 details the methodology and data used. Section 4 presents the simulation results in our hard landing scenario, highlighting the transmission channels, before discussing some of the caveats. Section 5 elaborates further on the economic implications that may be derived from our results. Section 6 concludes.

2 Motivations and literature review

2.1 China's growth prospects: towards a hard landing?

China has enjoyed high growth over the past thirty years. Until 2007, this success was mainly driven by exports and investment; however imbalances, both external (a large current account surplus) and internal (high investment-to-GDP ratio, low consumption-to-GDP ratio) also worsened at the same time. As argued

[3] Outside these two regions, Russia and Saudi Arabia would be particularly affected as well.

[4] Counterfactual analysis in a GVAR framework has been conducted notably by Pesaran et al. (2007) and Bussière et al. (2009).

[5] Keeping in mind that emerging economies are, on average, commodity exporters, as documented by Fernández et al. (2015).

by Huang & Wang (2010), Huang & Tao (2011), and Dorrucci et al. (2013), imbalances are an inherent feature of the Chinese growth model. In fact, high growth and imbalances appear to be deeply interrelated, and both growth and imbalances can be seen as – partly – deriving from three key factor price distortions, regarding the exchange rate, wages, and interest rates.[6]

First, an undervalued exchange rate has enabled China to reap considerable benefits from its accession to WTO from end-2001 onwards (Rodrik 2008, Goldstein & Lardy 2009). Strong price competitiveness has boosted manufactured exports and allowed China to strongly increase its global market shares. Exports dynamism also supported related investment in the manufacturing sector, while strong FDI inflows (again attracted by an undervalued exchange rate, as argued by Xing (2006)) facilitated technology transfers that helped boost domestic productivity (Yao & Wei, 2007). At the same time, the undervalued exchange rate weighted on household consumption by slowing their purchasing power gains.

Second, low wages have been another key factor to boost export price competitiveness. Along with the undervalued exchange rate, they have arguably been one of the reasons for China to become the "world's factory". Indeed, while still dynamic when compared to other countries, wages have progressively lost ground in relation to nominal GDP growth throughout the 2000s, revealing an increasingly unequal sharing of the value added. This has been a consequence of abundant rural labor supply and of the hukou system, which regulates internal migrations from rural to urban areas, but also of the lack (and poor enforcement) of workers' rights. Lower income growth in relation to nominal GDP growth (rather than rising households' savings), by constraining households' purchasing power gains, has been the main factor behind the decrease of the ratio between private consumption and GDP (Aziz & Cui, 2007).

Third, very low interest rates have helped support strong investment growth. Financial repression is indeed a key feature of the Chinese growth model (Johansson, 2012). One of its particular characteristics is the system of administered benchmark interest rates, the higher one being (until recently) a floor for lending rates, and the lower one being a ceiling for the remuneration of deposits (Feyzioglu et al., 2009). As such, it has been guaranteeing a net interest rate margin for banks. Since both benchmark rates were set at very low levels, households' interest earnings have been compressed (thus providing an additional explanation to the decrease in the private-consumption-to-GDP ratio; see Lardy 2008), while cheap funding was available for investment.

The 2008-09 *Great Recession* and its aftermath had significant implications for China's growth model. Except during a brief rebound immediately following the international crisis, exports were no longer able to support China's growth. On one hand, the prolonged sluggishness in advanced economies' activity hampered China's external demand. On the other hand, labor shortages (which could be explained by China reaching the

[6] At first sight, the assertion that high growth is a result of distortions may seem contrary to conventional wisdom: Hsieh & Klenow (2009) for example argue that capital in China is misallocated, and that a better allocation would significantly improve TFP. However this argument only holds to the extent that the total amount of capital available in the economy is predetermined/exogenous. If distortions can raise national savings, then the resulting capital accumulation could well more than offset the loss in TFP. Moreover, to the extent that distortions can enhance market share gains abroad, they also enable a faster reallocation of labor from agriculture to manufacturing, hence boosting TFP. For more details, including on how distortions can raise national savings, see Albert et al. (2015).

Lewis Turning Point), especially within the coastal areas, led to faster rises in wages; this, together with an appreciating yuan, implied some loss of price competitiveness.[7]

China thus had to rely more heavily on investment to maintain high growth rates, starting with a huge stimulus in 2009; while driving investment-to-GDP ratio to record highs (46.1 percent in 2012), this allowed China to maintain fairly high growth rates. This also had important consequences on China's imbalances: external imbalances (the current account surplus, which is the difference between national savings and investment) were sharply reduced, while at the same time internal imbalances worsened (Ahuja et al., 2012). As argued by Lemoine & Ünal (2012), these internal imbalances are reflected in the imbalanced geographical structure of China's external trade: the decrease in the Chinese trade surplus between 2007 and 2012 was mainly due to a sharp increase in the trade deficit vis-à-vis commodity exporters, the investment surge being itself highly commodity-intensive (see figure A.1).

Although the Chinese authorities seem committed to rebalancing the economy towards greater private consumption (especially after the reform package announced in the wake of the Third Plenum), they have not been successful so far (see figure A.2): while some progress was achieved in 2011, as investment slowed down, these progresses were reversed from 2012 onwards as the Government pushed up investment once again to prevent growth from slowing below the official 7.5 percent target. In fact, slowing investment progressively affected corporate profits and hence employees' wages, leading to a (delayed) slowdown in private consumption. According to Dorrucci et al. (2013), the persistence of internal imbalances can be attributed to the lack of a "critical mass" of reforms so far. Indeed, while some progress has been made to reduce some of the distortions mentioned earlier (exchange rate, wages), the fundamental characteristics of the historical Chinese growth model, especially financial repression, have so far remained in place.

This growth model now seems to have reached its limits, as shown by the continuous growth deceleration that China has been experiencing since the beginning of 2011. Albert et al. (2015) argue that this slowdown is a structural trend and may in fact intensify as rebalancing proceeds. This could lead to a Japanese-style "hard landing", i.e. a prolonged period of slow growth led by a sharp deceleration in investment, and a much smoother consumption slowdown, which would allow the Chinese economy to rebalance. Haltmaier (2013), Hoffman & Polk (2014) and Albert et al. (2015) provide such scenarios where growth slows around or below 5 percent by 2020. Pettis (2013) argues growth could slow to 3 percent per year, as rebalancing proceeds; similarly, Nabar & N'Diaye (2013) mention a downside scenario where growth slows to less than 4 percent per year.[8] More recently, Pritchett & Summers (2014) argued that mean-reversion is one of the most robust empirical features of economic growth, implying the possibility of a much sharper than expected growth slowdown in China. The

[7] It has been argued that as China progressively upgrades its exports, it may be now less sensitive to price competitiveness. Poncet & Starosta de Waldemar (2013) cast doubts on the extent of China's exports upgrading.

[8] According to the authors, "continuing with the current growth model reliant on factor accumulation and efficiency gains related to labor relocation (across sectors from the countryside into factories) could cause the convergence process to stall with the economy growing at no more than 4 percent". This scenario relies on the assumptions that reforms are delayed, and the economy fails to rebalance orderly; in that case, ultimately "the investment-to-GDP ratio corrects sharply downward (by about 10 percentage points)".

reasons why such a scenario may indeed occur are fourfold: historical rebalancing precedents; overinvestment; unsustainable debt trends; and a growing real estate bubble.

First, it should be noted that many countries in the past adopted a growth model similar to the Chinese one; looking at how these countries rebalanced can shed some light on China's growth prospects. RGE (2013) identified 47 episodes of rebalancing following investment-led growth: on average, growth in the five years following the investment peak was 3.5 percent lower than growth in the five years preceding the peak; additionally, internal imbalances are now much greater in China than in most of the countries of RGE's sample, which may imply a sharper correction for China.[9] Eichengreen et al. (2012) adopt a somewhat different perspective and look for some common characteristics among countries that experienced a sharp growth slowdown; they find that China shares many of these characteristics, such as a high investment-to-GDP ratio, an undervalued currency, and an ageing population.

Second, China's extremely high investment-to-GDP ratio naturally raises the question of overinvestment. Concerns are not new (Dollar & Wei, 2007), but have been exacerbated since the 2009 investment surge. In a recent paper based on cross-country comparisons, Lee et al. (2012) estimate that China may have overinvested between 12 and 20 percent of GDP from 2007 to 2011. Focusing on China, Lee et al. (2013) and Shi & Huang (2014) find some evidence of overinvestment in infrastructure in western provinces, as early as 2008, casting some doubt on the economic efficiency of the *Go West* policy. Finally, Standard & Poor's (2013) finds that, among a 32-country sample, China has the highest downside risk of an economic correction because of low investment productivity over recent years. This has led to rising excess capacity in a number of sectors: IMF (2012c) estimates that the capacity utilization rate dropped from almost 80 percent before the crisis, to around 60 percent in 2012.

Third, the investment surge has been financed by a sharp increase in overall debt, in contrast with the 2003-07 period where debt remained constant as a share of GDP (see figure A.3). In that sense, it can be argued that China switched from an investment- and export-led growth model before the crisis, to a credit-fuelled investment-led growth model after the crisis. Whereas most of the initial credit surge was due to bank lending, shadow banking progressively took the lead as a way to circumvent the authorities' tougher controls on bank lending. While the fast-growing shadow banking sector entails its own risks, as argued by Xiao (2012), what is most worrying is that current debt trends seem unsustainable. Drehmann et al. (2011) document the predictive power of the credit-to-GDP gap[10] as an early warning signal for financial crises; by this metrics, China is well into the danger zone (see figure A.4).

Fourth, the bursting of a real-estate bubble may well be the trigger of a hard landing, just as for Japan at the beginning of the 1990s. The Chinese context is indeed especially prone to the development of real-estate bubbles, as evidenced by Ahuja et al. (2010) and Wu et al. (2012): housing is the main alternative investment

[9]In RGE's sample, investment peaked at 36.1 percent of GDP on average, whereas China's investment-to-GDP ratio reached 46.1 percent in 2012.

[10]i.e., a significant upward deviation of credit-to-GDP from its historical trend.

vehicle for households in search of higher returns than the capped-rate deposits; and land sales are an important source of funds for local governments, since their spending needs cannot be met by their limited fiscal revenue and Central Government transfers.[11] Rising price-to-income ratios (see figure A.5, and Gaulard 2014) point to the existence of a bubble, at least in the largest coastal cities; price-to-rent ratios offer a similar picture. Above all, extremely high (and rapidly rising) cement production levels make the Chinese case look worse than any of the past known cases of real estate bubbles (see figure A.6).[12] China's development stage clearly cannot explain this pattern (see figure A.7); nor can urbanization, the pace of which has remained fairly stable in the past few years. Should China's real-estate bubble burst, it would have severe consequences on local public finances, real activity, and banking system (Ahuja et al., 2010).

2.2 China and commodity markets: stylized facts and literature review

China's investment-led growth has been highly commodity-intensive. China's demand for oil, while rising significantly over the period (+68 percent between 2003 and 2011), falls in fact far behind its demand for metals, especially copper (+157 percent) and iron ore (+213 percent); in 2011 China represented around 11 percent of global oil consumption, 41 percent of global copper consumption and 54 percent of global iron ore consumption (see figures A.8 to A.10). High investment levels and the urbanization process in China have indeed significantly boosted its demand for metals, as argued by Yu (2011).[13] On the contrary, oil demand may be more related to consumption (and the development of the automobile sector, figure A.13), since coal, rather than oil, is the main energy source in China (figure A.14).

China's rising demand has been pointed as one of the main drivers of the commodity price boom over the last decade. Previous research has mainly focused on the impact of China's (and India's) rapid growth on the global oil market (Hicks & Kilian, 2013). Some papers also studied their impact on other commodities' price: Francis (2007) documents the impact of China on oil and metals prices; Arbatli & Vasishtha (2012) attribute a significant part of metals' price increases (but a rather limited part of oil price increases) to growth surprises in emerging Asia. Farooki (2010) argues that the base metals price boom was driven by the Chinese demand for raw materials as inputs into infrastructure, construction and manufacturing (as well as to supply-side constraints in terms of capacity and expansion). Roache (2012) finds a significant effect of China's industrial activity on copper prices. Finally, Erten & Ocampo (2013) show that non-oil commodity (especially metals)

[11] Whereas local governments receive around 50 percent of total fiscal revenues in China, they are responsible for the quasi-totality of social spending and, especially since 2008, of the investment-based stimuli. They are theoretically not allowed to borrow, and have to rely on Local Government Financing Vehicles.

[12] According to the *International Cement Review*, China accounted for around 57 percent of cement's world production in 2010; there is little international trade in this sector (only 5 percent of world production is exported, and China was not even the first exporter in 2010). China's production is thus mainly used domestically.

[13] Admittedly, part of China's apparent consumption of metals could be attributed to its growing role as the "world factory", to the extent that metals can be used to produce goods that are exported to other parts of the world. However, data on end-use of global demand for copper (figure A.11) and steel (which is itself the main use of iron ore; figure A.12) show that construction and infrastructure building are a very significant part of metals' end-use at the global level; for steel, the construction share is probably even higher in China (50 percent in 2007, according to Sun et al. 2008; Yu 2011 gives a similar figure of 55 percent for construction and infrastructure) than at the global level (38 percent). Hence, a significant part of metals' demand is related to China's own internal demand, and is not intended to be reexported.

price super-cycles are essentially demand-determined; they attribute the on-going super-cycle primarily to China's industrialization and urbanization.

Given China's growing importance in the world economy, several recent papers have tried to assess potential spillovers from a shock originating in China. Using a GVAR model, Feldkircher & Korhonen (2012) find that a 1 percent positive shock to Chinese output translates into a 0.1 to 0.5 percent rise in output for most large economies. Samake & Yang (2011) use a mix of GVAR and SVAR models to investigate both direct (through FDI, trade, productivity, exchange rates) and indirect (through global commodity prices, demand, and interest rates) spillovers from BRICs to LICs. Similarly, Dabla-Norris et al. (2012) document the expanding economic linkages between LICs and "emerging market leaders" and find that the elasticity of growth to trading partners' growth is high for LICs in Asia, Latin America and the Caribbean, and Europe and Central Asia. Moreover, for commodity-exporting LICs in Sub-Saharan Africa and the Middle East, terms of trade shocks and demand from the "emerging market leaders" are the main channels of transmission of foreign shocks. Focusing on the consequences of China's WTO accession, Andersen et al. (2013) find that roughly one-tenth of the average annual post-accession growth in resource-rich countries was due to China's increased appetite for commodities. Using a GVAR model that takes into account trade linkages, financial variables and oil prices, Cashin et al. (2012) find that the MENA countries are more sensitive to developments in China than to shocks in the Euro Area or the United States. Finally, also using a GVAR model, Rebucci et al. (2012) show that the long-term impact of a China GDP shock on the typical Latin American economy has increased by three times since mid-1990s – although they do not find evidence that this may be due to the commodity price channel –.

However, few papers so far have explicitly focused on the negative spillovers of a growth slowdown in China. Ahuja & Nabar (2012) find that a one percentage point slowdown in investment in China is associated with a reduction of global growth of just under one-tenth of a percentage point (the impact being about five times larger than in 2002), with regional supply chain economies and commodity exporters with relatively less diversified economies being the most vulnerable. Their results do show a decrease in metal prices, although the commodity price channel is not explicitly taken into account when assessing the impact on commodity exporters. Using a two-region factor-augmented VAR model, Ahuja & Myrvoda (2012) find that a 1 percent decline in China's real estate investment would cause a 0.05 percent global output loss (with Japan, Korea, and Germany among the hardest hit) and a metal prices decline of 0.8 to 2.2 percent. Using a Bayesian VAR methodology, Erten (2012) finds that a permanent slowdown of Chinese growth to 6 percent would affect relatively more Latin American countries than emerging Asia.[14] Finally, IMF (2014a) use different methodologies to assess the global spillovers from slower growth in emerging economies; while they take into account a wide range of transmission channels – trade linkages, commodity prices, financial linkages, "neighborhood" effects –, each transmission

[14] More specifically, emerging Asia's growth would decelerate from 3.5 percent to 1.7 percent in two quarters, before rebounding to 2.9 percent at the forecast horizon; in contrast, Latin American economies would suffer a reduction in their growth rate from 2.8 percent to 2 percent in three quarters, but the deceleration would continue to about 1.3 percent at the end of the forecasting period. Erten attributes the stronger impact on Latin America to their reliance on primary commodity exports and less diversified productive structures.

channel is analyzed separately rather than in a unique integrated framework, thus possibly missing some of the interactions between these transmission channels.

Turning to individual countries, the IMF has in recent years regularly assessed the impact of a significant slowdown in China on commodity exporters. IMF (2011) estimates that a "tail risk scenario" where Chinese growth drops to 6 percent (due to problems in the real estate market, or financial market disturbances) for one year before rebounding, would cause real GDP in Australia to fall by about 1/4 to 3/4 percent relative to baseline;[15] IMF (2012a) warns that a hard landing in China may also trigger a fall in house prices in Australia. Turning to Chile, IMF (2012b) provides some evidence on its high dependency to commodity exports,[16] and estimates that a 10 percent decline in copper prices would reduce GDP by 0.8 percent over 8 quarters; the report also puts forward investment as a significant transmission channel, since "investment appears to be very sensitive to copper prices (while private consumption also tends to increase during copper price booms)". Similarly, IMF (2013c) shows the high and rising dependency of Peru to commodity exports (mining exports accounted for 60 percent of total exports, and 15.5 percent of GDP, in 2011)[17] and China (which has replaced the United States as Peru's largest export destination in 2011); the report states that "Peru's vulnerability to China is not only related to a possible slowdown but also to the impact of Chinese demand on global commodity prices as development patterns change". Finally, IMF (2013a) mentions the Chinese hard landing scenario as a significant downside risk for Colombia.

3 Methodology and data

3.1 General overview of the methodology

Global VAR (GVAR) models, first developed by Dees et al. (2007) and based on the work of Pesaran et al. (2004), are now widely used in the literature.[18] One of the value added of the GVAR methodology is to allow to study international linkages despite time sample limit. This is thus particularly relevant to assess global spillovers from a given country, in our case from China.

At the center of the GVAR modeling framework are individual VARX models (one for each country). The global VAR model is then obtained by combining all individual VARX models. More precisely, the country i's VARX model can be written as follows:

[15] More precisely, slower growth in China would trigger a persistent fall in global commodity prices by about 13 percent; government revenue would fall due to lower commodity-related tax revenues and lower economic activity; the nominal trade balance would worsen by about 1.5 percent of GDP. However a depreciation of the Australian dollar and cuts in the policy interest rate would help buffer the shock.

[16] Specifically, the report states that "Chile is one of the most commodity dependent economies among emerging markets: [...] commodities represent almost 70 percent of total exports, with a very high concentration in metals (mainly copper); [...] commodity-related fiscal revenues are also significant, accounting for 17 percent of total revenues (3.5 percent of GDP) in 2012".

[17] However, the IMF also notes that the export structure may have helped to reduce vulnerabilities: copper (23 percent of total exports) and gold (22 percent of total exports) represent the major part (80 percent) of mineral exports; the fact that gold prices show little correlation with other metal prices (due to the status of gold as a "safe haven asset" in crisis times) may have helped to buffer negative terms of trade shocks.

[18] We estimated the model with the GVAR toolbox (available on CFAP's website: http://www-cfap.jbs.cam.ac.uk/research/gvartoolbox/index.html) and used our own code to construct conditional forecast.

$$x_{it} = a_{i0} + a_{i1}t + \sum_{j=1}^{p} \Phi_{ij} x_{i,t-j} + \sum_{k=0}^{q} \Gamma_{ik} x^*_{i,t-k} + u_{it}$$

where x_{it} is the vector of country i specific variables and x^*_{it} the vector of foreign variables for the country i; x^*_{it} is a weighted average of all other countries' specific variables. The GVAR toolbox allows to choose the number of lags (p and q) with some information criteria (we choose SBC) and also allows to test for unit roots, co-integration relationships and weak exogeneity. The whole GVAR model can be rewritten as:

$$x_t = b_0 + b_1 t + \sum_{i=1}^{l} F_i x_{t-i} + v_t \tag{1}$$

where $x_t = [x_{1t}; x_{2t}...; x_{nt}]$ and F_i are based on Φ_i and Γ_i (hence on weights).[19] The companion form of the GVAR model is as follow:

$$X_t = F X_{t-1} + D_t + V_t \tag{2}$$

If for example $l = 3$, equation (2) is of the form:

$$\begin{pmatrix} x_t \\ x_{t-1} \\ x_{t-2} \end{pmatrix} = \begin{pmatrix} F_1 & F_2 & F_3 \\ I_k & 0 & 0 \\ 0 & I_k & 0 \end{pmatrix} \begin{pmatrix} x_{t-1} \\ x_{t-2} \\ x_{t-3} \end{pmatrix} + \begin{pmatrix} b_0 + b_1 t \\ 0 \\ 0 \end{pmatrix} + \begin{pmatrix} v_t \\ 0 \\ 0 \end{pmatrix}$$

Conditional and unconditional forecasts: In order to study the potential impact of a hard landing in China, we use conditional forecast methodology (so that we can constrain some Chinese variables over the forecast period); this is conceptually similar to counterfactual analysis, as in Pesaran et al. (2007) or Dubois et al. (2009). It can be shown that the mean μ_h and variance-covariance Ω_{hh} matrix of the forecast of x_t for horizon h (x_{t+h}) can be written as:[20]

$$\mu_h = E_1 F^h X_T + \sum_{s=0}^{h-1} E_1 F^s D_{T+h-s}$$

and:

$$\Omega_{hh} = E_1 \sum_{s=0}^{h-1} F^s \tilde{\Sigma} F'^s E_1'$$

where $E_1 = (I_k 0_{k\times k} 0_{k\times k})$, T is the time sample size and

$$\tilde{\Sigma} = \begin{pmatrix} \Sigma & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$ if for example $l = 3$,

with Σ being the variance-covariance of the residuals of the GVAR model.

[19] l is the maximum of lags (l=$max(p, q)$).

[20] See Pesaran et al. (2007) for details.

As shown by Pesaran et al. (2007), under the assumption of normality of x_{t+h} and for a given matrix of constraints Ψ corresponding to the set of conditions for the conditional forecast, the mean μ_h^* of the conditional forecast can be written as follows:[21]

$$\mu_h^* = \mu_h + (s'_{h\bar{H}} \otimes I_k)\tilde{\Omega}(I_{\bar{H}} \otimes \Psi')[(I_{\bar{H}} \otimes \Psi)\tilde{\Omega}(I_{\bar{H}}(I_{\bar{H}} \otimes \Psi')]^{-1}\tilde{g}_{\bar{H}}$$

where $s_{h\bar{H}}$ is the $\bar{H} \times 1$ selection vector with unity as its h^{th} element and zeros elsewhere, and $\tilde{\Omega}_{\bar{H}}$ is the $k\bar{H} \times k\bar{H}$ matrix:

$$\tilde{\Omega}_{\bar{H}} = \begin{pmatrix} \Omega_{11} & \Omega_{12} & \cdots & \Omega_{1\bar{H}} \\ \Omega_{21} & \Omega_{22} & \cdots & \Omega_{2\bar{H}} \\ \vdots & \vdots & \ddots & \vdots \\ \Omega_{\bar{H}1} & \Omega_{\bar{H}2} & \cdots & \Omega_{\bar{H}\bar{H}} \end{pmatrix}$$

where:

$$\Omega_{ij} = \begin{cases} E_1 \left(\sum_{s=0}^{i-1} F^s \tilde{\Sigma} F'^s\right) F'^{(j-i)} E_1' & \text{if } i < j \\ E_1 F'^{(i-j)} \left(\sum_{s=0}^{i-1} F^s \tilde{\Sigma} F'^s\right) E_1' & \text{if } i > j \end{cases}$$

and $\{\Omega_{ii}\}_{i=1}^{\bar{H}}$ are given above. Finally, Ψ is a matrix of c constraints defined such that $\Psi x_{T+h} = d_{T+h}$ where d_{T+h} is a $c \times 1$ vector of constants which give the constraints for the conditional forecast.

Bootstrap of forecasts: In order to take into account parameter uncertainty, we use bootstrap techniques to generate R simulated within-sample values of x_t.[22] For each of the R simulations, we choose $v_t^{(r)}$ drawn with a nonparametric method and we construct $x_t^{(r)}$ with the estimated parameters of equation (1):

$$x_t^{(r)} = b_0 + b_1 t + \sum_{i=1}^{l} F_i x_{t-i} + v_t^{(r)}$$

This allows us to estimate $F_i^{(r)}$ and then apply unconditional and conditional forecast methodology described above in order to obtain $\mu_h^{(r)}$ and $\mu_h^{(r)*}$. Hence, based on our R simulations it is straightforward to calculate median and other quantiles of conditional and unconditional forecasts.

3.2 Data and modeling choices

Our sample, presented in table B.1, includes 36 countries representing around 88 percent of the world economy (at market prices): 20 of these countries are advanced economies (95 percent of the advanced world), and the remaining 16 are emerging economies (76 percent of the emerging and developing world). Within our sample,

[21] It is also possible to calculate the variance-covariance matrix of conditional forecast but we do not need it here. See Pesaran et al. (2007, p. 65) for details.

[22] Our methodology is inspired by the bootstrap methodology used in the GVAR toolbox for GIRF and GFEVD and by Greenwood-Nimmo et al. (2012). We ran 1000 replications.

12 countries are net mineral commodity (i.e. metals and energy) exporters: Saudi Arabia, Norway, Russia, Canada, Malaysia, Indonesia and Mexico export energy, while Chile, Peru, Australia, South Africa and Brazil export metals (see figure A.17 for an overview of net commodity exports by country, and tables B.3 and B.4 for detailed data of net exports of iron ore, copper, aluminium, lead, zinc, coal, crude oil, natural gas).[23] [24]

We use quarterly data from 1995 Q1 to 2014 Q3. For all countries, we include the following variables: real GDP, inflation, real investment, real exports and the real effective exchange rate.[25] While the inclusion of real GDP and inflation is standard in the GVAR literature, our choice of including additional variables is motivated by our focus on commodity exporters, and the ways a Chinese hard landing would impact them. In particular, we try to identify three possible transmission channels to commodity exporters: through commodity prices, through export volumes, and through investment (since lower commodity prices should reduce the incentives to invest in the mining sector). Including investment also has an additional advantage: it enables us to constrain scenarios where Chinese GDP growth and investment growth follow different paths, thus to simulate a rebalancing of the Chinese economy. Finally, including the real effective exchange rate provides some insight on its effectiveness at cushioning large terms-of-trade shocks.

Table B.8 summarizes which variables are endogenous and/or exogenous for each country; in particular, all countries are impacted by foreign GDP, foreign investment and foreign inflation. For a given country i, foreign variables are weighted averages of other countries' variables; we define the weight of each other country j as the share of exports from country i to country j, in country i's total exports (as is common in the GVAR literature).

Turning to commodities, while most papers relying on a GVAR methodology only incorporate oil prices, Cashin et al. (2012) add an oil production variable to their GCC model, in order to account for supply-side factors in the oil market; in addition, Dées et al. (2008) show that incorporating data on OPEC spare capacity significantly improves oil price forecasts; we thus include data on global oil production and OPEC spare capacity, in addition to oil prices. Similarly, Frankel & Rose (2010) give some evidence of the role played by inventories in determining mineral commodity prices; we also use data on metals production and inventories in addition to the Metal Price Index (MPI).[26] Importantly, instead of linking global variables to a specific country or region (generally the United States), as in usual GVAR modeling,[27] we create two "commodity blocks" (one for each commodity,

[23]Our sample also includes two major net food exporters, New Zealand and Argentina. However, we do not focus particularly on food prices in this paper, since we expect a Chinese hard landing to only have a moderate impact on these prices: indeed in our scenario, the hard landing is driven by an investment slowdown while consumption (and hence food prices) would be more resilient. Supporting our choice, IMF (2014a) finds a larger effect from an emerging markets growth shock, on energy and metals prices than on food prices.

[24]World Development Indicators present Hong Kong as a major commodity exporter, which we believe highly implausible and related to incomplete bilateral trade data with China.

[25]Data sources are available in table B.2.

[26]However, due to lack of access to a complete dataset, we use copper production and inventories as proxies for the whole metal market. Iron ore and copper being the two most important metals in terms of global trade flows, we thus implicitly assume that iron ore production and inventories behave in the same way as for copper. This assumption seems rather legitimate since (i) China consumes about half the world production of both metals (see subsection 2.2); and (ii) both metals' end-use may be to a large extent linked to the construction sector (steel for reinforced concrete, copper for electrical wire).

[27]Cashin et al. (2012), for example, link the oil price to the United States, and oil production to the Gulf Cooperation Council region.

namely "metal block" and "oil block"); these "blocks" are treated in the GVAR model just as usual countries, differing only by their specific variables (the respective price, production and surplus/inventory variables of metals and oil). The use of such auxiliary models for commodities in GVAR frameworks has developed only recently, and in very few cases so far: Georgiadis (2015) includes an oil block in a GVAR model to analyze the monetary policy transmission in the euro area; Gauvin & Rebillard (2013) use two "commodity blocks", each comprising a single price variable; finally, Gruss (2014) relies on three auxiliary models to group Net Commodity Price Indexes according to similarities in the commodity mix among countries. In the present paper, having separate "commodity blocks" allows us to use more adequate weights for those blocks' foreign variables, than those implied by the United States trade pattern: instead, we define the blocks' weights as countries' shares in the global demand for the corresponding commodity.[28] Commodity blocks are impacted by foreign GDP and foreign investment. Conversely, commodity prices are allowed to impact all countries, regardless of their status as net exporters or importers; we thus take into account all spillovers from a fall in commodity prices, whether negative (for commodity exporters) or possibly positive (for net importers).[29]

Our sample period, from 1995 Q1 to 2014 Q3, encompasses several episodes of crises. During such episodes, our individual VARX models are likely to perform poorly, because the drop in domestic GDP and investment can hardly be explained by our foreign variables (this is especially the case for balance-of-payment crises); large residuals would then translate into large confidence intervals, due to our bootstrapping methodology. To avoid this, we follow Bussière et al. (2009) and include dummy variables to the relevant VARX models to account for crises and other "exceptional" events.[30]

Further details regarding the Global VAR specification are available in appendices B.2 and A.2. Table B.9 presents the number of lags and cointegration vectors for countries and commodity blocks. Tables B.10 and B.11 show results from stability tests, table B.12 presents those from unit root tests, and table B.13 lists adjusted R-squared statistics for all single equations in the Global VAR model. Finally, persistence profiles can be found in figure A.19.

4 Results and discussion

4.1 Simulation scenarios

Based on the methodology described above, we now assess the impact of a hard landing scenario, compared to the baseline soft landing scenario. Both scenarios are simulated using conditional forecast, by constraining

[28] Weights for the "metal block" are calculated with copper and iron ore consumption (see tables B.5 and B.7); weights for the "oil block" are calculated with regional oil demand for oil (see table B.6) which is then split between countries according to their weights in the region's GDP.

[29] However, positive spillovers are likely to be limited: Erten & Ocampo (2013) find that global GDP impacts non-oil commodity prices, but do not find any reverse causality. As for oil, a fall in oil prices led by a negative demand shock would probably have a positive impact on oil importers, but the effect may be small; see ECB (2010, table 4, page 49).

[30] More precisely, we add "crisis dummies" for: Indonesia, Korea, Malaysia, Philippines, Thailand (1997-1998), Russia (1998), Brazil (1999 devaluation), Turkey (2001), Argentina (2001-2002), all countries and "commodity blocks" (Global Financial Crisis), Thailand (2011 floods), Japan (Fukushima accident in 2013), euro area countries (2010-...).

Chinese GDP and investment to follow a predefined path.[31]

The baseline "soft landing" scenario assumes that GDP growth will slow very progressively, from 7.4 percent in 2014 to 6.4 percent by end-2019; this is broadly consistent with the latest consensus forecast. Investment growth would slow down somewhat more, to 5 percent by end-2019. Such a scenario implicitly assumes that consumption would remain dynamic, growing at around 7.5 to 8 percent a year, implying a moderate rebalancing away from investment and towards consumption: the investment-to-GDP ratio would fall from 46 percent in 2013, to around 44 percent in 2019. Indeed proponents of the "soft landing" scenario argue that rebalancing, while necessary, should occur only progressively and over a long time period.[32]

In our hard landing scenario, we assume Chinese GDP growth to drop from 2015 Q1 onwards:[33] growth slows progressively, although rather sharply, over a two-year transition period before stabilizing at 3 percent a year over the remainder of the forecast horizon. This growth slowdown is driven by a sharp deceleration in investment, which is assumed to converge over the same two-year transition period towards a new steady-state of much weaker investment growth (1 percent per year over the remainder of the forecast horizon). This scenario again implicitly assumes that consumption would hold up better, growing at close to 5 percent after the transition period; as a result, the investment-to-GDP ratio would fall from 46 percent in 2013, to around 42 percent in 2019. In that sense, it can be viewed as a "forced but, to some extent, controlled rebalancing" scenario. Indeed, the two-year transition period is a way to take into account the buffers that China can mobilize to smooth the deceleration in investment: "augmented" public debt, at 54 percent of GDP, is still low and enables China to compensate, at least partially, for a fall in housing investment through public infrastructure stimulus (IMF 2014b); a full-blown crisis (such as balance-of-payment crises experienced in other countries following investment booms) is unlikely given China's current account surplus, capital controls and large foreign exchange reserves. However, the need to clean up banks' balance sheets would durably constrain their ability to lend and, thus, investment. Our scenario is in many ways similar to what occurred in Japan at the beginning of the 1990s (see Fracasso (2015) for a detailed assessment of the similarities between China and Japan).

4.2 Simulation results by regions and countries

Our results are illustrated in figures A.20 to A.27, and tables B.14 and B.15. Looking first at regions, the most severely affected would be ASEAN (with a cumulated GDP loss of 9.4 percent over five years), due to strong trade linkages with China, followed by Latin America (cumulated GDP loss of 7.5 percent) in line with the region's reliance on commodity exports; while not constituting a region in itself, the "other emerging

[31]The unconditional forecast tends to replicate past patterns; in particular, it would imply that Chinese growth returns to its past 10 percent average, which is now widely considered as very unlikely. See Gauvin & Rebillard (2013) for simulations based on unconditional forecasts.

[32]World Bank (2013) has an even more optimistic rebalancing scenario, assuming that major reforms are implemented and no major shock occurs; in this scenario, GDP growth remains strong at 7 percent a year on average between 2016 and 2020, while the investment-to-GDP ratio falls to 38 percent by 2020.

[33]The chosen starting date (2015 Q1) is only illustrative and should not be considered as a forecast.

economies" which include large commodity exporters such as Russia and Saudi Arabia (and, to a lesser extent, South Africa) would be even more impacted (cumulated GDP loss of 9.9 percent). On the contrary, advanced economies would be less affected. This is consistent with what would be expected: advanced economies are mostly net commodity importers and thus likely to benefit from lower commodity prices; moreover, emerging economies still represent a rather low (although growing) share of advanced economies' export destinations, which should imply a higher resilience from a Chinese hard landing. Among advanced economies, Asian countries would be more impacted (cumulated GDP loss of 5.8 percent) than the euro area (4.3 percent) and other advanced economies, notably the United States. Overall, global activity would be 6.7 percent lower in a hard landing scenario than in a soft landing, five years after the shock.

In Southeast Asia, Singapore, Malaysia and Thailand would be the hardest hit, due to highly open economies and strong integration into global value chains, including with China. With less open economies, Indonesia and the Philippines would be somewhat more resilient, although Indonesia (as a net commodity exporter) would also be hurt by lower commodity prices (the same is true for Malaysia). *In the rest of Asia*, Hong Kong ranks highest, for obvious reasons; Japan lies in an intermediate position, with a significant share of its exports (18%) directed to China, but a less open economy than other Asian countries. India would be more resilient: the country has weaker trade linkages with China, and is likely to benefit significantly from lower commodity prices; however, India would also be to some extent vulnerable to a fall in exports to ASEAN and GCC countries, and to lower remittances from GCC countries. Finally, we find a surprisingly low impact on Korea (cumulated GDP loss of 3.1 percent); this may seem counter-intuitive at first sight, given Korea's geographical proximity and hence strong trade links with China: in 2013, China represented 26% of Korean exports (see figure A.18). However, while Korean exports are indeed hardly hit (see table B.14), Korea is also one of the countries most dependent on commodity imports in our sample, and hence would benefit significantly from lower commodity prices (see figure A.17).[34]

Among Latin American countries, Mexico would be the most resilient: its dependence on net oil exports is rather limited (see figure A.17), and the country would benefit from strong trade linkages with the United States, itself little affected. The impact would be stronger on Chile, Peru and Brazil. Among the three countries, Chile is the most dependent on net commodity exports (especially copper) but would suffer a slightly lower GDP loss than Peru and Brazil; this may be attributed to a strong policy framework, in particular a highly flexible exchange rate, which would cushion the external shock through a significant depreciation (see figure A.25). In Peru however, a still partially dollarized economy would deter the authorities from letting the exchange rate fully accommodate the shock. Finally, the impact we find for Brazil is rather strong, especially when assessed against its relatively low ratio of net mineral commodity exports to GDP; part of this sizable effect is clearly related to our results for Argentina. Indeed, we find Argentina to be the most severely hit country in our sample. This is at first sight surprizing, as Argentina exports mainly food, whose prices are not expected to

[34] Estimations realized in an earlier version of this paper (Gauvin & Rebillard 2013) showed a stronger impact on Korea, but did not take into account the impact of lower commodity prices.

be significantly affected by a Chinese hard landing (our scenario implicitly assumes resilient consumption in China; see subsection 4.1). First, it should be noted that confidence intervals are extremely large, implying that this result should be taken with caution. That said, other studies report large effects of external shocks on Argentina: World Bank (2015) finds Argentina and Peru to be the most affected Latin American countries following a 1 percent decline in China's growth; similarly, Gruss (2014) finds that Argentina would be among the hardest hit in Latin America (along with Trinidad & Tobago and Venezuela) in the event of less favorable commodity price developments. From an economic point of view, these results can be tentatively explained by the limited flexibility of the exchange rate – which would not fully accommodate the external shock – and by limited access to international capital markets, in the context of a longstanding dispute with holdout creditors.[35]

Regarding other emerging economies, Russia and Saudi Arabia would be among the hardest hit countries in our sample; this is consistent with intuition given their high dependency on oil (and gas) exports. Although they would benefit, as net importers, from lower commodity prices, Poland and Turkey would be significantly affected as well, mainly through indirect spillovers from Russia and Saudi Arabia: among all the countries in our sample, Poland and Turkey are indeed (along with Finland, see below) those with the highest share of exports destined to Russia; and Turkey is (along with India) the country with highest export exposure to Saudi Arabia. Finally, the impact on South Africa would be more benign: while the country is an important metal exporter, it would benefit from lower oil prices; in addition, South Africa's reliance on gold exports may to some extent cushion the negative impact from lower iron ore prices, as gold prices may benefit from higher risk aversion and flight to quality; finally, the rand's flexibility would also help accommodate the shock.

Within the euro area, all countries are net commodity importers, and thus likely to – moderately – benefit from lower prices; the overall impact will depend on each country's particular trade linkages. In this respect, we find Finland to be the most vulnerable – and in fact one of the most severely hit countries in the whole sample – due to strong trade linkages with neighboring Russia: Finland is indeed the country with highest export exposure to Russia in our sample. In addition, being part of the euro area significantly constrains the policy response (whether on the monetary or exchange rate side) to accommodate the shock. This result is consistent with those from Vitek (2013), who finds Finland to be much more affected than other Nordic countries by a slowdown in emerging economies. Netherlands (due to its role as a trade hub) and Germany (due to stronger trade linkages with Russia, Poland and Turkey, and higher reliance on capital goods exports) would also be more affected than other countries within the euro area, notably Belgium and France. We do not find any significant impact on Spain; this may be linked to the predominant role of domestic demand (especially the real estate boom and bust) as a driver of growth over our estimation period.

[35] The lack of access to international capital markets would constrain Argentina's ability to finance a large current account deficit. Therefore, a fall in exports (due to lower soybean prices and subdued economic activity in key tading partners) would have to be matched by a similar fall in imports, possibly through restrictive measures (Argentina indeed reinforced administrative controls on imports at the end of 2014, when pressures on foreign exchange reserves intensified). Such restrictive measures would in turn constrain the supply of production inputs and further weight on domestic activity.

Among other advanced economies, Sweden would be more affected (due to spillovers from trade linkages with Finland), followed by Switzerland (whose main trading partner is Germany). For all other countries, we find slightly negative but non statistically significant effects. In the United Kingdom and, most importantly, the United States, the positive effect from lower commodity prices would to a large extent compensate for negative (but moderate) spillovers through trade channels. The role of domestic consumption as a driver of growth in the United States, and the role of finance and housing in the United Kingdom, help explain their resilience to external shocks. What is more surprizing is the non significant impact we find on advanced commodity exporters such as Canada, Norway and Australia. All three countries have highly flexible exchange rates, whose depreciation may help cushion the shock. In addition, Canada would clearly benefit from the United States' resilience; Norway is also widely considered as a model of prudent management of oil revenues through a sovereign wealth fund. Nonetheless, these results should be taken with caution. This is especially the case for Australia, which is an important exporter of iron ore and coal (see figure A.17 and table B.3), and is highly reliant on direct trade linkages with China (see figure A.18); a high exchange rate flexibility may help explain this low effect.[36] Finally, the insignificant effect we find for New Zealand is linked to our results for Australia.

4.3 Transmission channels

As in standard GVAR models, the main transmission channel from a Chinese hard landing to the rest of the world relies on trade linkages. This includes direct spillovers, due to countries' exposure through exports to China (figure A.18), but also indirect spillovers through exposure to countries themselves severely hit. Our results tend to indicate that, in some cases, these "neighborhood" effects – as labelled by IMF (2014a) – may be large, especially for Finland and, to a lesser extent, for Poland, Turkey and India. In a region where virtually all countries are net commodity exporters, such as Latin America, neighborhood effects may also compound the negative impact from lower commodity prices and direct trade linkages to China (as our results illustrate in the case of Argentina and Brazil). Conversely, neighborhood effects may act as a buffer for some countries, such as Mexico and Canada, given the United States' resilience to external shocks.

Beyond traditional direct and indirect trade linkages, our modelization choices enable us to look at the different transmission channels to commodity exporters – commodity prices, exports volumes and investment – as well as the exchange rate behavior as a possible shock absorber. *First*, regarding commodity prices, figure A.24 shows that metal prices would be more affected than oil prices, as expected: metal prices would fall by -66% after five years in the hard landing scenario, against -12% in the baseline soft landing scenario; for oil prices, we find a -41% fall (hard landing) versus a modest +13% rise (soft landing). These results echo those from RGE (2012b), who finds a sharper impact of a Chinese hard landing (see the "crash and burn" scenario) on

[36] Previous estimations show a significantly larger impact on Australia (Gauvin & Rebillard 2013). However, the impact significantly decreased after we introduced ASEAN countries within the sample. ASEAN countries have a high variability of GDP growth over time, not least due to the Asian crisis (although we attempt to account for that through dummies; see subsection 3.2); they also are important trade partners for Australia. Thus, introducing ASEAN countries increased the variability of Australia's foreign variables, and consequently reduced the elasticity of Australian growth to foreign variables. It should be noted that growth in Australia shows little variability (and no recession) over the estimation period.

copper and iron ore demand, than on oil demand. This is in line with commodities' different end-use patterns (mostly investment for metals, and consumption for oil) in the context of a rebalancing process (investment slowing much more than consumption), and also reflecting a much higher share of China in metals' global consumption compared to oil (see subsection 2.2). Moreover, RGE (2012a) find a strong impact of a hard landing on copper prices (-80 percent after four years), which is quite in line with our own results for metal prices (-66% after five years), especially given that metal prices have already significantly declined over the past few years. Nonetheless, the fall in oil prices in our hard landing scenario is also quite significant: despite lower consumption from China (when compared to metals), oil prices seem more sensitive to demand shocks than metal prices.[37] Finally, other variables within the "oil block" behave as expected: in a hard landing scenario, oil production would adjust downwards, although at a slow pace. This is consistent with anecdotal evidence: producers are reluctant to cut production of operating wells, even in situations of excess supply / insufficient demand; instead, the reduction in production would come after a lag, following cuts in related investment. As a consequence, OPEC spare capacity would rise. Within the "metal block", production would also adjust downward progressively but, contrary to what would be expected, inventories would also fall. It should be noted that, given the lack of access to a complete dataset, we used copper inventories as a proxy for metal inventories; this proxy may not be the best suited.

Second, it appears that export volumes would *not* be a major transmission channel for commodity exporters. Indeed, figure A.26 shows rather moderate cumulated export losses for Latin America and for "other emerging economies" (an aggregate of five countries, including Russia, Saudi Arabia and South Africa). In contrast, Asia stands by far as the region most severely hit through this channel, as we would expected given strong regional trade integration. Among commodity exporters, cumulated export losses would be higher for Indonesia, Malaysia (in line with their integration into global supply chains), South Africa, and to a lesser extent Saudi Arabia and Chile; export losses are not statistically significant (but remain negative) for other commodity exporters. In the case of Peru, this result is in line with Han (2014), who finds that spillovers from China derive mainly from indirect income effects through Peru's terms-of-trade, rather than from direct trade linkages and real exports.

Third, on the contrary, our results indicate that investment would be a major transmission channel to commodity exporters. Figure A.27 shows that Latin America and "other emerging economies" would be among the regions most severely hit through this channel, along with ASEAN. At a country level, cumulated investment losses would be highest for Malaysia, Russia, Saudi Arabia, Brazil, Indonesia (although not statistically significant), Peru and Chile; the impact would be more moderate for Norway and South Africa, and not significant (although still negative) in other commodity exporters. These results are consistent with those from Magud & Sosa (2015), who find that lower commodity prices have been the largest contributor to the recent slowdown in private investment in Latin America and in the Commonwealth of Independent States: indeed, lower

[37] This can be seen in figures A.8 and A.10: in spite of a much larger drop in iron ore consumption than in oil consumption during the Global Financial Crisis, oil prices actually dropped by more than metal prices.

commodity prices reduce incentives to invest in the mining and oil sectors. Spillovers from lower commodity prices may also spread beyond the extractive sector, to investment in the rest of the economy, through effects on income, the current account and fiscal balances (Cardoso 1993): in the case of public investment, lower commodity-related fiscal revenues may have to be matched through cuts in public infrastructure spending.

Finally, the real effective exchange rate may act as a buffer to accommodate the sharp negative terms-of-trade shock, in countries with a flexible exchange rate regime. Within our sample of commodity exporters, this is clearly the case for Brazil, Indonesia, Russia, Canada, Australia, South Africa, Malaysia and Chile (see figure A.25 and table B.14). While flexible, Norway and Mexico's currencies would depreciate more moderately. In contrast, Saudi Arabia and Peru would see their real effective exchange rate *appreciate* in the hard landing scenario (in comparison to the baseline soft landing). Indeed, the US dollar would appreciate by around 16% in real effective terms after five years, due to capital inflows towards "safe havens" following a rise in risk aversion; due to its peg to the US dollar, the Saudi riyal would follow. As for Peru, the still high level of dollarization in the country would limit the authorities' willingness to let the exchange rate depreciate too much against the dollar (Han 2014), resulting in a moderate 7% appreciation in real effective terms after five years.

4.4 Discussion

Results are more robust than in Gauvin & Rebillard (2013), as evidenced by significantly smaller confidence intervals. This is due to the introduction of dummies to take into account crises episodes, as detailed in subsection 3.2. Indeed, during balance-of-payment crises, individual VARX models are likely to perform poorly because the drop in domestic GDP and investment is not related to similar evolution in foreign variables; introducing "crisis dummies" thus lowers residuals and (through the bootstrapping methodology) leads to smaller confidence intervals.[38] Nonetheless, our results on individual countries should be taken with some caution, and rather as rough orders of magnitude than precise estimates. The numerous simulations we ran (based on different specifications of the GVAR model) show that estimates of the impact from a Chinese hard landing on individual countries may differ at times in a non-negligible way; rankings of the most affected countries (figure A.22) may also marginally change. In adition, as noted above, our results may underestimate the impact of a Chinese hard landing on some countries (Australia, and perhaps Korea); conversely, the impact on Argentina may be overestimated. However, *at the regional level*, our results appear fairly robust: in nearly all the simulations we ran, ASEAN, Latin America and "other emerging economies" were far more affected than the euro area and other advanced (ex. Asia) economies.

Our results are broadly consistent with those from Erten (2012), who finds a somewhat larger impact from a Chinese hard landing on Latin America than on Emerging Asia (ex. China). However, we find a smaller difference between the respective impacts on those regions. This can be explained by different country samples

[38] Adding countries such as Argentina, ASEAN countries, and Turkey in our sample made "crisis dummies" all the more necessary; without these dummies, confidence intervals were even larger than in our previous estimations (Gauvin & Rebillard 2013).

and a different definition of the baseline scenario: our soft landing already assumes some rebalancing away from investment, which would be negative for Latin American mineral commodity exporters. Our results are also to a large extent consistent with IMF (2013d), who find that among commodity exporters, Mongolia (not in our sample), Saudi Arabia and Chile would be severely affected by a Chinese slowdown; the impact on Brazil and South Africa would be more moderate, while Canada and Mexico would barely feel any effect. There are however a few discrepancies, regarding Australia – one of the most affected countries in IMF (2013d), as we would expect – but also, less intuitively, Russia and Peru – for which IMF (2013d) find surprisingly low effects –. Ahuja & Nabar (2012) also report results broadly in line with ours, as they find economies within the Asian regional supply chain among the hardest hit, while some commodity exporters such as Chile and Saudi Arabia would also be significantly affected. However, they do not take into account indirect trade linkages and the commodity price channel, and report other sets of results in which, surprisingly, they find Germany to be the most vulnerable among G20 economies. Similarly, Ahuja & Myrvoda (2012) find Japan, Korea, and Germany to be among the hardest hit by a Chinese real estate slowdown; while they document a significant effect on metal prices of a real estate downturn in China, the commodity price channel is not taken into account to derive estimates of growth impacts. Finally, our results differ significantly from IMF (2014a), who find that a shock on Chinese growth would affect other emerging economies less than advanced economies, *through trade linkages*. The use of different trade weights may be one of the reasons for diverging results: they use export plus import value-added weights, thus significantly increasing the importance of China – who exports massively to advanced economies – as a determinant of advanced economies' output fluctuations. This choice is however questionable: there is little reason to expect significant spillovers through Chinese *exports* from lower domestic activity in China, unless social unrest hampers the ability for China to produce export products; spillovers are much more likely to materialize through lower Chinese *imports* only. In addition, while IMF (2014a) also assess spillovers from China (or large emerging economies) through the commodity price channel, financial linkages, and neighborhood effects, each exercise is performed separately; in contrast, our methodology allows us to assess the *joint* impact from a Chinese hard landing through three of the four channels considered in IMF (2014a): trade linkages, commodity price channels, and neighborhood effects.

There are some limits to our work, and hence scope for further research. *First*, our methodology does not incorporate financial contagion, and we are not aware of any work assessing the *joint* impact from a Chinese slowdown through all channels – direct trade linkages, neighborhood effects, commodity price channels, and financial linkages –. A hard landing in China may negatively affect confidence elsewhere in the world, hampering investment; and the resulting rise in risk aversion may trigger significant capital outflows from emerging economies towards safe havens (as has been the case at the end of 2008). An interesting issue for further research would be to see how spillovers from a hard landing in China may interact with the coming increase in interest rates by the Fed: the fall in commodity prices would cause commodity exporters' current account deficits to widen, while lower FDI towards extractive/oil industries would make the financing of current account deficits more reliant on portfolio or banking flows; in this context, an increase in US interest rates may exacerbate vulnerabilities by triggering portfolio outflows, as the 2013 *Taper Tantrum* showed for India, South Africa, Indonesia, Brazil and Turkey.[39]

Turning to commodity prices, our modelization is significantly improved compared to Gauvin & Rebillard (2013): introducing production and inventories allows us to better account for market dynamics. In particular, when facing an unexpected negative demand shock, production usually takes time to adjust, leading to a rapid accumulation of inventories and a sharp drop in price; we indeed find stronger impacts on commodity prices than in our previous work. However, our methodology still entails some caveats. *First*, one reason we may *overestimate* the impact on metal prices is that not all Chinese metal consumption is linked to domestic investment; some of it is related to manufacturing and goods exports.[40] However, as evidenced by figures A.11 and A.12, the extent of possible overestimation due to this specific factor may not be very large. *Second*, since our model is mostly linear, the decrease in commodity prices occurs at a regular pace. This is however unlikely to be the case in practice: Deaton & Laroque (1992) argue that non-linearities are a central feature of commodity markets. In a hard landing scenario, financial markets would probably quickly revise down their expectations, thus provoking a much sharper initial adjustment in commodity prices; conversely, the cost structure within commodity industries may prevent prices to drop too far below production costs, with insolvencies and closure of mines / oil fields possibly accelerating the downward adjustment on production. *Third*, and perhaps most importantly, our scenario consists of a pure demand shock; we do not take into account potential supply shocks. The shale oil and gas revolution in the United States, coupled with an inflexion in OPEC's strategy, already triggered a large fall in oil prices, which is *not* embedded in our estimations. The possibility that the past investment boom in extractive industries may generate a similar supply shock for metals cannot be ruled out. We elaborate further on this below.

5 Economic implications

5.1 The end of the "commodity supercycle"

Our findings can be replaced into the broader context of commodity price cycle theories. Sturmer (2013) recalls that commodity prices are subject to long-term fluctuations and boom-and-bust cycles. Focusing on oil, Dvir & Rogoff (2009) argue that price booms are due to persistent aggregate demand shocks combined with supply constraints; similarly, Jacks (2013) characterizes commodity price super-cycles as "demand-driven episodes closely linked to historical episodes of mass industrialization and urbanization which interact with

[39] Bastourre et al. (2012) document the strong negative correlation between commodity prices and sovereign spreads in commodity exporting economies, suggesting strongly pro-cyclical capital flows in these economies.

[40] Our choice to weight the global demand impact on the "metal block" with countries' respective shares of metals' apparent consumption, implies that the whole metals' apparent consumption of a given country is assumed to be linked to its own domestic uses. In fact, part of China's apparent consumption is related to manufactured goods that are exported, thus ultimately linked to *other* countries' internal uses.

acute capacity constraints in many product categories – in particular, energy, metals, and minerals". Indeed, when prices are low, extracting industries have few incentives to invest and expand capacity. When confronted to an unexpected positive demand shock, they are unable to adjust quickly, as investment projects take several years to complete in capital-intensive mining sectors (Erten & Ocampo, 2013). Supply constraints thus generate a price boom (as can be expected from the shape of supply curves, the vertical part of which indicating the maximum production capacity; see figures A.15 and A.16), which in turn makes investment profitable and push extracting industries to expand capacity. Conversely, when facing an unexpected negative demand shock, extracting firms tend to maintain production at high levels, thereby exacerbating the fall in price (Radetzki, 2008).[41]

The surge in mineral commodity prices during the 2000s can thus be explained as the result of unexpectedly strong Chinese growth (Arbatli & Vasishtha, 2012),[42] leading to supply constraints due to a lack of investment in extracting industries in the previous years (Morgan Stanley, 2012). Jacks (2013) shows that 15 out of 30 commodities, including copper, iron ore and steel, demonstrate above-trend real prices starting from 1994 to 1999. Since most commodity prices cycles are typically 10 to 20 years long, Jacks goes on arguing that the turning point may come soon. Supporting this view, Morgan Stanley explains that the commodity price boom generated a supply-expanding investment surge that will lead to a significant *acceleration* in production capacity expansion in coming years. For copper, Morgan Stanley estimates that "the increase in global supply *in each of the next seven years* will be roughly equal to the increase in supply over the decade to 2011"; for iron ore, global supply may double from 2011 to 2020 (see figures A.15 and A.16). Therefore, unless global demand *accelerates*, which is highly unlikely,[43] prices are set to decrease.

Overall, recent downward trends in commodity prices may probably be long-lasting, signalling the end of the "commodity supercycle", since both trends that originated the price boom may be about to reverse simultaneously. *First*, Chinese demand, which used to be strong, has already slowed down and could weaken significantly more. And *second*, production capacity, which has been insufficient for several years, has already expanded strongly for oil, and may be about to expand as well for metals.

5.2 Towards recoupling?

Finally, our results also shed light on the decoupling-recoupling debate. As noted by Willett et al. (2011) there has been different versions of the decoupling hypotheses. By the mid-2000s, decoupling was seen as the possibility that emerging economies could maintain their own growth dynamism, thanks to strong domestic demand, thus consistently outperforming advanced economies' growth. At the end of 2007, after the subprime crisis erupted in the US, some analysts even asserted that emerging economies had become unaffected by

[41] Cited by Sturmer (2013), underlining the "common experience in the extractive sector that firms keep their utilization rates high even after negative price and demand shocks hit the market".

[42] Consensus Forecasts systematically underestimated China's growth between 2004 and 2007.

[43] Even an optimistic rebalancing scenario for China, away from investment, would imply a slowdown in demand for metals.

advanced economies' business cycles; this thesis was proven wrong with the *Global Financial Crisis*, and recoupling talks quickly spread. However, as emerging economies managed to weather the crisis quite well, and soon resumed high growth, the decoupling theory rapidly reappeared: emerging economies were not immune to advanced economies' business cycles, but they still were able to outperform them in terms of growth. In other words, the "growth gap" between emerging and advanced economies had remained mainly intact, and would remain so in the foreseeable future; emerging economies were increasingly bound to become the world's main growth drivers.

Our results – as well as recent developments – cast some doubts on this theory. As shown in figure A.23, a hard landing in China would cause the "growth gap" between emerging and advanced economies to tighten significantly, from 6 percent in the years 2007-09, to less than 1 percent from 2017 onwards: in other terms, emerging economies may (at least *partially*) recouple, *under the assumption that China lands hard.*[44] Admittedly, much of the reduction in the "growth gap" derives directly from our very assumption: China itself represents a large part of emerging economies' aggregate GDP, so a hard landing would mechanically drive down overall emerging economies' growth. That being said, for all the reasons mentioned in subsection 2.1, a hard landing in China can definitely not be ruled out; what our results indicate, is that under these circumstances the most affected would be other emerging economies, whether because of their geographical proximity and strong trade integration with China (Asia) or because of commodity linkages (Latin America, Gulf Cooperation Council, Commonwealth of Independent States).[45]

These findings echo those of Rebucci et al. (2012), who note that "the emergence of China as an important source of world growth might be the driver of the so called *decoupling* of emerging markets business cycle from that of advanced economies reported in the existing literature". Similarly, Levy Yeyati & Williams (2012) find that the real decoupling is in fact more a growing dependence on China.[46] Esterhuizen (2008) relates the decoupling theory to commodity prices, and estimates that "recoupling may become a reality if commodity prices collapse".[47] Decoupling could thus be reinterpreted as the consequence of China's emergence as a major economy, its highly unbalanced growth pattern (with an excessive reliance on commodity-intensive investment), and the implied spillovers on commodity exporters.[48] Supporting this hypothesis, is the fact that many emerging economies took off *simultaneously*, at the beginning of the 2000s; that the exceptionally large Chinese stimulus package, with a high investment content, probably helped commodity exporters to weather the crisis;[49] and that, once again, many emerging economies are now facing difficulties *simultaneously*, as China's

[44] Under the baseline soft landing scenario, the "growth gap" would stabilize around 2.5 percent.

[45] Given the strength of commodity linkages to China (Farooki, 2010), extending our work to Sub-Saharan Africa may also lead to question the sustainability of its recent take-off. Drummond & Liu (2013) indeed find significant spillovers to Sub-Saharan Africa – especially in resource-rich countries – from a shock on Chinese investment.

[46] Levy Yeyati & Williams' results also point to a financial recoupling between advanced and emerging economies.

[47] However, Esterhuizen puts greater emphasis on the role played by the US, rather than China, as a commodity importer.

[48] It should be noted that many large emerging economies (notably Latin American countries, Russia and Middle-East) are commodity exporters, and thus depend to some extent on China. Emerging Asia, although comprising few commodity exporters, is also dependent on China because of geographical proximity. The only emerging economies that do not have strong links to China are those of Eastern Europe; while they also experienced a significant take-off at the beginning of the 2000s, this had probably more to do with booming credit in the context of financial integration with Western Europe, and ultimately proved to be unsustainable in a number of them in the aftermath of the Great Recession.

[49] Figure A.1 shows that the Chinese trade deficit vis-à-vis commodity exporters widened significantly starting from 2009-10.

growth is slowing. In that respect, our results provide a possible explanation to the "gradual, synchronized and protracted" growth slowdown in emerging economies observed in recent years (IMF 2014a).[50] If China were to land hard, decoupling may turn out to be more a decade-long parenthesis, rather than the "new normal". In other words, the convergence process at work for the last decade may stall, and a number of emerging economies could remain caught in the "middle-income trap". As noted by World Bank (2013), very few countries (13 out of 101) have managed to reach a high-income status since 1960. While convergence may have appeared easier under the favorable circumstances of the past decade, it will certainly be more challenging going forward.

6 Conclusion

We estimated in this paper the potential spillovers of a hard landing in China on the rest of the world, with a special focus on mineral (metals and oil) commodity exporters. After recalling the main arguments pointing to a hard landing scenario in China, we used conditional forecast in a Global VAR framework to assess its impact. We highlighted the respective roles of each of the three transmission channels embedded in our methodology: a Chinese hard landing would cause commodity prices to fall (especially for metals, but also for oil), while export volumes would be less affected; investment would drop significantly (in line with worse expected prospects for oil and extracting industries, and possibly cuts in infrastructure spending due to lower fiscal revenues); in countries with a flexible exchange rate regime, the exchange rate would act as a buffer as terms-of-trade worsen. Outside China, we found ASEAN, Latin America and other emerging economies to be the most severely hit; advanced economies would be less affected.

Our contribution to the literature is fourfold. *First*, we provide a brief analysis of the Chinese growth model, highlighting the links between high growth and imbalances, the role of factor price distortions, and the recent rise in vulnerabilities. *Second*, in terms of methodology, while counterfactual analysis is not fundamentally different from conditional forecast, few papers so far have explicitly performed conditional forecast in a global VAR framework. *Third*, we modeled metals and oil markets, embedding price, production and inventory variables, as two separate entities in our Global VAR framework, while other studies mostly use a single commodity price variable which is generally endogenous to the United States (this is especially the case for oil); on the contrary, the exceptionally high share of China in metals' world consumption needed to be taken into account in a specific way in our view. *Finally*, we contribute to the decoupling-recoupling debate by showing that, *under the assumption that China lands hard*, the commodity supercycle would come to an end and the "growth gap" between emerging and advanced economies would significantly be reduced (what we refer to as *partial recoupling*). We thereby challenge the common view that emerging economies should be tomorrow's global growth drivers.

Additionally, it is worth noting that Australia, which is among the countries most dependent to China, did not experience any recession in 2009.

[50] There are admittedly alternative (complementary) explanations, such as sluggish growth in advanced economies, or spillovers from Fed's announcements about tapering.

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Appendix

A Figures

A.1 Stylized facts

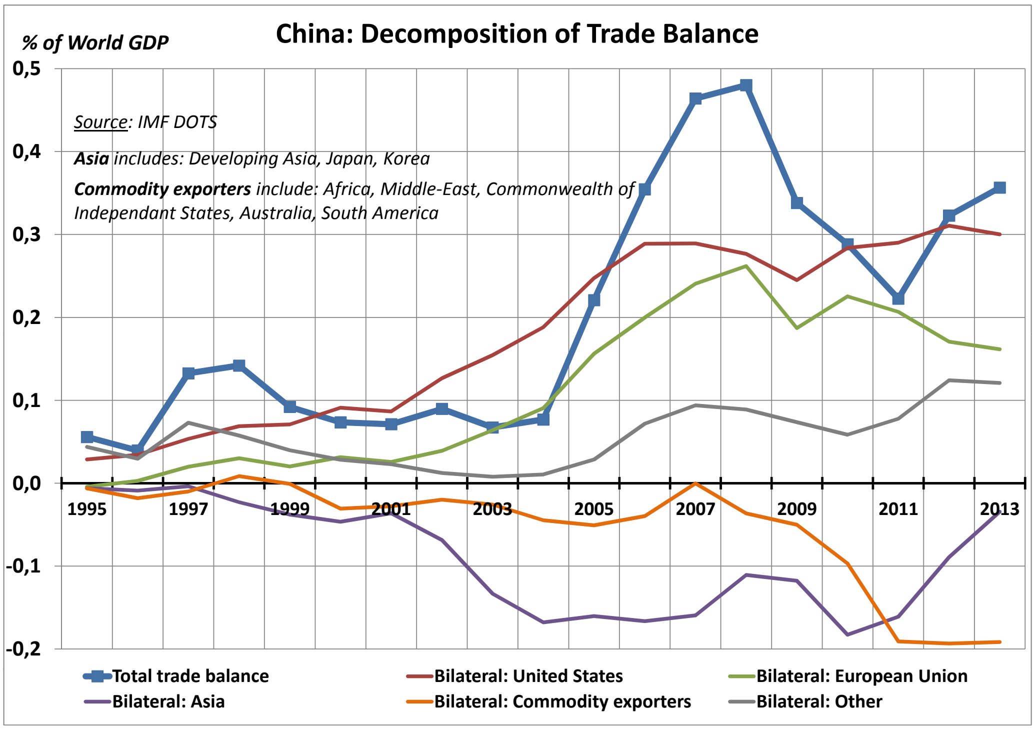

Figure A.1: China's bilateral external imbalances.

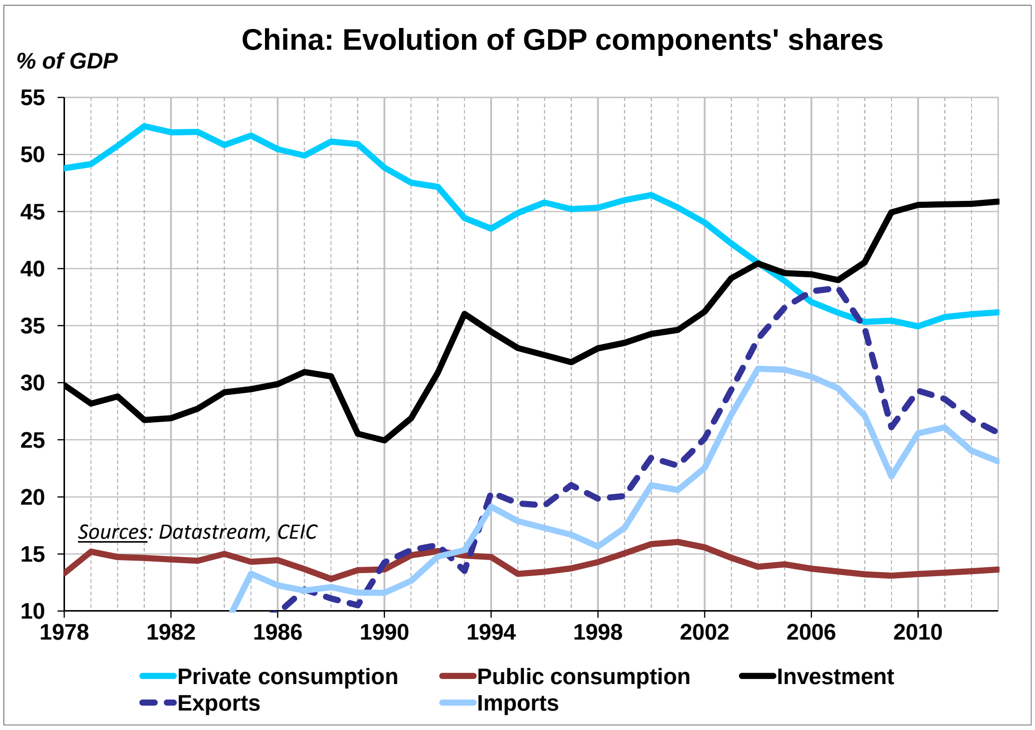

Figure A.2: China's internal imbalances.

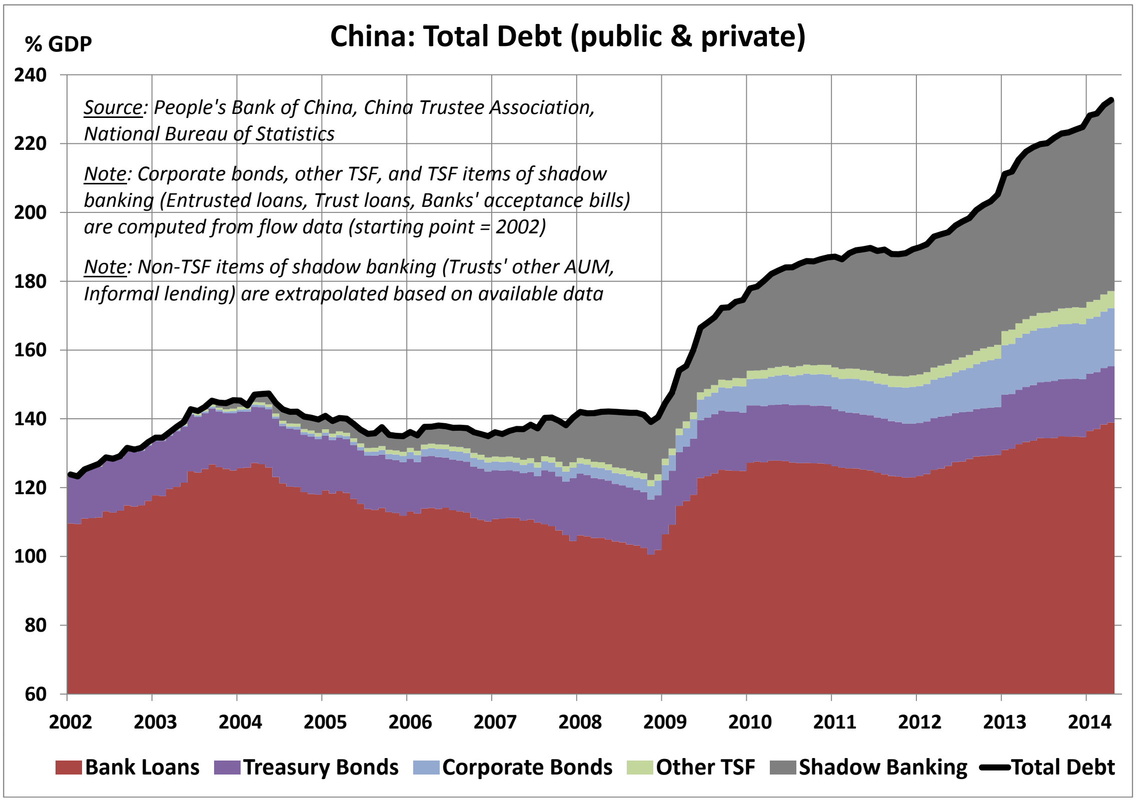

Figure A.3: China's total debt surge.

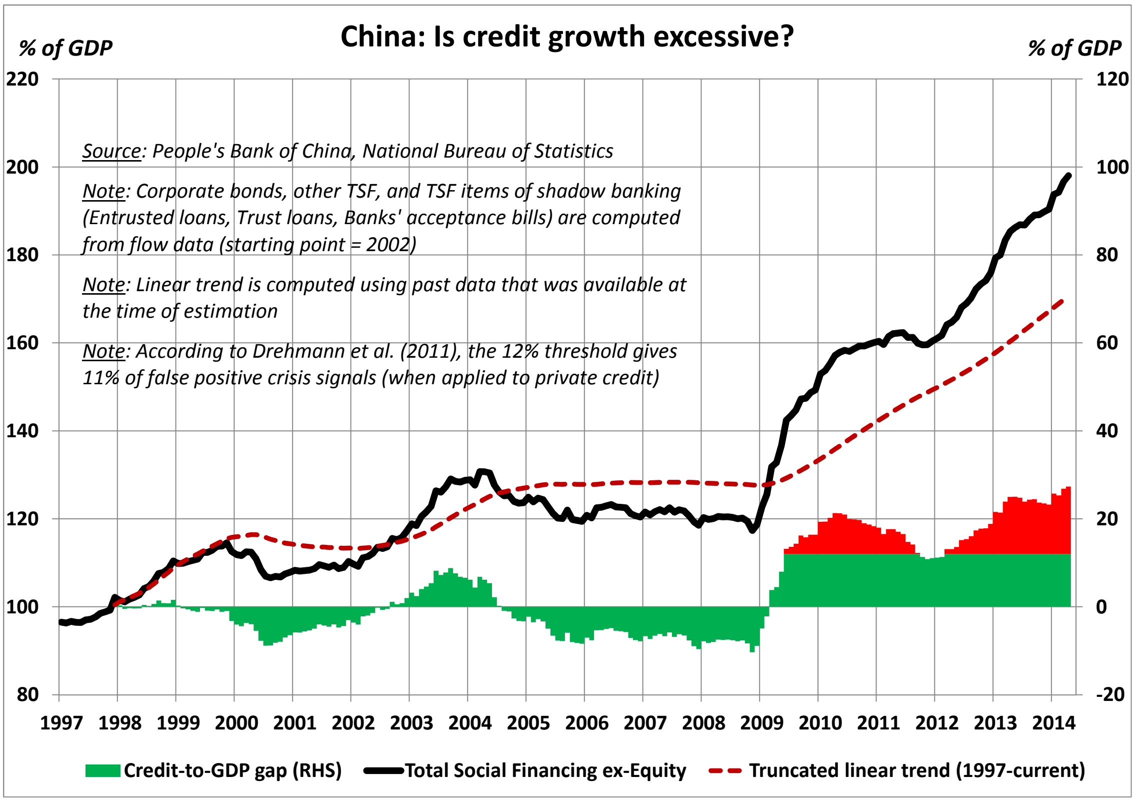

Figure A.4: China's credit-to-GDP gap.

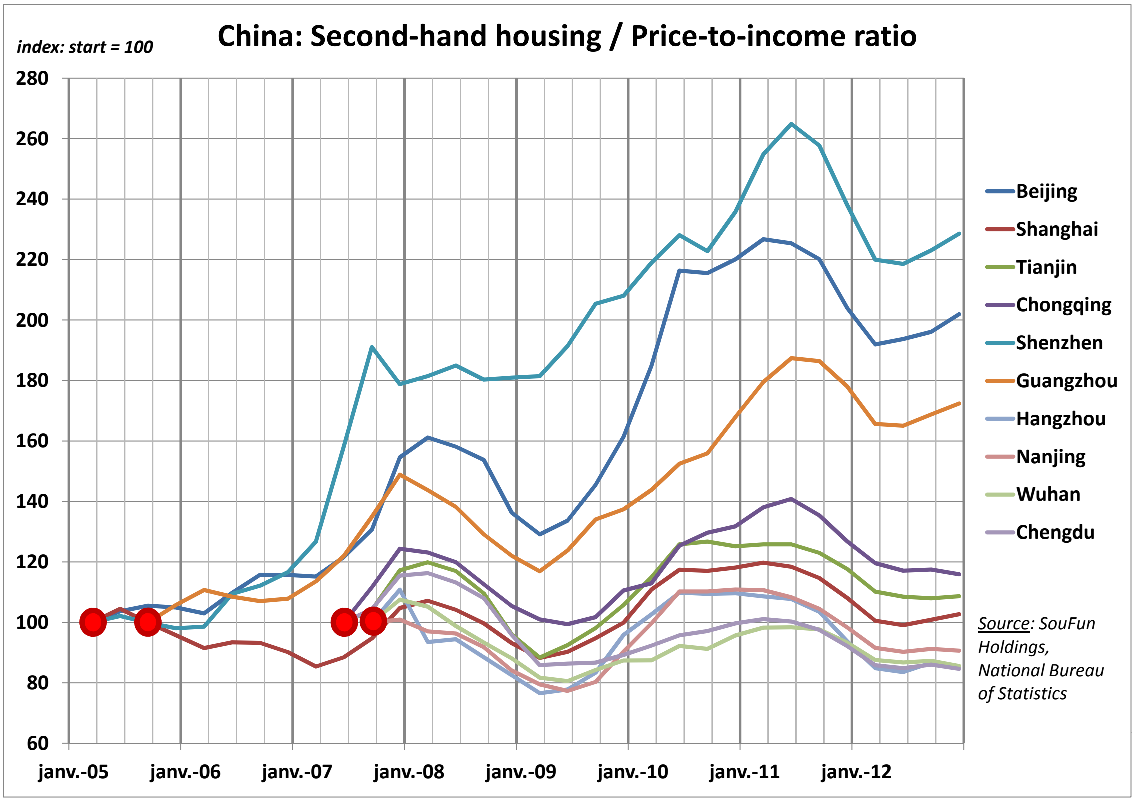

Figure A.5: Price-to-income ratios in China's ten largest cities.

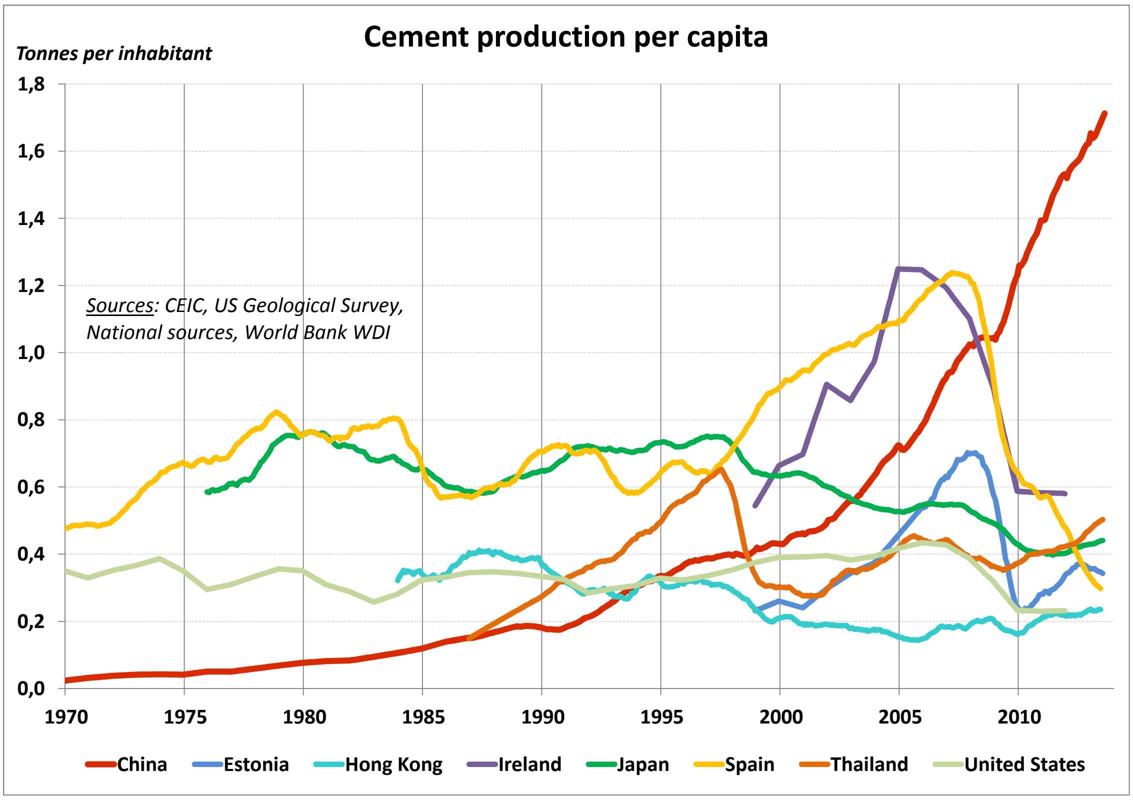

Figure A.6: Cement production in China compared to past real estate bubbles.

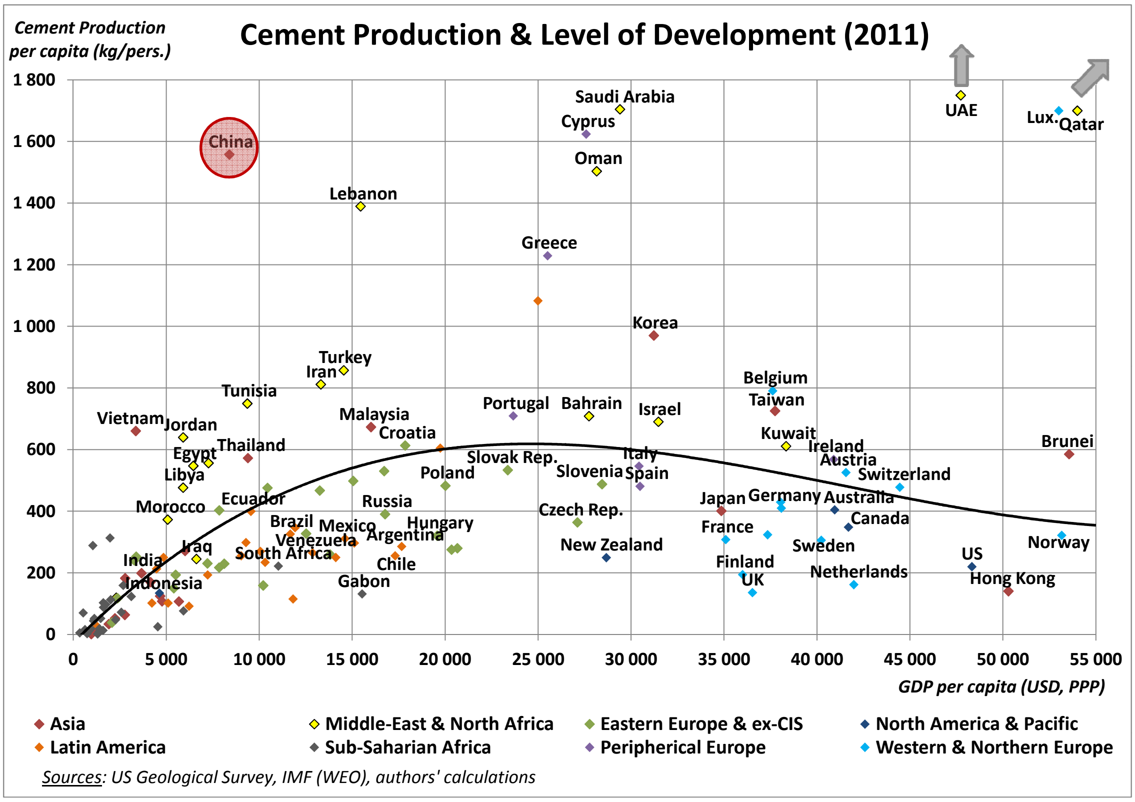

Figure A.7: Cement production and level of development.

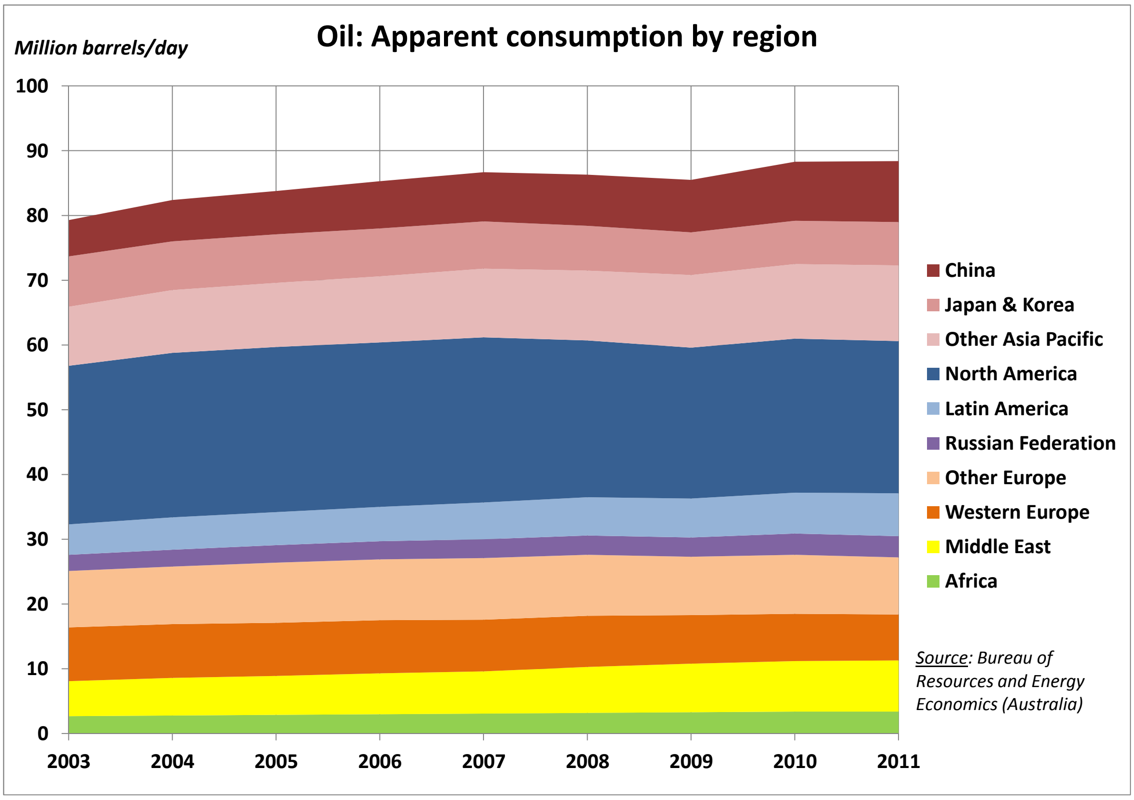

Figure A.8: Oil consumption by region.

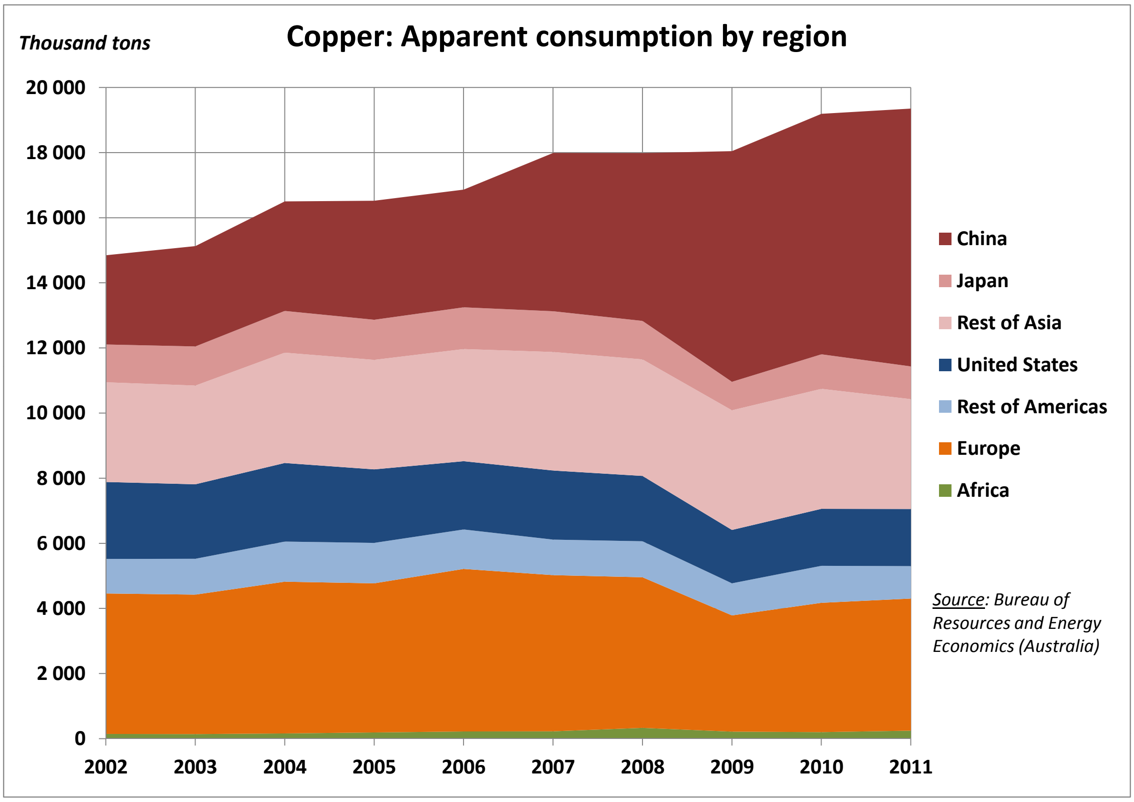

Figure A.9: Copper consumption by region.

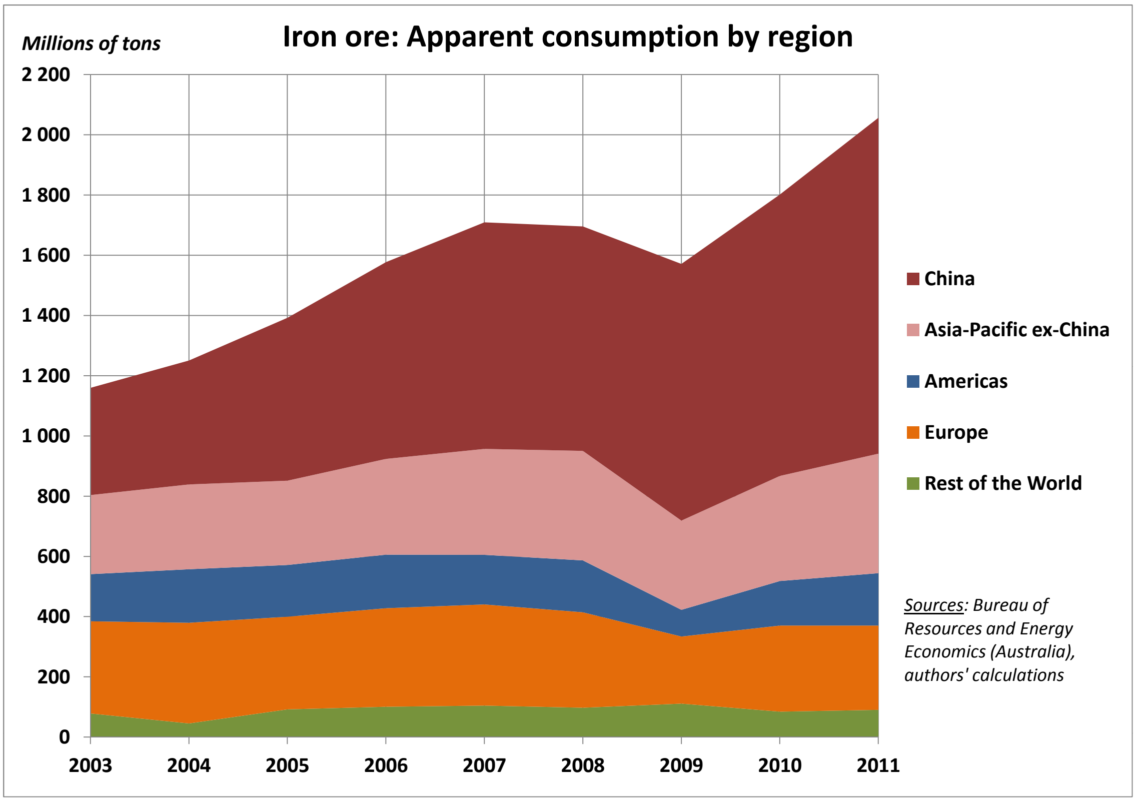

Figure A.10: Iron ore consumption by region.

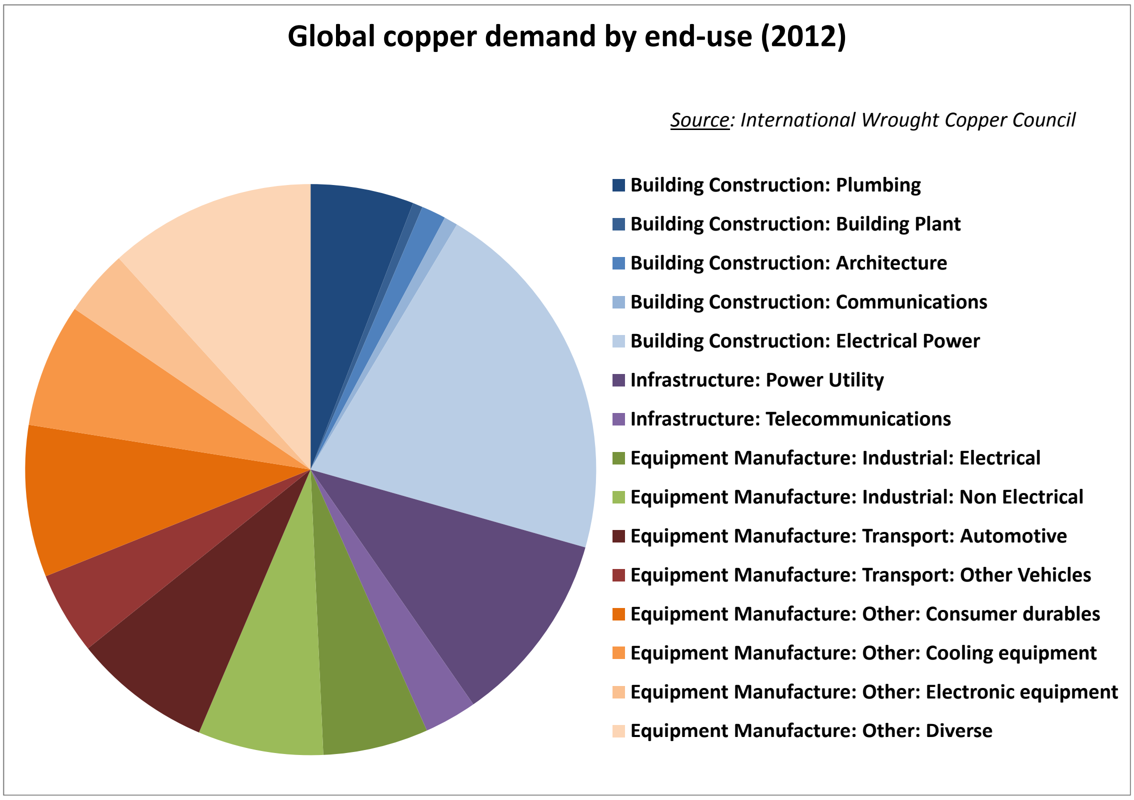

Figure A.11: Global demand by end-use: copper.

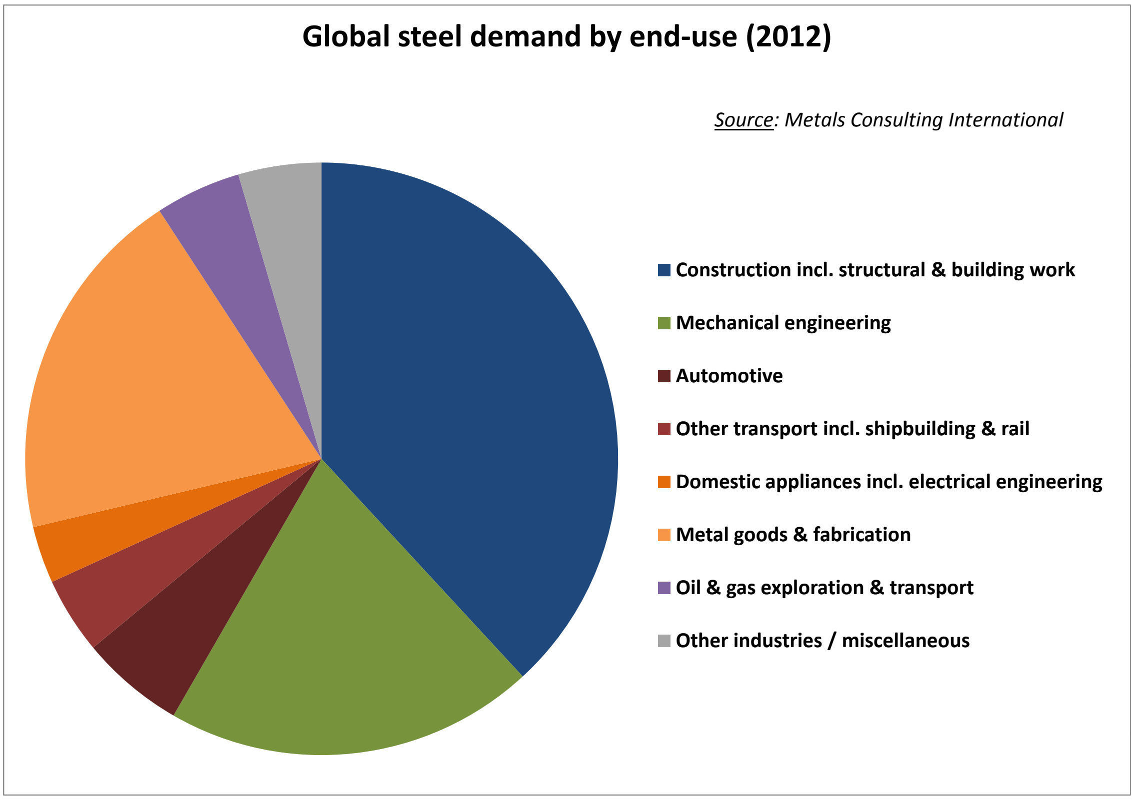

Figure A.12: Global demand by end-use: steel.

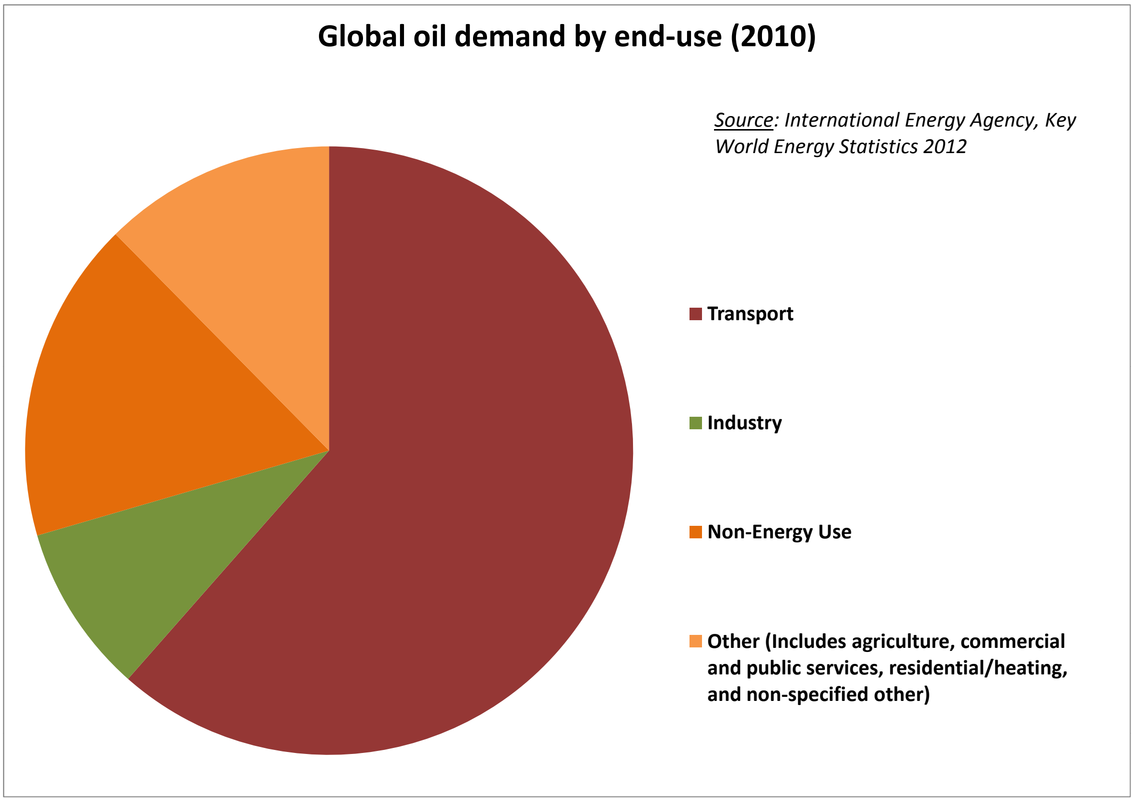

Figure A.13: Global demand by end-use: oil.

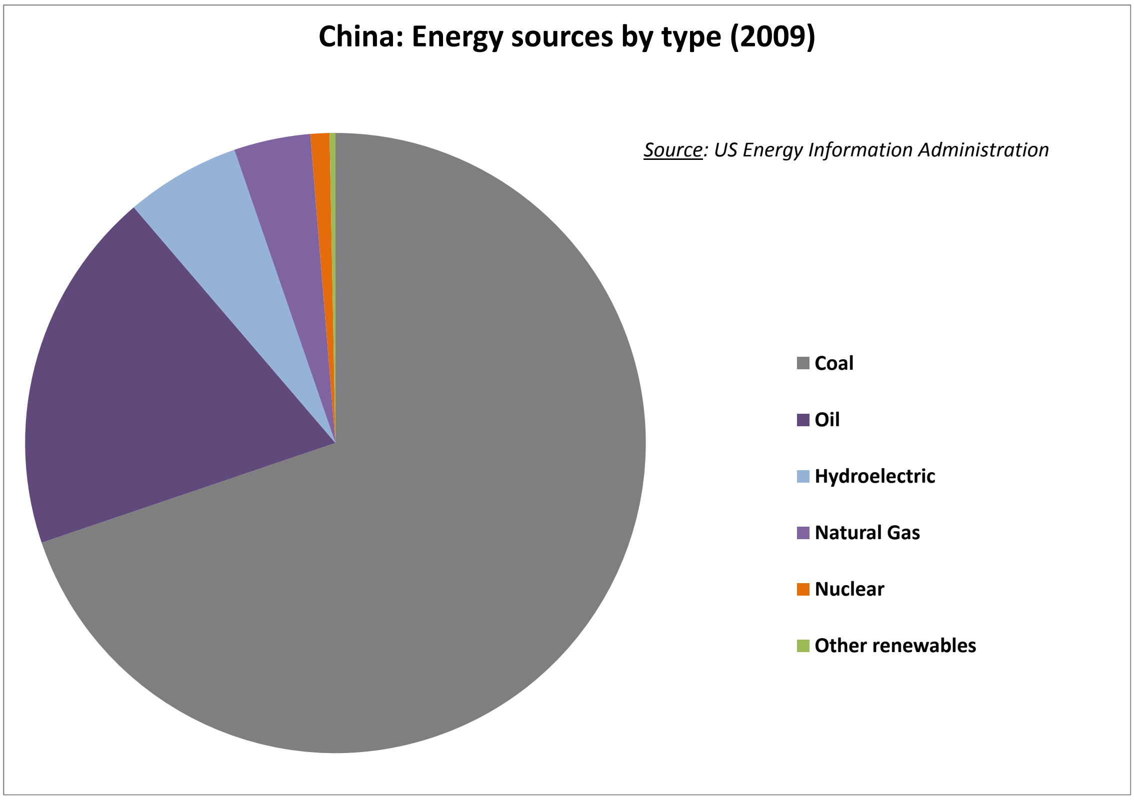

Figure A.14: Sources of energy in China.

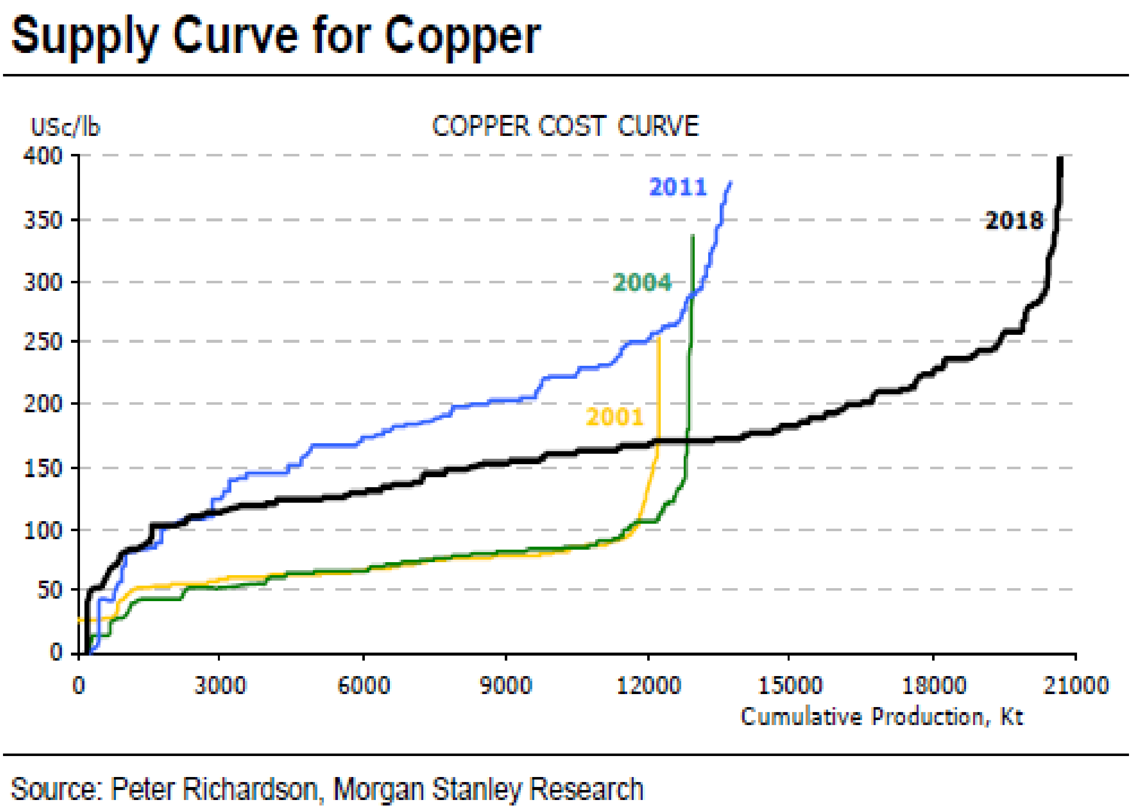

Figure A.15: Supply Curve of Copper: Evolution from 2001 to 2018.

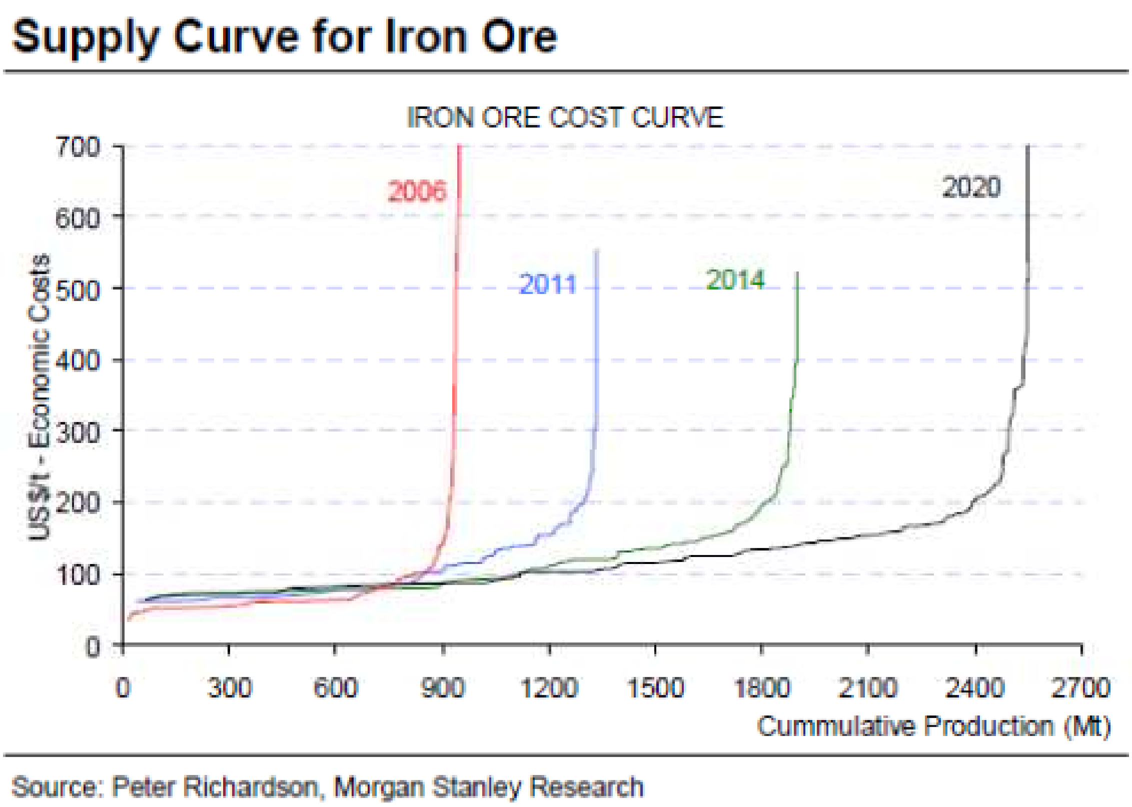

Figure A.16: Supply Curve of Iron Ore: Evolution from 2006 to 2020.

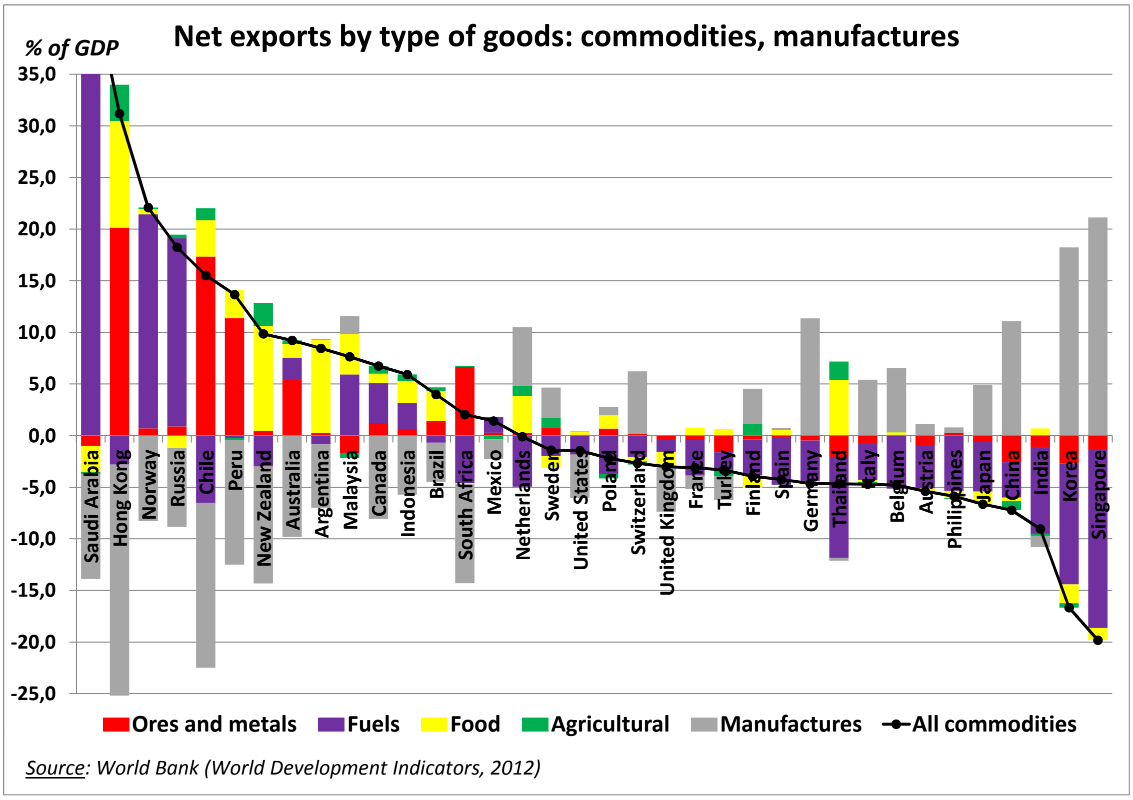

Figure A.17: Dependency on Net Commodity Exports.

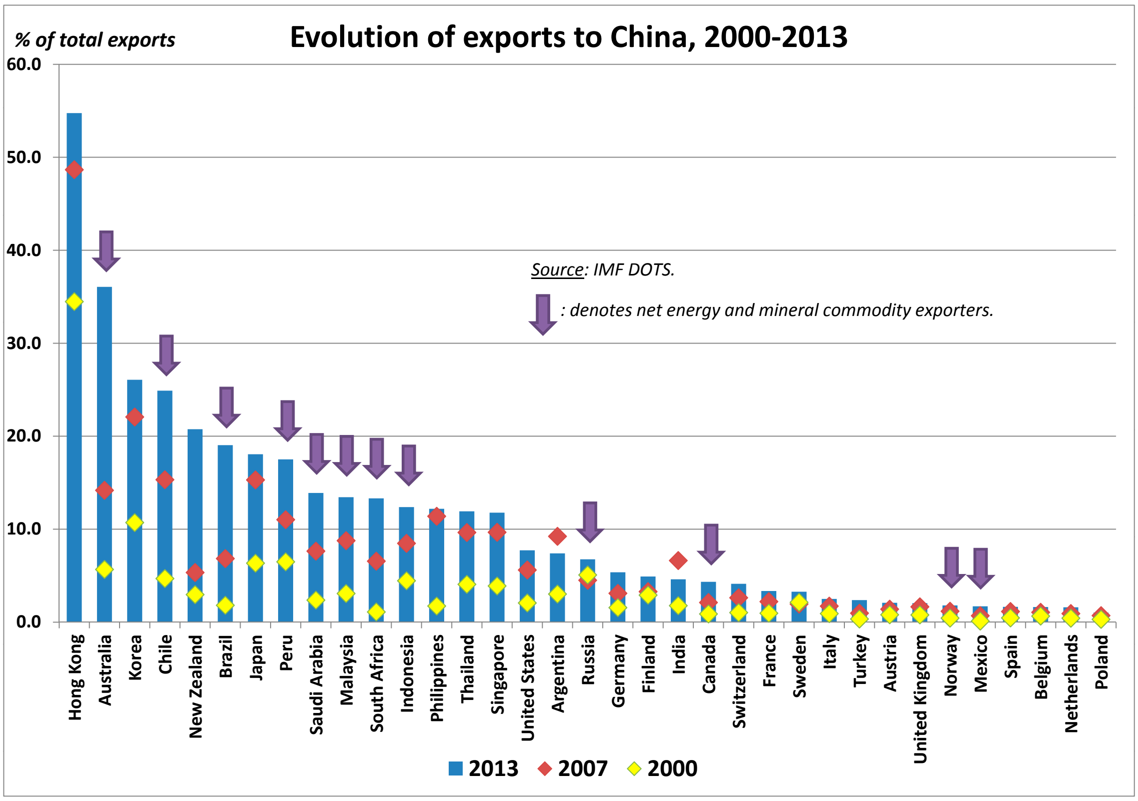

Figure A.18: Dependency on Exports to China.

A.2 GVAR modelization: persistence profiles

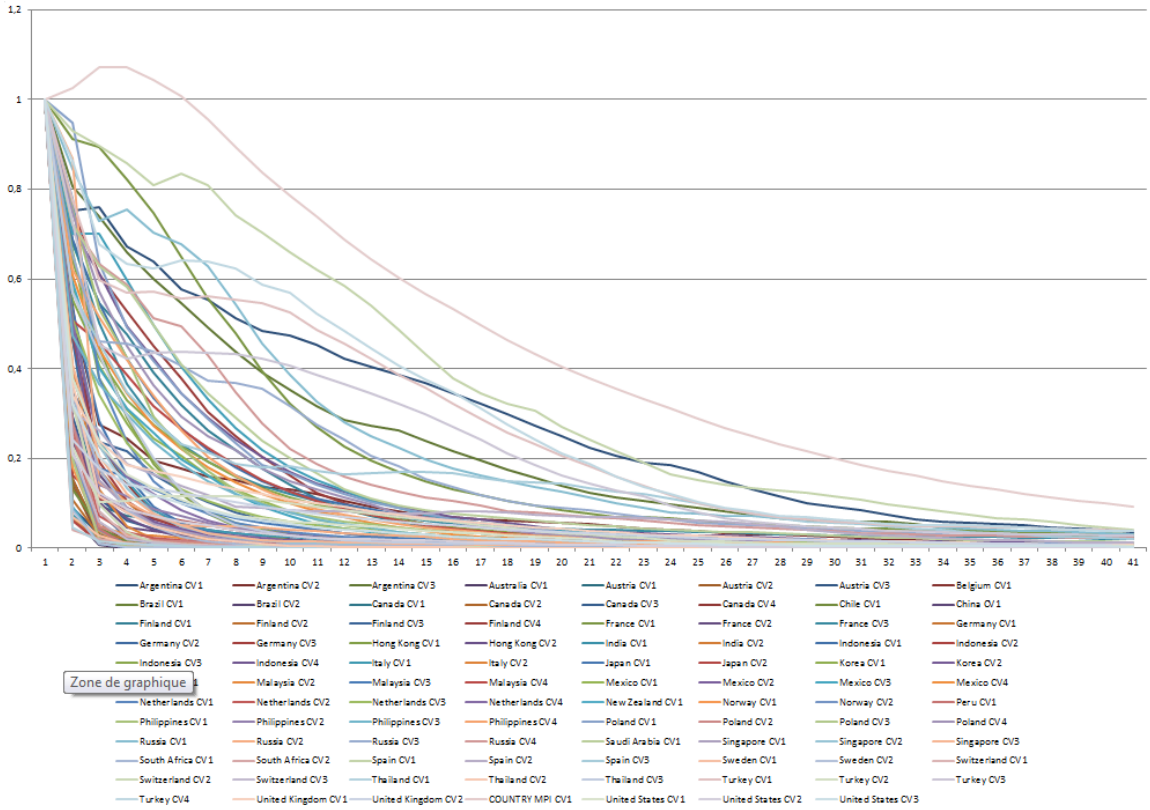

Figure A.19: Persistence Profile.

†Persistence Profile of the Effect of System-Wide Shocks to the Cointegrating Relations of the GVAR Model - Bootstrap Median estimates

A.3 Simulation results: Comparison between hard landing and soft landing

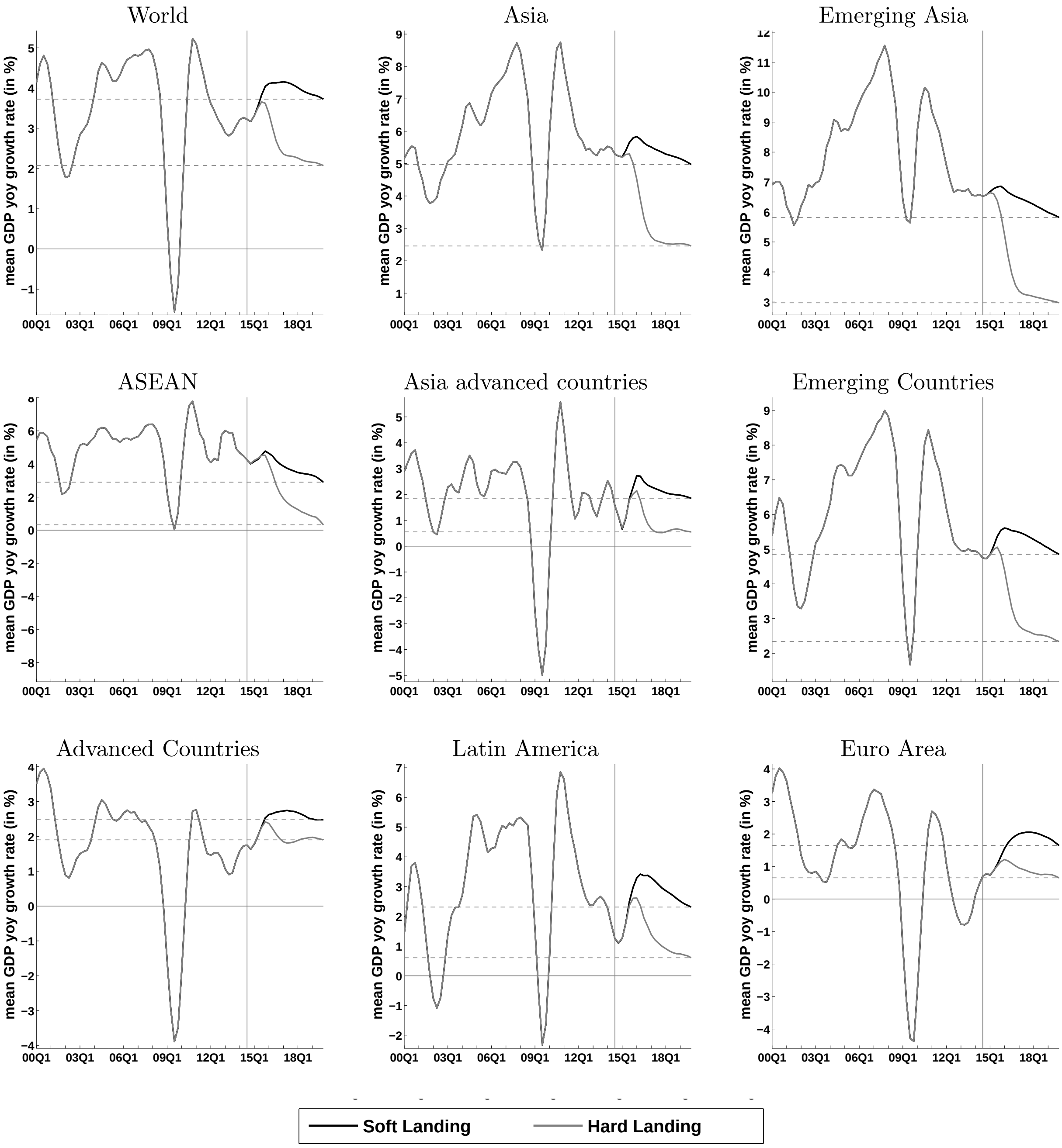

Figure A.20: Impact of a Chinese hard landing on given regions' GDP growth.

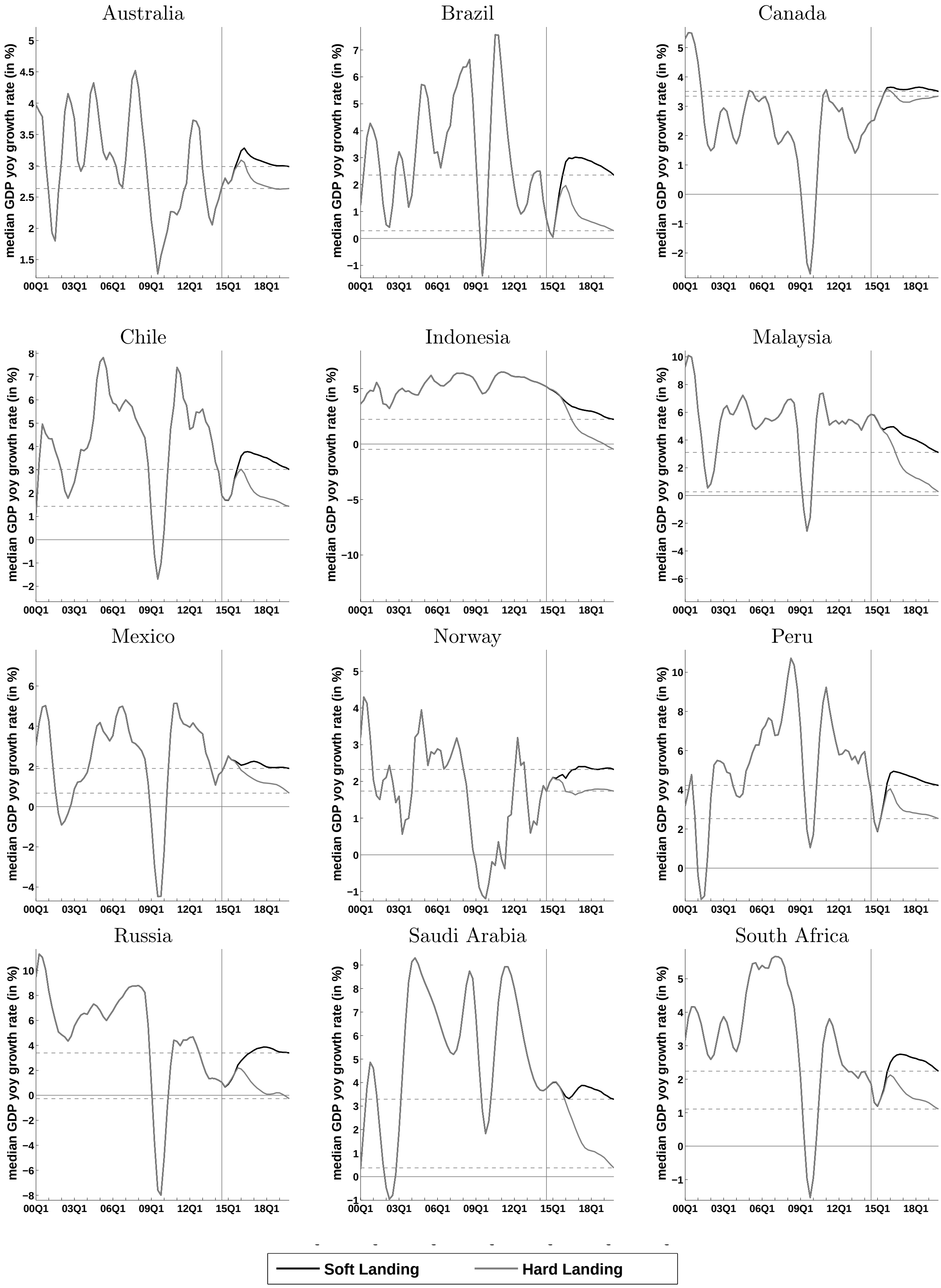

Figure A.21: Impact of a Chinese hard landing on net commodity exporters' GDP growth.

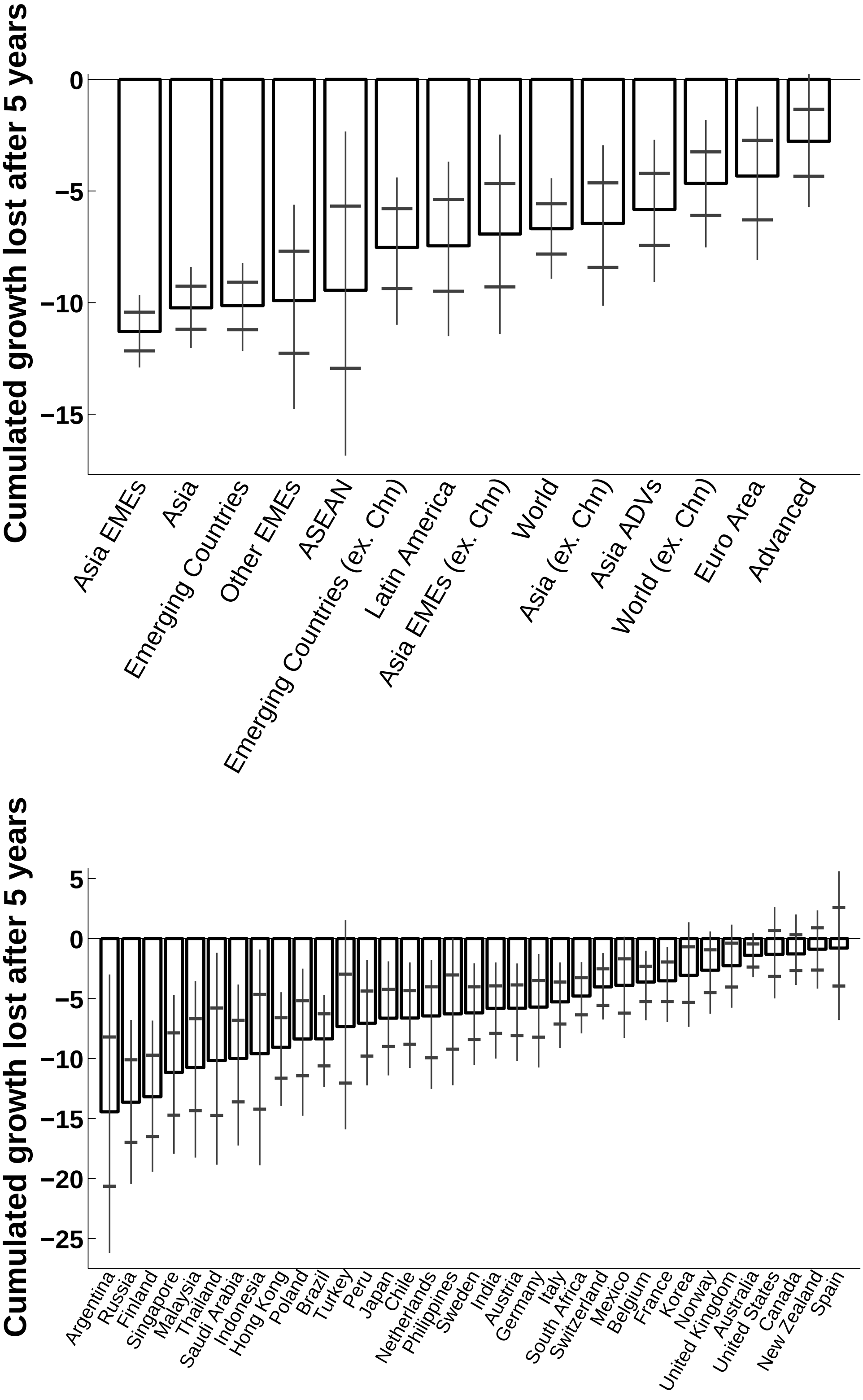

Figure A.22: Hard landing vs soft landing: Cumulated GDP loss after 5 years.

†Bars represent medians. First and last quartiles are given by small horizontal lines. First and last deciles are given by vertical lines.

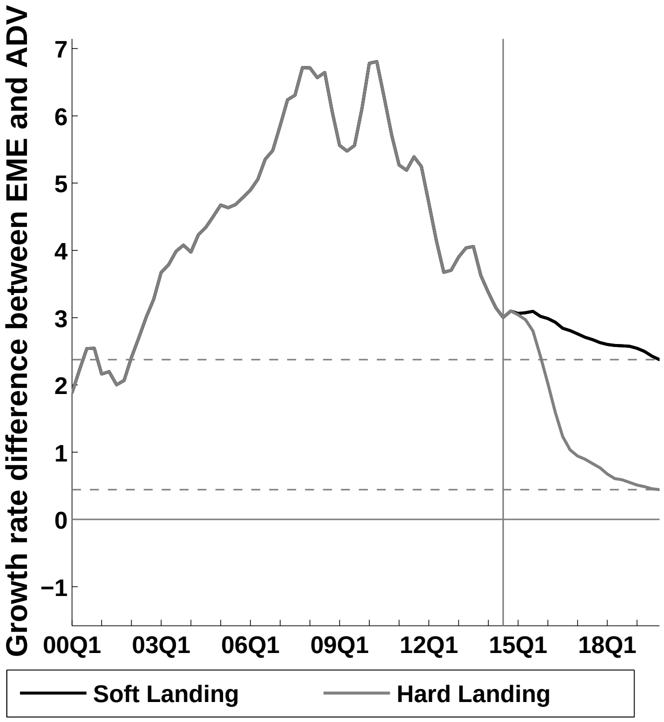

Figure A.23: Hard landing vs soft landing: "Growth gap" between advanced and emerging countries.

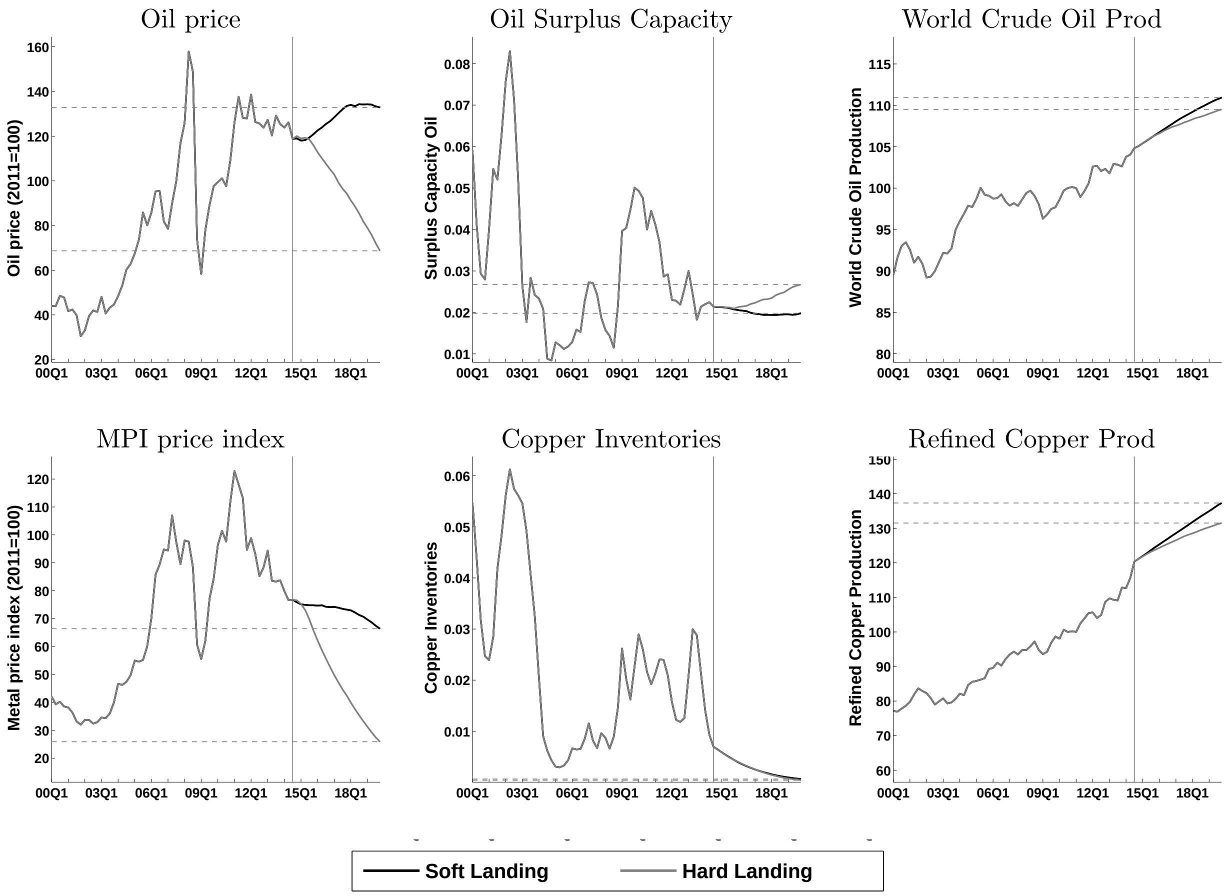

Figure A.24: Impact of a Chinese hard landing on commodity blocks.

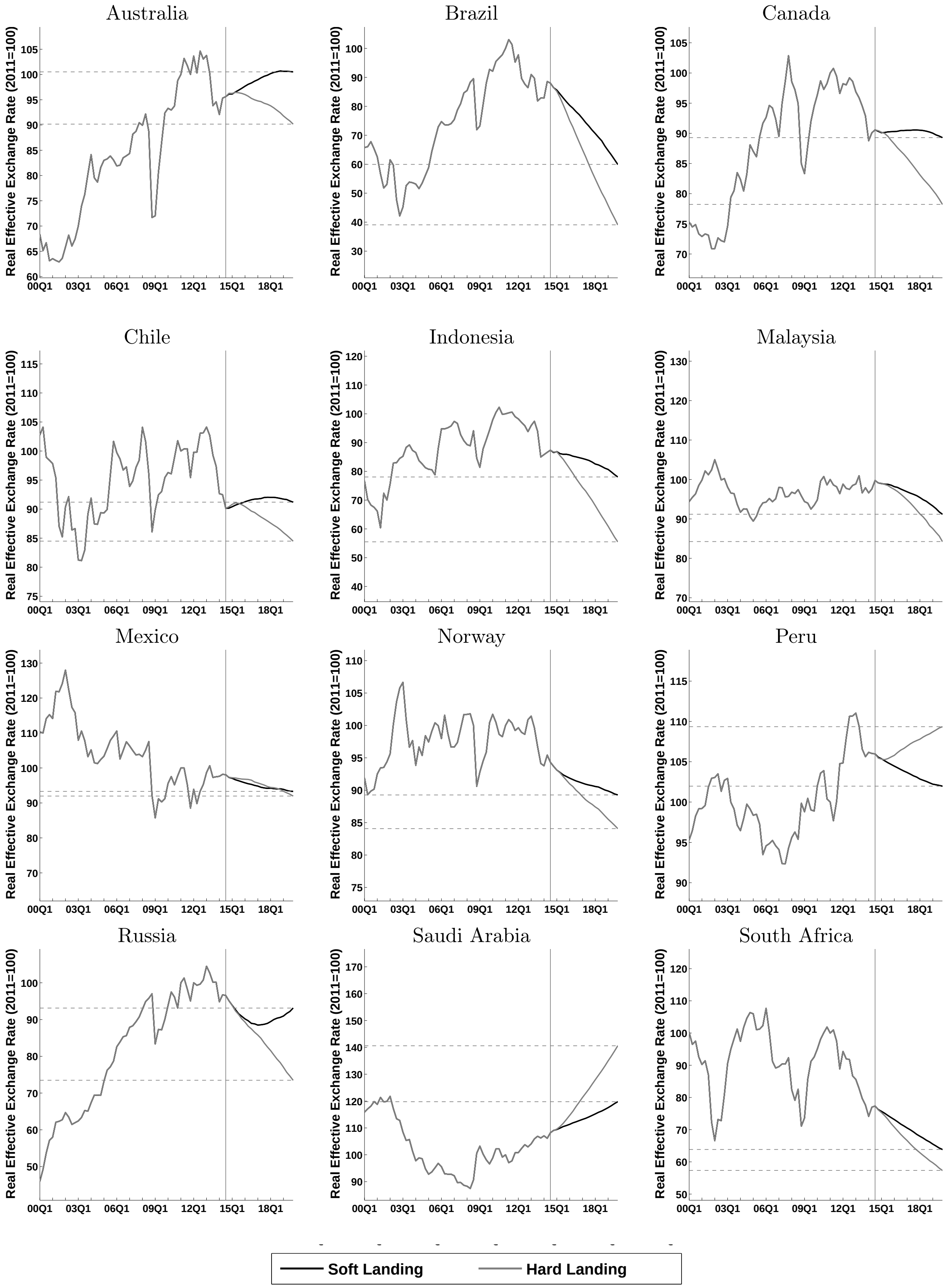

Figure A.25: Impact of a Chinese hard landing on commodity exporters' real effective exchange rate.

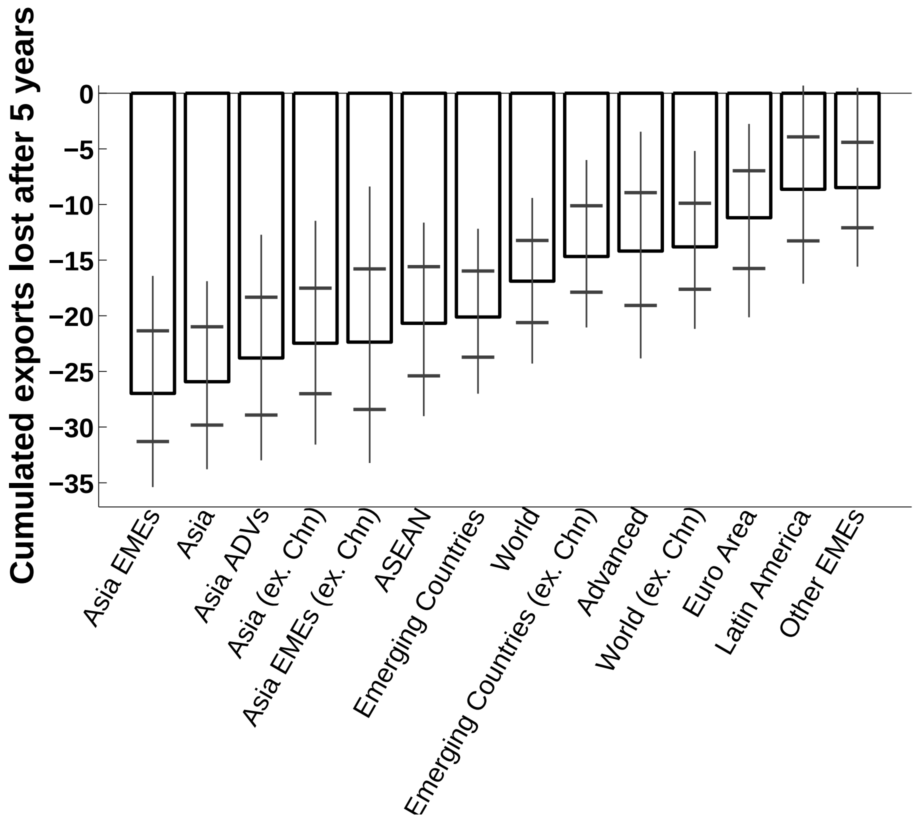

Figure A.26: Hard landing vs soft landing: Cumulated export loss after 5 years.

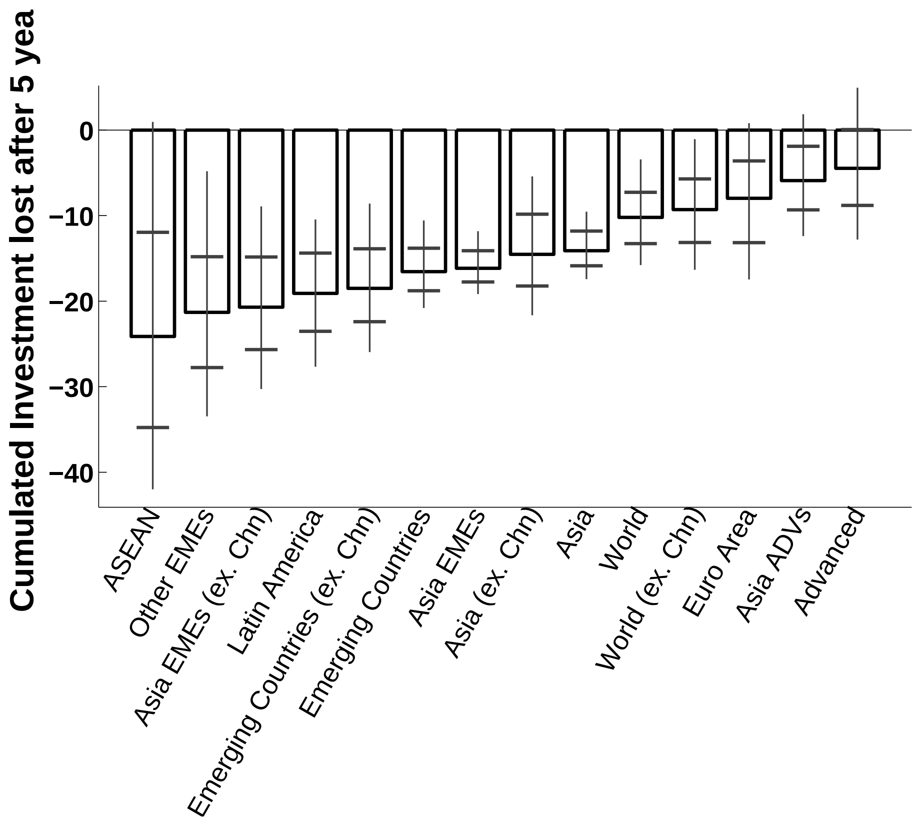

Figure A.27: Hard landing vs soft landing: Cumulated investment loss after 5 years.

† Bars represent medians. First and last quartiles are given by small horizontal lines. First and last deciles are given by vertical lines.

B Tables

B.1 Country sample, data sources and stylized facts

Advanced economies	**Emerging economies**
Advanced Asia	*Emerging Asia*
Hong Kong	China
Japan	India
Korea	Indonesia
Singapore	Malaysia
	Philippines
Euro Area	Thailand
Austria	*Latin America*
Belgium	
Finland	Argentina
France	Brazil
Germany	Chile
Italy	Mexico
Netherlands	Peru
Spain	
	Other Emerging economies
Other Advanced economies	
	Poland
Australia	Russia
Canada	Saudi Arabia
New Zealand	South Africa
Norway	Turkey
Sweden	
Switzerland	
United Kingdom	
United States	

Note: ASEAN countries in our sample are both emerging (Indonesia, Malaysia, Philippines, Thailand) and advanced (Singapore).

Table B.1: Country sample and groupings

Variables	Description	Sources
Country variables		
Real GDP (y)	Quarterly (2011Q1=100), seasonally adjusted in log	National sources (Datastream codes ending in "GDP...D" or "GDP...C" when available), Oxford Economics
Real Investment (Inv)	Quarterly (2011Q1=100), seasonally adjusted in log	National sources (Datastream codes ending in "GFCF..D" or "GFCF..C" when available), Oxford Economics
Real Exports (X)	Quarterly (2011Q1=100), seasonally adjusted in log	National sources (Datastream codes ending in "EXNGS.D" or "EXNGS.C" when available), Oxford Economics
Inflation (Dp)	Quarterly growth rate of the seasonally adjusted CPI	National sources (Datastream codes ending in "CONPRCF" when available), Oxford Economics, IMF IFS
Real Effective Exchange Rate (REER)	Quarterly index (2011Q1=100), seasonally adjusted in log	BIS (Datastream codes ending in "BISRXNR" or "BISRXBR" when available), JP Morgan (Datastream codes ending in "JPMRBTF"), OECD
Oil block		
Oil Price Index (Poil)	Price index in log. Simple average of three spot prices: Dated Brent, West Texas Intermediate, and the Dubai Fateh	IMF
Oil Production (ProdOil)	World oil production in log	US Energy Information Administration, Monthly Energy Reviews
Oil Surplus (Soil)	OPEC surplus capacity, in percent of world oil production, in log	OPEC (Datastream code "OXSURPCOI")
Metal block		
Metal Price Index (MPI)	Price index in log. Includes Copper, Aluminum, Iron Ore, Tin, Nickel, Zinc, Lead, and Uranium Price Indices	IMF
Metal Production (ProdMetal)	World refined copper production in log	International Copper Study Group (monthly press releases), *Produccion minera en Chile* (quarterly profile 1995-2001)
Metal inventories (Smetal)	Copper inventories, in percent of world copper production, in log	London Metal Exchange (Datastream code "LCPWARE")
GVAR weights		
Trade weights for countries' exogenous variables	2008-2012 average of exports to the other countries in the sample	IMF DOTS & authors' calculations
Weights for commodity blocks' exogenous variables	2008-2011 average of commodity consumption (oil; and copper, iron ore for metals) by country	BREE Australia & authors' calculations

Table B.2: Data Sources

Country	Exports	Iron Ore		Copper		Aluminium		Lead		Zinc		Coal		Crude Oil		Natural Gas		Metals		Energy		Commodities	
	Ch	W	Ch	W	Ch	W	Ch	W	Ch	W	Ch	W	Ch	W	Ch	W	Ch	W	Ch	W	Ch	W	Ch
Argentina	-1.0	-0.4	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-0.4	0.1	-0.3	0.0	-0.1	-0.1	-0.8	0.1	-0.9	0.0
Australia	2.0	4.1	2.9	0.6	0.2	0.3	0.0	0.1	0.0	0.2	0.1	3.2	0.3	-1.4	0.2	0.7	0.0	5.3	3.2	2.5	0.5	**7.7**	3.7
Austria	-1.2	0.6	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	0.0	-2.7	0.0	-0.9	0.0	0.5	0.0	-3.8	0.0	-3.3	0.0
Belgium	-2.0	0.8	-0.3	-0.1	0.2	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-3.4	0.1	-1.4	0.0	0.5	-0.1	-4.8	0.1	-4.3	0.0
Brazil	0.5	1.9	0.8	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	-0.2	0.2	-0.2	0.0	1.9	0.8	-0.6	0.2	**1.3**	0.9
Canada	-1.8	-0.2	0.0	0.2	0.1	0.3	0.0	0.0	0.0	0.1	0.0	0.4	0.0	2.4	0.0	0.7	0.0	0.4	0.0	3.4	0.1	**3.8**	0.1
Chile	2.4	0.0	0.2	17.6	6.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.5	0.0	-5.3	0.0	-1.0	0.0	17.6	6.2	-6.8	0.0	**10.8**	6.2
China	N/A	-0.8	0.0	-0.9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	-0.3	0.0	-2.8	0.0	-0.2	0.0	-1.7	0.0	-3.3	0.0	-4.9	0.0
Hong Kong	10.5	-0.4	0.2	-0.1	0.4	0.0	0.1	0.0	0.0	0.0	0.1	-0.5	0.0	-6.1	-1.1	-0.5	-0.4	-0.6	0.8	-7.0	-1.5	-7.6	-0.7
Finland	0.2	0.8	0.0	0.0	0.1	-0.1	0.0	0.0	0.0	0.1	0.0	-0.5	0.0	-2.6	0.0	-0.7	0.0	0.7	0.0	-3.8	0.0	-3.0	0.0
France	-1.3	-0.1	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-2.4	0.0	-0.7	0.0	-0.2	0.0	-3.3	0.0	-3.5	0.0
Germany	-0.6	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	-2.5	0.0	-1.0	0.0	-0.1	0.0	-3.7	0.0	-3.8	0.0
India	-2.1	0.1	0.1	-0.3	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.8	0.0	-4.0	0.0	-0.6	0.0	-0.3	0.1	-5.3	0.0	-5.6	0.2
Indonesia	-0.4	-1.1	-0.2	0.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.7	-2.6	0.0	2.5	0.0	-0.3	0.0	2.9	0.8	**2.6**	0.7
Italy	-1.2	0.2	-0.1	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	-2.1	0.0	-1.4	0.0	-0.1	-0.1	-3.7	0.0	-3.8	-0.1
Japan	-0.4	0.3	0.1	-0.1	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.5	0.0	-2.6	0.0	-1.2	0.0	0.1	0.1	-4.4	0.0	-4.3	0.1
Korea	4.3	-0.7	-0.6	-0.7	0.2	-0.3	0.0	-0.1	0.0	-0.1	0.0	-1.7	-0.1	-6.5	0.8	-2.7	0.0	-1.9	-0.5	-10.9	0.8	-12.8	0.3
Malaysia	1.8	-1.7	-0.4	-0.6	0.0	-0.3	-0.1	0.0	0.0	-0.1	0.0	-0.9	0.0	1.1	0.4	6.1	0.2	-2.7	-0.5	6.3	0.6	**3.5**	0.1
Mexico	-4.0	-0.6	-0.1	0.1	0.1	-0.4	-0.1	0.1	0.0	0.1	0.0	-0.1	0.0	2.4	0.1	-0.4	0.0	-0.8	0.0	1.8	0.1	**1.1**	0.1
Netherlands	-4.0	0.2	-0.1	0.0	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.3	0.1	-3.1	0.0	-0.3	0.0	0.2	0.1	-3.7	0.1	-3.5	0.1
New Zealand	-0.7	-0.1	-0.1	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2.6	0.0	0.0	0.0	0.3	-0.1	-2.6	0.0	-2.3	-0.1
Norway	-1.1	-0.4	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.1	0.0	8.1	0.0	0.2	-0.1	21.2	0.0	**21.4**	0.0
Peru	0.4	-0.8	0.2	6.2	1.8	-0.1	0.0	1.0	0.4	1.0	0.2	0.0	0.0	-1.3	0.0	0.8	0.0	7.3	2.6	-0.5	0.1	**6.8**	2.6
Philippines	-0.2	-0.6	-0.2	0.1	0.2	-0.1	0.0	0.0	0.0	0.0	0.0	-0.2	0.1	-4.7	-0.1	-0.2	-0.1	-0.6	-0.1	-5.1	-0.2	-5.7	-0.3
Poland	-3.2	-0.5	-0.1	0.6	0.2	-0.3	0.0	0.0	0.0	0.0	0.0	0.3	0.0	-3.5	0.0	-0.3	0.0	-0.2	0.0	-3.5	0.0	-3.7	0.0
Russia	-0.7	0.7	0.0	0.2	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.6	0.0	13.7	1.1	3.7	0.0	1.3	0.0	17.9	1.2	**19.2**	1.2
Saudi Arabia	N/A	-1.7	-0.2	-0.4	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	46.0	0.0	1.2	0.0	-2.4	-0.3	47.3	0.0	**44.9**	-0.3
Singapore	1.8	-1.4	-0.7	-0.1	0.1	-0.4	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	-13.1	1.6	-1.7	0.0	-1.9	-0.7	-14.8	1.6	-16.7	0.9
South Africa	-0.4	3.8	1.7	0.2	0.1	0.4	0.0	0.0	0.0	0.0	0.0	1.7	0.3	-4.5	0.0	-0.1	0.0	4.5	1.8	-2.9	0.3	**1.7**	2.1
Spain	-1.5	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-3.1	0.0	-0.9	0.0	-0.1	-0.1	-4.1	0.0	-4.1	-0.1
Sweden	-0.1	1.2	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-1.9	0.0	-0.2	0.0	1.3	0.1	-2.2	0.0	-0.9	0.1
Switzerland	0.4	-0.4	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.5	0.0	-0.2	0.0	-0.5	0.0	-1.7	0.0	-2.2	0.0
Thailand	-0.9	-4.0	-0.8	-0.8	0.0	-0.5	-0.1	-0.1	0.0	0.0	0.0	-0.3	0.1	-7.1	0.1	-1.4	0.0	-5.4	-0.9	-8.8	0.3	-14.2	-0.7
Turkey	-2.5	-0.9	-0.1	-0.3	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	-1.2	0.0	-0.4	0.0	-1.4	-0.1	-1.7	0.0	-3.1	-0.1
UK	-1.7	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	-0.6	0.0	-0.3	0.0	-0.1	0.0	-1.0	0.0	-1.1	0.0
USA	-2.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-2.2	0.0	-0.1	0.0	-0.2	0.0	-2.2	0.0	-2.3	0.0

Sources: UN Comtrade & authors' calculation.
Net exports of specified commodities to China (columns "Ch") and to the World (columns "W"), expressed in % of GDP. The second column ("Exports Ch") corresponds to total net exports to China; the next five double-columns present net exports of specified metals (iron ore, copper, aluminium, lead, zinc), while the following three correspond to net exports of energy products (coal, crude oil, naural gas). The last columns present aggregate figures for metals, energy, and total mineral commodities (i.e. metals and energy).
Gray cells emphasize figures greater than 1% for more clarity. Country names are in bold for net mineral commodity exporters, i.e. when the figure in the column ("Commodities W") is positive.

Table B.3: Net commodity – metals and energy – exports to China / to the World (in % of GDP).

Country	Exports	Iron Ore		Copper		Aluminium		Lead		Zinc		Coal		Crude Oil		Natural Gas		Metals		Energy		Commodities	
	Ch	W	Ch	W	Ch	W	Ch	W	Ch	W	Ch	W	Ch	W	Ch	W	Ch	W	Ch	W	Ch	W	Ch
Argentina	-5.2	-2.3	-0.2	1.2	-0.1	0.6	-0.1	0.1	0.0	0.0	0.0	-0.5	0.0	-2.3	0.5	-1.6	0.0	-0.4	-0.3	-4.4	0.5	-4.8	0.2
Australia	11.3	22.7	16.2	3.3	1.1	1.6	0.0	0.7	0.1	0.9	0.3	18.0	1.7	-7.9	1.1	3.7	0.0	29.1	17.7	13.7	2.8	**42.8**	20.5
Austria	-2.9	1.5	-0.1	-0.3	0.0	0.1	0.0	0.0	0.0	-0.1	0.0	-0.7	0.0	-6.5	0.0	-2.1	0.0	1.2	-0.1	-9.3	0.0	-8.1	-0.1
Belgium	-2.2	0.8	-0.3	-0.1	0.2	-0.1	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	-3.6	0.1	-1.5	0.0	0.6	-0.1	-5.2	0.1	-4.6	0.0
Brazil	4.5	18.7	7.3	-0.6	0.1	0.2	-0.1	-0.1	0.0	-0.1	0.0	-2.1	-0.1	-2.0	1.9	-1.8	0.0	18.2	7.3	-5.8	1.8	**12.4**	9.0
Canada	-7.0	-0.8	-0.1	1.0	0.3	1.4	0.0	0.0	0.0	0.3	0.0	1.6	0.2	9.3	0.1	2.6	0.0	1.7	0.2	13.5	0.3	**15.2**	0.4
Chile	7.3	0.1	0.5	54.3	18.7	-0.3	-0.1	0.0	0.0	0.0	0.0	-1.4	0.0	-16.5	0.0	-2.9	0.0	54.2	19.0	-20.8	0.0	**33.3**	19.0
China	N/A	-3.2	0.0	-3.3	-0.1	0.4	0.0	-0.2	0.0	-0.2	0.0	-1.1	0.0	-10.9	0.0	-0.6	0.0	-6.4	-0.1	-12.6	0.0	-19.1	-0.1
Hong Kong	5.7	-0.2	0.1	-0.1	0.2	0.0	0.1	0.0	0.0	0.0	0.0	-0.3	0.0	-3.3	-0.6	-0.2	-0.2	-0.3	0.5	-3.8	-0.8	-4.1	-0.4
Finland	0.8	2.6	0.0	-0.1	0.2	-0.3	0.0	0.0	0.0	0.3	0.0	-1.7	0.0	-8.6	0.0	-2.2	0.0	2.5	0.2	-12.5	0.0	-10.1	0.2
France	-6.4	-0.5	-0.1	-0.2	0.0	-0.4	0.0	0.0	0.0	0.0	0.0	-0.5	0.0	-11.7	0.0	-3.4	0.0	-1.1	-0.1	-15.6	0.0	-16.7	-0.1
Germany	-1.5	0.0	0.0	-0.1	0.1	-0.1	0.0	0.0	0.0	-0.1	0.0	-0.6	0.0	-6.1	0.0	-2.4	0.0	-0.3	0.0	-9.1	0.0	-9.4	0.0
India	-12.9	0.3	0.4	-1.6	0.5	-0.5	-0.2	-0.1	0.0	0.2	0.0	-4.8	-0.1	-24.8	0.3	-3.6	0.0	-1.7	0.8	-33.2	0.1	-34.9	0.9
Indonesia	-1.6	-4.4	-0.7	3.5	0.4	-0.1	0.2	-0.1	0.0	-0.2	0.0	12.6	2.9	-10.9	0.0	10.5	0.2	-1.3	-0.2	12.3	3.2	**10.9**	3.0
Italy	-5.2	0.7	-0.4	-1.0	0.0	0.0	-0.1	0.0	0.0	-0.1	0.0	-0.7	0.0	-9.0	0.0	-5.9	0.0	-0.5	-0.4	-15.6	0.0	-16.1	-0.4
Japan	-2.7	2.0	0.7	-0.7	0.4	-0.8	-0.1	-0.1	0.0	-0.1	0.0	-3.7	-0.1	-18.9	0.2	-8.6	0.0	0.4	0.9	-31.2	0.0	-30.9	1.0
Korea	8.6	-1.4	-1.3	-1.4	0.3	-0.6	0.0	-0.3	0.0	-0.1	0.0	-3.5	-0.1	-13.1	1.7	-5.4	0.0	-3.9	-0.9	-21.9	1.5	-25.8	0.6
Malaysia	2.3	-2.2	-0.5	-0.8	0.0	-0.3	-0.2	-0.1	0.0	-0.1	0.0	-1.1	0.0	1.4	0.5	7.7	0.3	-3.5	-0.7	8.0	0.8	**4.5**	0.1
Mexico	-13.2	-2.0	-0.2	0.2	0.5	-1.2	-0.3	0.3	0.1	0.2	0.0	-0.4	0.0	7.9	0.4	-1.3	0.0	-2.5	0.0	6.1	0.4	**3.6**	0.4
Netherlands	-6.3	0.4	-0.1	0.0	0.2	-0.1	0.0	0.0	0.0	0.0	0.0	-0.5	0.1	-4.8	0.0	-0.5	0.0	0.3	0.1	-5.8	0.1	-5.5	0.2
New Zealand	-3.0	-0.6	-0.6	-0.1	0.1	2.0	0.0	0.1	0.0	-0.1	0.0	-0.1	0.0	-11.2	0.0	0.0	0.0	1.3	-0.5	-11.3	0.0	-10.0	-0.5
Norway	-3.3	-1.3	-0.1	0.0	0.0	1.9	-0.1	0.0	0.0	0.1	0.0	-0.1	0.0	40.1	0.1	24.9	0.0	0.7	-0.2	64.8	0.1	**65.6**	-0.1
Peru	1.4	-3.2	0.9	24.3	6.9	-0.4	-0.1	3.9	1.6	4.0	0.8	-0.2	0.0	-5.1	0.1	3.3	0.1	28.5	10.1	-1.9	0.2	**26.6**	10.3
Philippines	-0.8	-2.9	-1.0	0.7	0.7	-0.7	-0.2	0.0	0.0	0.0	0.0	-0.8	0.3	-21.8	-0.6	-1.1	-0.5	-3.0	-0.5	-23.7	-0.7	-26.7	-1.2
Poland	-8.6	-1.4	-0.3	1.6	0.4	-0.8	-0.1	0.0	0.0	0.0	0.0	0.9	0.0	-9.6	0.0	-0.8	0.0	-0.6	0.0	-9.5	0.0	-10.0	0.1
Russia	-2.6	2.6	0.0	0.8	0.0	1.2	-0.1	0.1	0.1	0.0	0.0	2.2	0.2	50.2	4.2	13.4	0.0	4.8	0.0	65.9	4.4	**70.6**	4.3
Saudi Arabia	N/A	-3.1	-0.4	-0.8	0.0	-0.4	-0.1	0.0	0.0	0.0	0.0	0.2	0.0	84.4	0.0	2.2	0.0	-4.3	-0.5	86.8	0.0	**82.5**	-0.5
Singapore	1.1	-0.9	-0.4	-0.1	0.1	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	-8.5	1.0	-1.1	0.0	-1.2	-0.4	-9.6	1.0	-10.8	0.6
South Africa	-1.9	16.4	7.2	1.1	0.3	1.9	-0.1	0.2	0.2	0.0	0.1	7.5	1.4	-19.6	0.0	-0.2	0.0	19.6	7.6	-12.4	1.4	**7.2**	9.0
Spain	-7.1	0.1	-0.4	-0.4	0.1	0.0	0.0	-0.1	0.0	0.1	0.0	-0.4	0.0	-15.0	0.0	-4.5	0.0	-0.3	-0.3	-19.9	0.0	-20.2	-0.3
Sweden	-0.4	3.5	0.3	-0.2	0.0	0.1	0.0	0.1	0.0	0.1	0.0	-0.3	0.0	-5.3	0.0	-0.7	0.0	3.6	0.3	-6.3	0.0	-2.7	0.3
Switzerland	1.2	-1.0	0.0	-0.3	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-4.1	0.0	-0.7	0.0	-1.5	0.0	-4.8	0.0	-6.3	0.0
Thailand	-1.4	-6.0	-1.1	-1.2	-0.1	-0.7	-0.2	-0.1	0.0	-0.1	0.0	-0.5	0.2	-10.7	0.2	-2.2	0.0	-8.2	-1.4	-13.3	0.4	-21.5	-1.0
Turkey	-14.3	-5.3	-0.7	-1.8	0.1	-0.7	-0.1	-0.1	0.1	-0.2	0.0	-1.0	0.0	-6.6	0.0	-2.0	0.0	-8.1	-0.6	-9.6	0.0	-17.7	-0.6
UK	-9.0	-0.3	-0.3	0.1	0.2	-0.2	0.0	0.0	0.0	0.0	0.0	-0.8	0.0	-2.9	0.0	-1.7	0.0	-0.5	-0.1	-5.4	0.0	-5.9	-0.1
USA	-21.2	-1.3	-0.5	0.0	0.3	-0.2	0.1	0.0	0.0	0.0	0.0	1.1	0.1	-23.3	0.0	-0.6	0.0	-1.6	-0.1	-22.8	0.1	-24.4	-0.1

Sources: UN Comtrade & authors' calculation.

Net exports of specified commodities to China (columns "Ch") and to the World (columns "W"), expressed in % of total exports. The second column ("Exports Ch") corresponds to total net exports to China; the next five double-columns present net exports of specified metals (iron ore, copper, aluminium, lead, zinc), while the following three correspond to net exports of energy products (coal, crude oil, naural gas). The last columns present aggregate figures for metals, energy, and total mineral commodities (i.e. metals and energy).

Gray cells emphasize figures greater than 5% for more clarity. Country names are in bold for net mineral commodity exporters, i.e. when the figure in the column ("Commodities W") is positive.

Table B.4: Net commodity – metals and energy – exports to China / to the World (in % of total exports).

Country/Region	2008	2009	2010	2011
Africa				
South Africa	0.5	0.5	0.3	0.4
Total	1.8	1.2	1.1	1.3
Americas				
Argentina	0.2	0.1	0.1	0.1
Brazil	2.1	1.7	2.4	2.2
Canada	1.1	0.8	0.8	0.7
Chile	0.6	0.5	0.5	0.5
Mexico	1.8	1.9	1.7	1.2
United States	11.1	9.0	9.1	9.0
Peru	0.3	0.3	0.3	0.3
Total	17.2	14.4	14.9	14.1
Asia				
China	28.4	39.0	38.2	40.6
Chinese Taipai	3.2	2.7	2.8	2.3
India	2.8	3.0	2.7	2.1
Indonesia	1.1	1.1	1.1	1.1
Japan	6.5	4.8	5.5	5.2
Korea, Rep. of	4.5	5.1	4.4	3.8
Malaysia	1.2	1.2	1.0	1.1
Turkey	2.0	1.8	1.9	2.0
Thailand	1.4	1.2	1.3	1.2
Total	54.6	64.0	62.7	63.1
Europe				
Finland	0.3	0.4	0.4	0.4
France	2.1	1.2	1.0	0.9
Germany	7.8	6.2	6.8	6.4
Greece	0.4	0.3	0.2	0.3
Italy	3.5	2.9	3.2	3.1
Poland	1.3	1.2	1.3	1.3
Russian Federation	4.0	2.3	2.4	3.5
Spain	1.7	1.7	1.7	1.6
Sweden	1.0	0.8	0.9	0.8
United kingdom	0.2	0.1	0.2	0.1
Total	25.2	19.6	20.5	20.8

Sources: Bureau of Resources and Energy Economics & authors' calculation.

Table B.5: Shares of copper consumption by country (in %).

Country/Region	2008	2009	2010	2011
Africa	3.7	3.9	3.9	3.8
China	9.2	9.5	10.3	10.6
Japan and Korea	8.0	7.7	7.6	7.6
Latin America	6.8	7.0	7.1	7.5
Middle East	8.2	8.8	8.8	8.9
North America	28.1	27.2	27.0	26.6
Russian Federation	3.5	3.5	3.7	3.7
Western Europe	9.2	8.8	8.3	8.0
Other Asia Pacific	12.5	13.1	13.0	13.2
Other Europe	10.9	10.5	10.3	10.0

Sources: Bureau of Resources and Energy Economics & authors' calculation.

Table B.6: Shares of oil demand by country/region (in %).

Country/Region	2008	2009	2010	2011
Africa and Middle East				
Qatar	0.1	0.1	0.2	0.2
Saudi Arabia	0.4	0.4	0.5	0.4
South Africa	1.0	0.7	0.5	0.3
Americas				
Argentina	0.3	0.1	0.4	0.3
Brazil	4.2	2.5	3.6	4.4
Canada	0.8	0.3	0.7	0.6
Mexico	0.2	0.1	0.1	0.1
United States	3.7	1.9	3.1	2.8
Venezuela	0.9	0.7	0.3	0.3
Asia and Oceania				
Australia	1.9	2.0	1.0	2.4
China	43.9	54.3	51.8	54.2
Chinese Taipei	0.9	0.8	1.0	1.1
India	6.9	6.4	6.4	6.1
Indonesia	0.1	0.1	0.1	0.1
Japan	8.3	6.7	7.5	6.2
Korea, Rep. of	2.9	2.7	3.1	3.1
Malaysia	0.3	0.1	0.2	0.2
Pakistan	0.1	0.0	0.0	0.1
Europe				
Austria	0.5	0.3	0.3	0.4
Belgium-Luxembourg	0.7	0.2	0.4	0.4
Bulgaria	0.0	0.0	0.0	0.0
Czech Republic	0.4	0.3	0.3	0.3
Finland	0.2	0.1	0.2	0.2
France	1.1	0.6	0.8	0.7
Germany	2.7	1.8	2.4	2.0
Hungary	0.1	0.1	0.1	0.1
Italy	1.0	0.5	0.7	0.7
Netherlands	0.6	0.4	0.5	0.5
Poland	0.5	0.3	0.3	0.3
Portugal	0.0	0.0	0.0	0.0
Romania	0.3	0.1	0.1	0.1
Russian Federation	5.2	5.1	5.1	4.1
Slovakia	0.3	0.3	0.3	0.2
Spain	0.4	0.3	0.3	0.3
Sweden	0.4	0.1	0.2	0.2
Turkey	0.4	0.4	0.4	0.3
Ukraine	3.1	2.7	2.8	2.3
United Kingdom	0.9	0.6	0.6	0.5
Rest of the World	4.2	5.9	3.5	3.5

Sources: Bureau of Resources and Energy Economics & authors' calculation.

Table B.7: Shares of iron ore consumption by country (in %).

B.2 Global VAR specification and tests

	Countries		Oil block		Metal block	
	Endogenous	Exogenous	Endogenous	Exogenous	Endogenous	Exogenous
GDP	X	X		X		X
Investment	X	X		X		X
Exports	X					
Inflation	X	X				
REER	X					
Oil price		X	X			
Oil surplus			X			
Oil production			X			
Metal price		X			X	
Metal inventories					X	
Metal production					X	

Table B.8: GVAR specification.

Country	Lags endogenous variables	Lags exogenous variables	Number of cointegration vectors
Argentina	2	1	3
Australia	1	1	1
Austria	1	1	3
Belgium	1	1	1
Brazil	1	1	2
Canada	1	1	4
Chile	1	1	1
China	1	1	1
Finland	1	1	4
France	1	1	3
Germany	1	1	3
Hong Kong	1	1	2
India	1	1	2
Indonesia	1	1	4
Italy	1	1	2
Japan	1	1	2
Korea	1	1	2
Malaysia	1	1	4
Mexico	1	1	4
Netherlands	1	1	4
New Zealand	1	1	1
Norway	1	1	2
Peru	1	1	1
Philippines	1	1	4
Poland	1	1	4
Russia	1	1	4
Saudi Arabia	3	1	1
Singapore	1	1	3
South Africa	1	1	2
Spain	1	1	3
Sweden	1	1	2
Switzerland	1	1	3
Thailand	1	1	3
Turkey	1	1	4
United Kingdom	1	1	2
United States	1	1	3
Metals block	1	1	1
Oil block	1	1	0

Table B.9: Number of lags and cointegration vectors.

Test	Number (percentage) of rejection of null of parameter stability					
	GDP	Inflation	Exports	Investment	REER	Total
PK sup	5 (13.9)	3 (8.3)	1 (2.8)	5 (13.9)	0 (0)	14 (7.8)
PK msq	6 (16.7)	1 (2.8)	4 (11.1)	4 (11.1)	0 (0)	15 (8.3)
Nyblom	7 (19.4)	4 (11.1)	4 (11.1)	4 (11.1)	6 (16.7)	25 (13.9)
Robust Nyblom	2 (5.6)	2 (5.6)	2 (5.6)	2 (5.6)	2 (5.6)	10 (5.6)
QLR	13 (36.1)	10 (27.8)	10 (27.8)	11 (30.6)	7 (19.4)	51 (28.3)
Robust QLR	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
MW	9 (25)	7 (19.4)	4 (11.1)	5 (13.9)	6 (16.7)	31 (17.2)
Robust MW	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Number (percentage) of rejection of null of parameter stability per variable across the country-specific models at 5% level. PKsup and PKmsq are based on the cumulative sums of OLS residuals, Nyblom test for time-varying parameters and QLR, MW are the sequential Wald statistics for a single break at an unknown change point.

Table B.10: Stability tests for countries.

	Test	Price	Stock	Production
Metal block	PK sup	0.708	0.933	0.619
	PK msq	0.089	0.108	0.119
	Nyblom	0.758	**1.214**	**1.046**
	Robust Nyblom	0.926	**1.047**	**1.259**
	QLR	16.721	**17.255**	16.967
	Robust QLR	15.374	16.270	12.874
	MW	6.607	**9.050**	**8.892**
	Robust MW	9.692	10.847	8.430
Oil block	PK sup	0.961	0.483	0.567
	PK msq	0.163	0.049	0.048
	Nyblom	0.412	0.276	0.204
	Robust Nyblom	0.644	0.373	0.291
	QLR	8.153	5.280	7.087
	Robust QLR	171.829	13.889	6.955
	MW	3.771	1.801	1.692
	Robust MW	135.020	9.264	2.939

In bold: rejection of null of parameter stability per variable across the Commodity block-specific models at 5% level. PKsup and PKmsq are based on the cumulative sums of OLS residuals. Nyblom test for time-varying parameters and QLR, MW are the sequential Wald statistics for a single break at an unknown change point.

Table B.11: Stability tests for commodity blocks.

Domestic variable	GDP		Inflation		Exports		Investment		REER	
Statistic	ADF	WS	ADF	WS	ADF	WS	ADF	WS	ADF	WS
Critical Value	-2.89	-2.55	-2.89	-2.55	-2.89	-2.55	-2.89	-2.55	-2.89	-2.55
Argentina	-3.65	-3.42	-7.28	-7.57	-5.35	-5.54	-3.71	-3.51	-6.43	-6.64
Australia	-5.66	-5.71	-7.29	-7.25	-7.18	-7.34	-5.84	-6.04	-6.20	-6.39
Austria	-5.74	-5.90	-6.57	-6.80	-4.33	-4.50	-4.21	-4.03	-5.23	-5.38
Belgium	-4.86	-5.05	-6.72	-6.94	-6.28	-6.15	-4.27	-4.39	-5.07	-5.27
Brazil	-6.06	-5.53	-6.58	-6.72	-6.64	-6.69	-6.03	-6.12	-6.41	-6.62
Canada	-4.91	-4.98	-7.50	-7.72	-4.82	-4.91	-5.09	-5.22	-6.48	-6.66
Chile	-5.64	-5.68	-8.32	-8.46	-4.01	-4.04	-5.94	-6.12	-7.08	-7.08
China	**-2.48**	-2.70	-7.23	-6.91	-4.99	-4.93	-5.26	-5.43	-6.26	-6.46
Finland	-4.56	-4.72	-8.61	-8.81	-5.98	-6.07	**-2.73**	-2.93	-4.52	-4.61
France	-3.31	-3.52	-10.52	-10.75	-4.06	-4.25	**-2.81**	-2.96	-4.95	-5.08
Germany	-4.74	-4.92	-11.46	-11.67	-4.91	-5.10	-5.44	-5.64	-4.88	-5.08
Hong Kong	-4.30	-4.38	-9.21	-9.42	-4.58	-4.78	-5.05	-5.17	-4.82	-5.00
India	-5.18	-5.28	-7.26	-8.31	-7.89	-7.77	-6.35	-6.24	-4.88	-4.61
Indonesia	-4.41	-4.60	-7.31	-7.58	-6.29	-6.60	-4.12	-4.31	-6.09	-6.34
Italy	-3.88	-4.08	-7.40	-7.59	-4.77	-4.96	**-2.81**	-2.87	-5.17	-5.06
Japan	-5.61	-5.68	-10.99	-11.23	-5.90	-6.10	-4.40	-4.30	-4.09	-4.29
Korea	-5.05	-5.19	-9.91	-9.94	-5.20	-5.31	-4.78	-4.92	-6.75	-6.95
Malaysia	-4.94	-5.06	-7.85	-8.19	-5.56	-5.75	-4.73	-4.88	-5.88	-6.07
Mexico	-4.67	-4.28	-6.25	**-2.13**	-5.60	-4.53	-3.31	-3.52	-4.23	-4.38
Netherlands	-3.32	-3.48	-10.34	-10.59	-4.03	-4.23	-4.86	-5.02	-5.01	-5.20
New Zealand	-5.87	-6.04	-9.84	-9.70	-7.72	-7.94	-6.87	-7.04	-5.54	-5.74
Norway	-7.42	-7.39	-11.67	-11.89	-7.16	-7.29	-6.71	-6.86	-6.16	-6.37
Peru	-5.46	-5.66	-6.75	-6.85	-7.97	-8.11	-4.23	-4.42	-5.53	-5.72
Philippines	-5.98	-6.17	-8.03	-8.04	-6.42	-6.48	-5.38	-5.57	-6.53	-6.73
Poland	-4.20	-3.31	-8.22	-7.78	-5.90	-5.51	-5.29	-5.25	-6.83	-7.03
Russia	-4.46	-4.66	-6.43	**-2.52**	-7.66	-7.60	-4.65	-3.78	-6.34	-5.72
Saudi Arabia	**-1.89**	**-1.95**	-9.08	-6.02	-5.52	-5.73	**-1.70**	**-1.94**	-6.10	-6.22
Singapore	-5.69	-5.60	-6.15	-6.44	-4.61	-4.71	-6.29	-6.44	-4.13	-4.31
South Africa	-3.54	-3.70	-7.53	-7.86	-7.69	-7.87	-3.55	-3.07	-5.97	-6.17
Spain	**-1.86**	**-2.16**	-9.59	-9.29	-5.70	-5.81	**-2.23**	**-2.49**	-4.58	-4.30
Sweden	-4.62	-4.95	-9.38	-9.31	-4.69	-4.80	-3.46	-3.50	-5.30	-5.22
Switzerland	-4.43	-4.62	-7.35	-7.28	-7.47	-7.68	-5.95	-6.12	-5.96	-6.13
Thailand	-5.74	-5.93	-7.82	-8.15	-5.76	-5.94	-3.45	-3.71	-6.75	-7.00
Turkey	-6.13	-5.85	-8.54	-8.88	-5.30	-5.26	-3.60	-3.82	-7.44	-7.59
United Kingdom	-4.12	-4.35	-8.13	-8.94	-6.98	-7.19	-5.73	-5.93	-5.19	-5.31
United States	-3.67	-3.87	-9.76	-10.16	-5.14	-5.24	-3.24	-3.45	-5.94	-6.00

Commodity variable	Price		Stock		Production	
Statistic	ADF	WS	ADF	WS	ADF	WS
Critical value	-2.89	-2.55	-2.89	-2.55	-2.89	-2.55
Metal block	-5.43	-5.62	-5.53	-5.56	-6.62	-6.28
Oil block	-7.15	-7.34	-6.34	-6.52	-5.63	-5.77

For first difference : in bold rejection of stationarity at 5%.The stationarity is rejected by both ADF and WS for first difference only in a few cases.

Table B.12: Unit root tests on first difference.

Country	GDP	Inflation	Exports	Investment	REER
Argentina	0.65	0.78	0.16	0.70	0.85
Australia	0.14	0.58	0.01	0.29	0.59
Austria	0.71	0.62	0.63	0.54	0.03
Belgium	0.71	0.81	0.64	0.16	0.03
Brazil	0.35	0.49	0.35	0.54	0.57
Canada	0.83	0.79	0.63	0.77	0.44
Chile	0.14	0.63	-0.02	0.38	0.16
China	0.22	0.16	0.46	0.64	0.19
Finland	0.76	0.65	0.70	0.58	0.11
France	0.70	0.87	0.64	0.73	0.22
Germany	0.68	0.78	0.82	0.44	0.29
Hong Kong	0.41	0.63	0.41	0.23	0.56
India	0.18	0.56	0.36	0.15	0.15
Indonesia	0.84	0.76	0.72	0.65	0.69
Italy	0.71	0.48	0.82	0.62	0.33
Japan	0.59	0.63	0.74	0.18	0.33
Korea	0.72	0.72	0.15	0.63	0.47
Malaysia	0.78	0.67	0.71	0.74	0.33
Mexico	0.65	0.43	0.63	0.38	0.45
Netherlands	0.77	0.70	0.57	0.56	0.44
New Zealand	0.07	0.68	-0.01	0.04	0.33
Norway	0.27	0.68	0.03	0.00	0.26
Peru	0.09	0.48	-0.08	0.10	0.01
Philippines	0.46	0.59	0.58	0.38	0.31
Poland	0.48	0.35	0.55	0.44	0.49
Russia	0.80	0.91	0.39	0.63	0.76
Saudi Arabia	0.92	0.21	0.91	0.95	0.33
Singapore	0.49	0.59	0.45	0.43	0.51
South Africa	0.57	0.01	0.62	0.59	0.16
Spain	0.91	0.73	0.64	0.80	0.06
Sweden	0.51	0.80	0.45	0.61	0.27
Switzerland	0.66	0.82	0.25	0.49	0.30
Thailand	0.79	0.78	0.72	0.46	0.36
Turkey	0.77	0.48	0.53	0.75	0.26
United Kingdom	0.55	0.73	0.16	0.32	0.49
United States	0.56	0.82	0.57	0.65	0.37

	Price	Stock	Production
Metals block	0.36	0.02	0.01
Oil Block	0.50	0.14	0.10

Table B.13: Single equation adjusted R-squared.

B.3 Simulation results: Comparison between hard landing and soft landing

Country	GDP	Exports	Investment	REER
Argentina	-14.5	-16.7	-35.9	0.0
Australia	-1.4	-3.7	-7.0	-9.6
Austria	-5.8	-17.0	-8.7	-4.5
Belgium	-3.6	-11.7	-7.0	-5.4
Brazil	-8.4	-9.7	-27.0	-31.2
Canada	-1.3	-4.0	-5.2	-11.5
Chile	-6.6	-12.2	-20.2	-7.1
China	-13.7	-31.1	-13.8	16.4
Finland	-13.2	-21.6	-24.9	-1.1
France	-3.5	-4.7	-10.0	-5.8
Germany	-5.7	-16.6	-10.9	-6.3
Hong Kong	-9.1	-10.0	-16.5	49.7
India	-5.8	-23.7	-20.1	-9.1
Indonesia	-9.6	-25.2	-24.4	-25.3
Italy	-5.3	-14.7	-10.9	-2.5
Japan	-6.6	-29.7	-4.7	4.4
Korea	-3.1	-17.4	-5.3	-5.4
Malaysia	-10.7	-16.0	-30.2	-7.4
Mexico	-3.9	-7.6	-7.0	-2.0
Netherlands	-6.4	-7.5	-16.0	3.9
New Zealand	-0.9	-3.3	6.2	-16.8
Norway	-2.6	0.3	-15.4	-5.3
Peru	-7.1	-6.9	-20.7	6.8
Philippines	-6.3	-29.9	-22.7	2.6
Poland	-8.4	-15.0	-28.5	-6.6
Russia	-13.6	-8.1	-29.8	-20.0
Saudi Arabia	-10.0	-14.7	-27.2	16.9
Singapore	-11.2	-19.4	-24.8	-4.9
South Africa	-4.8	-18.3	-13.8	-9.0
Spain	-0.8	-7.9	-1.5	-3.7
Sweden	-6.2	-13.7	-13.8	-7.0
Switzerland	-4.0	-9.3	-9.6	-0.3
Thailand	-10.2	-15.8	-29.3	-16.4
Turkey	-7.3	-0.8	-16.1	-10.8
United Kingdom	-2.3	-14.6	-3.8	11.5
United States	-1.3	-15.1	-2.6	16.5

Table B.14: Hard landing vs soft landing: Median cumulated losses after 5 years for each country (in %).

Region	GDP	Exports	Investment
Advanced	-2.8	-14.2	-4.5
ASEAN	-9.4	-20.7	-24.1
Asia	-10.2	-25.9	-14.1
Asia (ex. Chn)	-6.5	-22.5	-14.5
Asia ADVs	-5.8	-23.8	-5.9
Asia EMEs	-11.3	-27.0	-16.2
Asia EMEs (ex. Chn)	-6.9	-22.4	-20.7
Emerging Countries	-10.1	-20.1	-16.6
Emerging Countries (ex. Chn)	-7.5	-14.7	-18.5
Euro Area	-4.3	-11.2	-8.0
Latin America	-7.5	-8.6	-19.1
Other EMEs	-9.9	-8.5	-21.3
World	-6.7	-16.9	-10.2
World (ex. Chn)	-4.7	-13.8	-9.3

Table B.15: Hard landing vs soft landing: Median cumulated losses after 5 years for each region (in %).