China and the world in 2030: Global dynamic scenarios

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1. Introduction

Simulations of various policy scenarios for the world economy, especially in the context of climate change, would be impossible without constructing a reliable baseline scenario depicting how the world economy might evolve over the coming decades. The analysis of any future policy responses relies on the comparison against the business as usual (or no policy response) scenario. The resulting policy agenda depends to a large extent on the accuracy of the baseline scenario.

Forecasting the size and structure of the world economy so far into the future is a very uncertain exercise; this makes the need to provide a detailed account of the underlying assumptions and modeling parameters along with a thorough sensitivity analysis even more crucial to a meaningful debate among various researchers involved in the long term dynamic modeling. The aim of this paper is to contribute to the ongoing debate by documenting the construction of the baseline scenario for the World Bank study on "China 2030" (DRC and World Bank, 2012) based on the Envisage model (van der Mensbrugghe, 2010). The focus of this study is on China, but the modeling effort is global and aims to capture the likely developments in the world economy. A similar set of issues arises in constructing a baseline for any country. A considerable attention has been paid to incorporate into the model the Balassa-Samuelson type of effects as we expect the price levels in China to approach the price level of developed economies as it reaches the high income status.

This paper documents the construction of the baseline (or low growth) scenario for the evolution of the global economy and China's role in the world in the coming decades for the "China 2030" study. This study includes also a high growth scenario, but to illustrate the mechanisms at work we focus only on the baseline scenario. World Bank's Envisage model with a dynamic core is essentially a neoclassical growth model. Aggregate growth is predicated on assumptions regarding the growth of the labor force, savings/investment decisions (and therefore capital accumulation), and productivity. The Envisage model has a considerably developed structure. First, it is multisectoral. This allows for complex productivity dynamics including differentiating productivity growth between agriculture, manufacturing, and services and picking up the changing structure of demand (and therefore output) as growth in incomes leads to a relative shift into manufactures and services. Second, it is linked multiregionally, allowing for the influence of openness—through trade and finance—on domestic variables such as output and wages. The model is also global, with globally clearing markets for goods and services and balanced financial flows. Third, the Envisage model has a diverse set of productive factors, including land and natural resources (in the fossil fuel sectors), and a labor split between unskilled and skilled. Finally,

ENVISAGE has been developed into an Integrated Assessment Model (IAM) with a fully closed loop between economics and climate change.

However, there are several phenomena that are difficult to capture in a structural dynamic CGE model. Over the recent years the price level in China has been increasing significantly and therefore the size of Chinese economy will be largely underestimated by our model that tracks only the historical volume growth, but underestimates the price growth. In addition our standard version of Envisage seems to also underestimate the structural change that would be consistent with that of other developing countries in the past. In addition the model needs to be modified to better capture the Balassa-Samuelson effect. This last issue has been the focus of the modeling effort in this study. The baseline includes several modifications to the model specification or parameters as compared to the standard version of the Envisage in order to better capture the Balassa-Samuelson effects. First, we model the real estate markets in the services sectors. In several developing countries fast economic growth and increases in real estate prices have been positively correlated, which in turn pushed up prices of non-tradable goods. Secondly ,we increase the Armington elasticities of substitution for manufacturing goods. This keeps the domestic prices of manufacturing products in line with the world prices. Finally, we increase of labor productivity in manufacturing relative to services by even more than in the standard version of the Envisage following sectoral TFP estimates for China. The paper provides a detailed account of the implication of each of the above modifications. Overall they result in a much faster growth of relative prices in developing countries than in high-income countries as compared to the standard Envisage specification. The prices in most developing regions are increasing at a faster rate than prices in high income countries except for South Asia and Sub-Saharan Africa. By 2030, prices in China increase 31% relative to their 2004 level, or 16 percentage points higher than the growth of US prices over the same period.

The final section summarizes implications of various changes to the key assumptions, parameters and functional forms, pointing out to their impact on economic growth, sectoral structure, and relative prices. The lessons will be drawn for the future scenario building based on the additional sensitivity analysis with respect to the key dynamic drivers (e.g. relative sectoral productivity growth) to be carried out in the near future.

2. Main features of the Envisage

The long-term scenarios described in this paper are based on the World Bank's Envisage model – a recursive global dynamic CGE model. It is calibrated to the GTAP version 7.1 database and allows for a flexible aggregation of 112 countries/regions and 57 sectors. The version employed in this study includes 14 countries/regions[1] and 20 sectors.

[1] The regions included in this applications: Japan, rest of high income countries, United States, EU27, China, Rest of East Asia, India, Rest of South Asia, Russia, Rest of Europe and Central Asia, Middle East and North Africa, Sub-Saharan Africa, Brazil, Rest of Latin America and the Caribbean.

This section covers the main features of the Envisage, a full description is provided in van der Mensbrugghe (2010). The production side of the model has an elaborate CES structure that allows for the formulation of various substitutability and complementarily relations between inputs and factors of production. The standard version has a non-energy bundle of goods combined with a value added and energy bundle to produce goods. The value added plus energy bundle is further decomposed into capital and energy on the one hand of all other factors of production on the other. The Envisage has a vintage structure of capital, typically energy will be less substitutable for capital in the short term i.e. with older vintages, but more substitutable in the longer term i.e. with newer vintages of capital.

Income is derived from returns to factors of production: labor, capital, land and natural resources. All income is allocated to a single representative household. Household demand is implemented with a consistent demand system. The Envisage allows for four different specifications: LES/ELES (extended/linear demand system), CDE (Constant differences in elasticity) and AIDADS (An Implicitly Directly Additive Demand System). LES/ELES have poor Engels behavior, which is a problem in the long term simulations. CDE has more flexibility, but is also restrictive in a dynamic setting. AIDADS allows for the marginal budget shares to change with income providing more plausible Engle behavior, but its estimation and calibration in the model are much more complex than of other demand system and is still a focus of research.

Government derives its income from various taxes: sales, excise, import duties, export, production, factors and direct taxes. Investment revenues come from household, government and net foreign savings. Government and investment expenditure function are derived from the CES functions.

International trade is associated with three different price wedges: export taxes, import tariffs and trade margins. Transportation margins are linked to the demand for actual services and allocated across the model's regions as to minimize cost.

Envisage has five factors of production: unskilled and skilled labor, capital, land, and natural resources that are sectors specific. In this version of the model we introduce market segmentation that allows for rural and urban migration as a function of relative wages. Aggregate land supply follows a logistic curve with an absolute maximum available supply calibrated to FAO data.

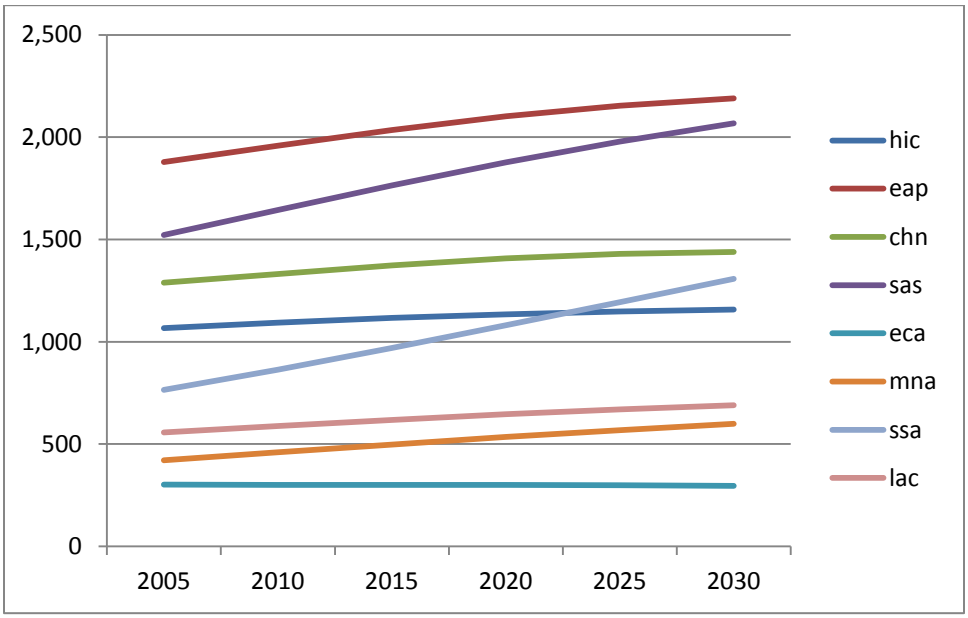
The standard scenario incorporates three closure rules. Typically government expenditures are held constant as a share of GDP, fiscal balance is exogenous while direct taxes adjust to cover any changes in the revenues to keep the fiscal balance at the exogenous level. The second closure rule determines the investment savings balance. Households save a portion of their income with the average propensity to save influenced by demographics and economic growth. Government savings and foreign savings are exogenous in the current specification. As a result, investment is savings driven, so that the total amount of savings depends on household savings, but the price of investment goods is determined by the overall volume of investment too. Finally, the last closure determines the external balance. In the current application we fix the foreign savings and therefore the trade balance. Therefore changes in trade flows will results in shifts in the real exchange rate.

Finally, ENVISAGE has been developed into an Integrated Assessment Model (IAM) with a fully closed loop between economics and climate change. Economic activity generates greenhouse gas emissions. ENVISAGE accounts for the so-called Kyoto gases that comprise of carbon (C or CO2), methane (CH4), nitrous oxide (N2O) and the fluoridated gases (F-gases). Greenhouse gas emissions are added to the existing stock of atmospheric gases—that also interact with terrestrial and oceanic stocks—leading to changes in atmospheric concentration. Using a reduced form set of equations, changes in atmospheric concentration convert into changes in radiative forcing that in turn drive changes in atmospheric temperature. ENVISAGE closes the loop between climate and the economy by converting the climate signal as summarized by the global mean temperature into an economic impact.

3. Core dynamic drivers and GDP baseline

The long term projections rely on the assumptions regarding developments in the core macroeconomic variables such as population and the main components of GDP, which in the neoclassical model consist of labor, capital and productivity. We take United Nations' population forecast revision from 2008 for the current simulations[2]. According to UN projections the world populations will increase from 6.5 billion in 2005 to 8.3 billion in 2030, while Chinese population is expected to increase from 1.29 billion in 2005 to 1.44 billion in 2030. Figure 1 displays UN forecast for China and seven major World Bank regions: high-income (HIC), East Asia and Pacific (EAP), South Asia (SAS), Europe and Central Asia (ECA), Middle East and North Africa (MNA), Sub-Saharan Africa (SSA) and Latin America and the Caribbean (LAC).

Figure 1 Population scenario, various regions through 2050, millions



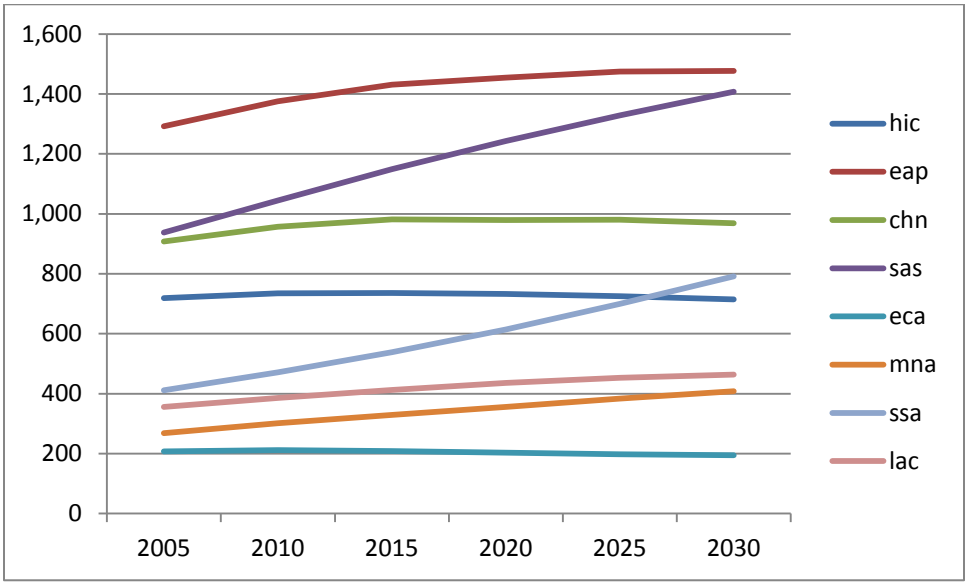
[2] The UN has released a new projection in May 2010. There are relatively modest changes with respect to the older projection with the total population in 2050 increasing to 9.31 billion versus 9.15 billion in the 2008 projections.

Source: UN Population Division, 2008 Revision

According to UN projections, almost all growth of population in 2030 comes from developing countries with the population of HICs growing by only 92 million out of the 1.8 billion total population' growth. ECA is the only region where the UN expects a drop in total population of 6 million over this period. The average annual population growth in China is expected to slow down from 0.64% in 2005 to 0.13% in 2030. As a result the share of Chinese population in world population will drop from 20% in 2005 to 17% in 2030.

The evolution of labor force is assumed to be in line with the growth of the working age population- i.e. population between 15 and 64[3]. According to UN forecast (Figure 2), high income countries and ECA would see their labor force declining from 2015 onwards. The labor force in South Asia is expected to increase by 50%, while Sub-Saharan Africa's labor force is expected to double over 2005-2030 period. From 2020 onwards the Chinese labor force stabilizes and then declines at an average annual rate of 0.3%. This will likely pose a challenge to the continuation of the fast economic growth.

Figure 2: Working age population (15-64) through 2050, millions



Source: UN Population Division, 2008 Revision

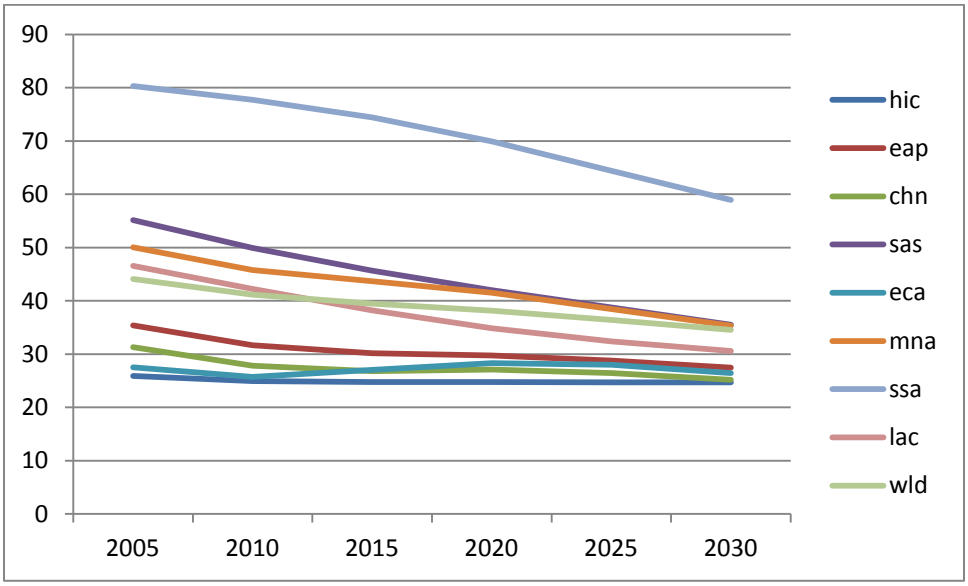
In the baseline the aggregate growth of labor force is assumed exogenous, but the skill mix of labor force will also impact the economic growth and structural transformation. In the current version of the baseline the growth rates of skilled and unskilled labor are assumed uniform. However, it can be expected that with increasing rates of education the growth of skilled labor force will surpass the growth of unskilled labor force. Further, the baseline simulation also allows for the labor market segmentation,

[3] This is a simplistic assumption given that the overall labor force participation rates are likely to increase as more women enter the labor force in developing countries or due to the rise in the retirement age in high income countries.

where rural and urban labor markets clear separately and where unskilled rural workers migrate to cities in response to expected relative level of wages (Harris and Todaro, 1970). The initial level of migration in 2004 is assumed to correspond to 1% of the unskilled rural labor force[4].

Capital accumulation in the model is assumed to follow the standard neo-classical growth dynamics where in any given period capital stock is equal to the depreciated capital stock from the previous period augmented with the new investment. We assume a depreciation rate of 6% for China throughout the entire period. Investment is driven by savings, which in turn depend on per capita income growth and the youth and elderly dependency ratios (the number of persons aged under-15 or over-65 respectively per 100 in the working age population). According to UN projections the global average youth dependency ratio is expected to decrease from 44 to 35 youth per 100 in the working age population over the 2005-2030 period (see Figure 3). All regions see a declining trend with the highest drop recorded in South Asia and Sub-Saharan Africa. In China the youth dependency ratio falls from 31 to 25 per 100 in the working age population and by 2030 it reaches the levels typical of the high income countries.

Figure 3 Youth dependency ratio, Number of persons aged under-15 relative to 100 working age population



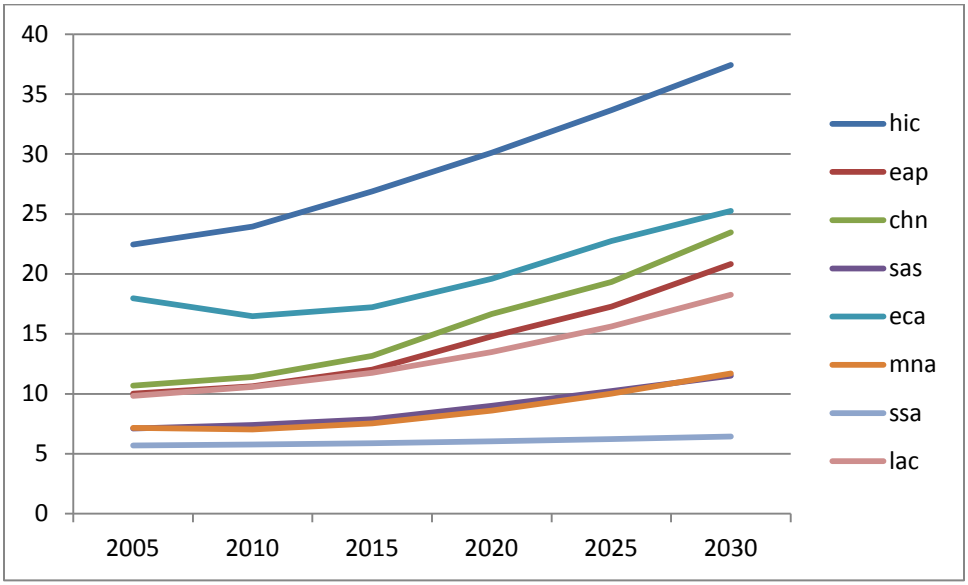
Source: UN Population Division, 2008 Revision

While youth dependency ratios decline, the elderly dependency ratios increase in all regions (see Figure 4). The world average elderly dependency ratio increases from 11 to 18 per 100 in the working age population. The highest elderly dependency ratio is typical for the high income countries, where the share of the elderly in total population increases to 23% in 2030 from 15% in 2005. However the elderly dependency ratio increases rapidly for all regions. In China the elderly are expected to constitute 16% of

[4] This assumption might be underestimating the actual migration. The net rural-urban migration during the 1990s was 125.5 million (Chan and Hu, 2003), which would indicate an annual outflow of about 4%, but it is likely that the rural-urban migration has slowed down significantly in the more recent years.

total population in 2030 with the old-age dependency ratio increasing from 11 per 100 in the working age population in 2005 to 25 in 2030. The aging of the population is likely to affect not only the saving rates and fiscal solvency of the pension system, but it is also likely to lead to a shift in consumer demand toward services (notably health-related) and away from consumer goods, durables an housing. The effects of population aging on consumer demand are not captured in the current version of the ENVISAGE model.

Figure 4 Elderly dependency ratio, Number of persons aged over 65 relative to 100 working age population



Source: UN Population Division, 2008 Revision

While the national savings are determined by income and demographic factors, the foreign savings are exogenous in the baseline. We assume the foreign savings level such that the current account balances decline to a sustainable level. In the case of China the current account surplus is consistent with the observed values up to 2010 and then declines from the projected 8% of GDP in 2011 to 3% of GDP in 2030.

The assumptions on productivity growth are more complex. Different approaches are adapted to three broad sectors: agriculture, manufacturing and services. In the case of agriculture, productivity growth is fixed and averages 2 per cent per annum. Productivity growth in manufacturing and services is only labor-augmenting. The two productivity paths are linked by the assumption that productivity growth in manufacturing is 2 percentage points higher than productivity growth in services. This wedge is doubled to 4 percentage points for developing countries and to 8 percentage points in the case of China. The assumption for China is broadly consistent with the findings of Bosworth and Collins (2007), who find that in late 1990s the output per worker in manufacturing grew over 6 times faster than the output per worker in services. Finally, the productivity in services is calibrated so as to achieve the assumed per capita income growth. This methodology is applied for the observed income growth up to 2010 and then to the World Bank Global Economic Prospects short term projections up to 2012. From 2013 onwards

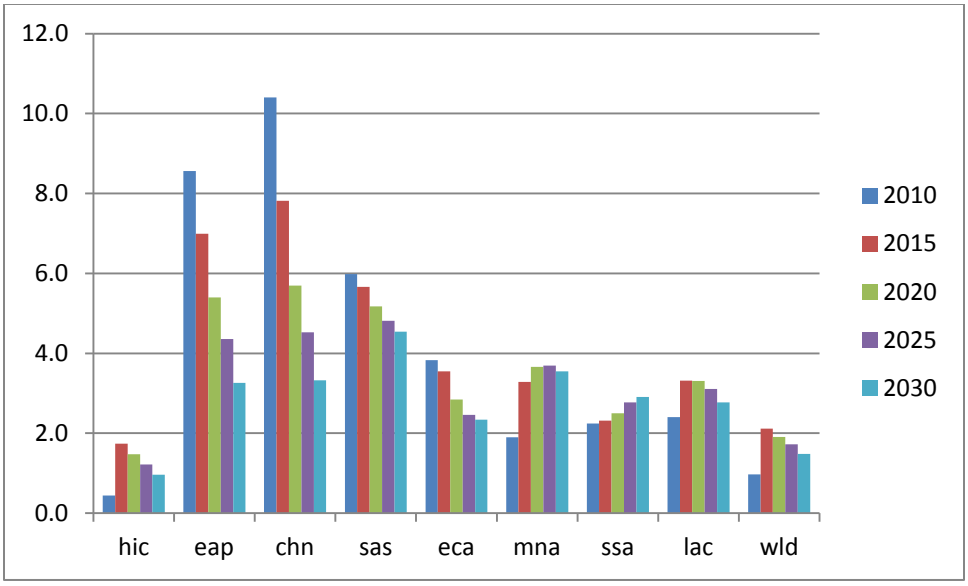
we assume an exogenous uniform productivity factor in services and income growth then becomes endogenous. In the baseline from 2013 onwards the uniform productivity factor in services s assumed to be equal to 6% for China[5] and India, to 3% for other developing countries and to 1% for high income countries.

The previous paragraphs discussed core dynamic drivers of the model, the resulting per capita growth rates are depicted in Figure 5. In the baseline scenario the average annual per capita growth in China slows down dramatically towards the end of the projection period from initial 10% to only 3%. The pattern of per capita income growth in the East Asia and Pacific is very similar to that of China, which dominates the region. The average per capita income growth in high income countries slows down from an average of 2% in 2015 to 1% in 2030. South Asia becomes the fastest growing developing region with an average growth of 5% per annum in 2030. This implies that in constant prices (2004 USD) China's weight of the world economy increases from 5% in 2005 to 13% in 2030, while the weight of developing countries almost doubles from 21% to 42% over this period. Similar weights in constant purchasing power parity prices would amount to 19% for China in 2030 (up from 9% in 2005) and 66% for developing countries (up from 44% in 2005). One should expect the nominal shares at market exchange rates to be even higher as prices are expected to grow faster in developing countries relative to high-income countries (Balassa-Samuelson effect).

In the low growth scenario the historical trend of a faster productivity growth in manufacturing as compared to agriculture and services is extrapolated. The productivity growth in developing countries is faster than in developed countries, as they catch up quickly to the productivity frontier. This results in a faster economic growth in developing countries overall. However, due to slower growth or productivity in services, their relative prices increase. This results in the increasing share of services in the economy and therefore slower macroeconomic growth overall as low productivity sectors (services) become relatively more important. The demand side developments also lead to the expansion of share of services. In high income countries the demand for health and personal services is expected to grow with the aging societies. In developing countries ageing will play a similar role, but demand for services is likely to increase as income per capita rises. The increasing importance of services will lead to a flow of capital to these sectors, which will further reduce the overall growth rates.

[5] The resulting productivity factor for manufacturing is 20% or (0.06+0.04)*2.

Figure 5 Per capita income growth rates, percent per annum.



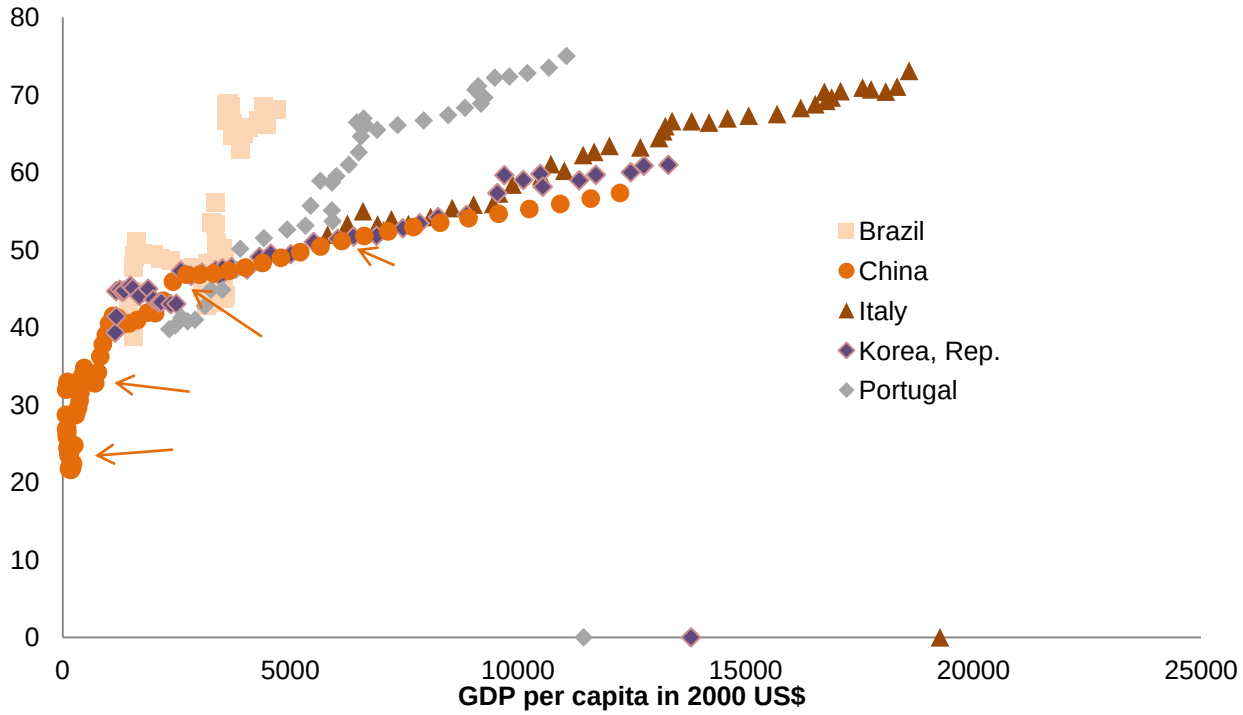
Source: World Bank Envisage model.

4. Capturing the Balassa-Samuelson effect

Developing countries and especially China have been experiencing much faster economic growth than developed countries. However, tradability varies across sectors and the scope for technological improvements is much slower in non-tradable sectors. With lower per capita income and lower productivity in tradable sectors, developing countries also have initially lower wages. As growth ensues and productivity gains are achieved in tradable sector real wages are driven up faster than labor productivity in non-tradable sectors. The prices in non-tradable sectors are driven up by higher wages resulting in real exchange rate appreciation.

Even though the model captures most of these mechanisms i.e. the productivity gains in the tradable sector are faster and hence result in a drop of prices of manufacturing products in developing countries relative to their tradable sectors and also relative to tradable goods in developed countries. However, the resulting changes in relative prices across tradable and non-tradable sectors and internationally, as well as the extent of structural change are much smaller than what we would have expected based on historical trends typical for developing countries (see Figure 6).

Figure 6 China's future share in services and historical experiences of other countries.



Source: China 2030, Figure 3, p. 403.

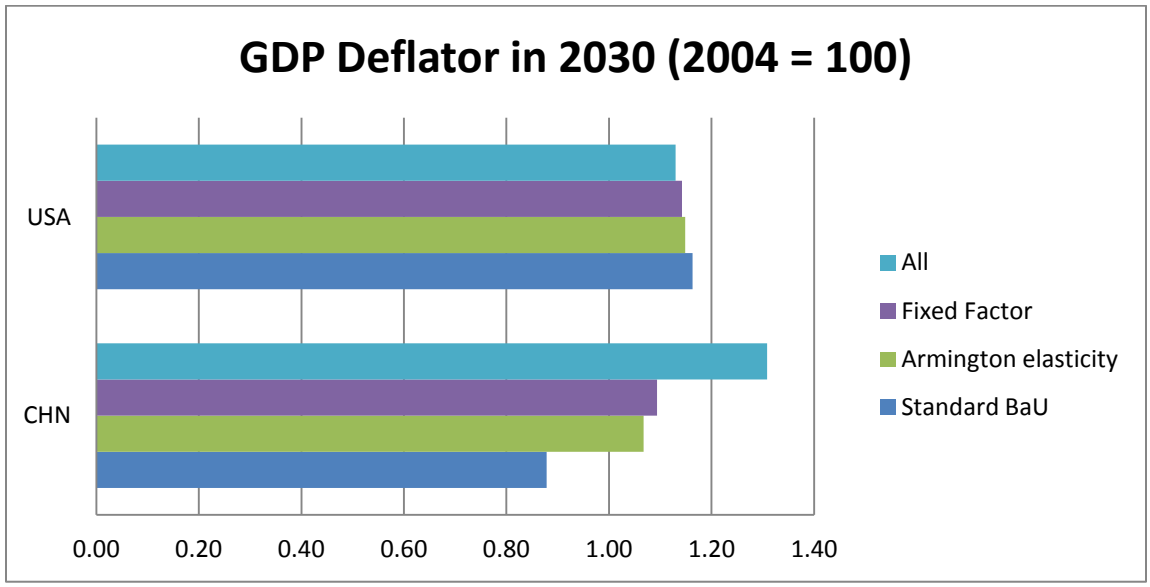
The baseline includes several modifications to the model specification or parameters as compared to the standard version of the Envisage to better capture the Balassa-Samuelson effect. We introduce a few modifications to the model specification and parameters. First, we model the land markets in the services sectors. In several developing countries economic growth tended to result in the faster growth of real estate prices as compared to other factors of production, which in turn pushed up the prices of non-tradable goods. Housing prices tend to increase with income and indeed the share of housing investment in China doubled from 5 to 10 percent over 2003-2010. The average housing prices tripled between 2003 and 2009. The bubble ended in late 2011 when prices began to fall, however in the long run housing prices are correlated with income growth and therefore expected to continue to increase faster than prices of other factors of production. Secondly, we double our standard assumption on the Armington elasticities of substitution for manufacturing goods. This keeps the domestic prices of manufacturing products in line with the world prices bringing them closer to the law of one price.

Both of the above modifications contribute to a faster growth of relative prices in China as compared to the US. The prices in most developing regions are increasing at a faster rate than prices in high income countries. By 2030 the prices in China increase 31% relative to their 2004 level, or 16 percentage points higher than the growth of US prices over the same period (see Figure 7). Without these modifications the relative prices in China would have been projected to fall relative to US prices, as fast capital

accumulation in China would be driving down the prices of capital-intensive manufacturing goods in China.

The relative contribution of different changes to the parameters and specification to the development of relative prices in China vs. the US is displayed in Figure 7. Relative to the standard specification the biggest impact on relative prices is achieved through the inclusion of a fixed factor in services representing the tensions in the property markets in urban areas where the availability of land is limited. The introduction of a fixed factor also leads to the fastest growth of the prices of services sectors and their expansion in the value of total output (see Table 1).

Figure 7 GDP Deflator in 2030 under various model specifications relative to the US GDP deflator (2004 = 1).



Source: World Bank Envisage model.

Table 1 Value share of services and prices of services in China in 2030.

	Value share of services	Index of services prices
Standard BaU	36.3	0.97
Armington elasticity	37.9	1.20
Fixed Factor	43.2	1.39
All	44.0	1.68

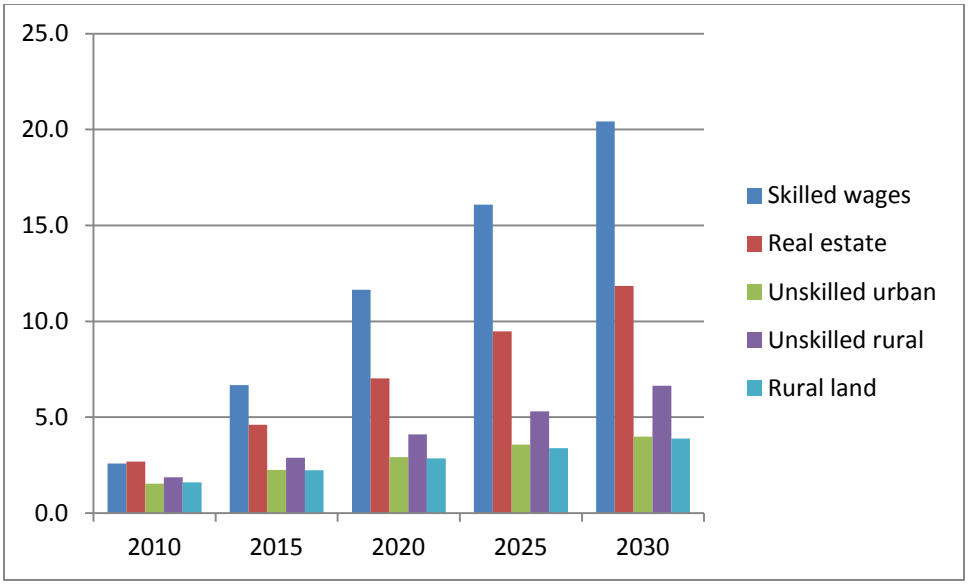
5. Focus on China

5.1.Factor prices and unit costs of production

As China becomes a high income country it is expected to move away from the production of agricultural and manufacturing products towards services. This is consistent with the developments in other developing countries where the rise of income has been associated with a growing share of services in total output. The structural shift is accompanied by changes in relative prices. The prices of services are expected to double over the 2005-2030 period (see Figure 7), while prices of manufacturing products fall. The rapid increase of productivity in manufacturing prevents the prices of manufacturing products from growing despite large inflation of the costs of factors of production (see Figure 8).

The expansion of production of services leads to a relatively faster increase in the rewards of factors used intensively in this sector. Hence the wages of skilled workers increase over 21 times, while the price of real estate (the sector-specific factor used in services) increases over 12 times over 2004-2030 period. The rapid growth of the economy is also associated with rising wages of unskilled workers in rural areas (6.5 times) and to a smaller extent in urban areas (4 times). The land prices in rural areas are also expected to rise almost 4-fold over 2005-2030.

Figure 8 Factor prices in China relative to their benchmark 2004 level (2004=1).



Source: World Bank Envisage model.

Table 1 Unit cost of production relative to their benchmark 2004 level (2004 =1).

	2005	2010	2015	2020	2025	2030
Crops	1	1.2	1.3	1.3	1.4	1.4
Livestock	1	1.2	1.3	1.4	1.4	1.4
Coal	1	1.1	1.3	1.5	1.7	1.8
Oil	1	1.1	1.2	1.3	1.5	1.5
Natural gas	1	1.1	1.2	1.3	1.5	1.6
Minerals n.e.s.	1	1.1	1.2	1.3	1.4	1.5
Food products	1	1.0	1.0	0.9	0.9	0.9
Textiles	1	1.0	1.0	0.9	0.9	0.9
Wearing apparel and leather	1	0.9	0.9	0.9	0.9	0.8
Chemical, rubber, plastic products	1	1.0	0.9	0.9	0.9	0.8
Mineral products and metals	1	1.0	0.9	0.9	0.9	0.9
Motor vehicles transport equipment	1	0.9	0.9	0.9	0.8	0.8
Electronic equipment	1	1.0	0.9	0.9	0.9	0.9
Other manufacturing	1	0.9	0.9	0.9	0.8	0.8
Petroleum, coal products	1	1.0	1.1	1.1	1.2	1.2
Coal based electricity	1	1.1	1.3	1.5	1.7	1.9
Gas and oil based electricity	1	1.0	1.0	1.0	1.0	1.0
Hydro electricity	1	1.0	0.7	0.7	0.7	0.7
Nuclear electricity	1	1.0	1.0	1.0	1.1	1.1
Other electricity	1	1.0	1.0	1.0	1.1	1.2
Gas distribution	1	1.0	1.0	1.0	1.0	1.0
Construction	1	1.0	1.0	1.0	1.0	1.0
Transport (air sea n.e.s.)	1	1.0	1.0	1.0	1.0	0.9
Services	1	1.3	1.7	1.9	2.1	2.1

Source: World Bank Envisage model.

5.2.Structural changes

The rebalancing of growth in China towards services and domestic consumption results in economic growth that is much more labor-intensive as compared to the investment-intensive growth of the previous decades. The share of investment in GDP in China decreases from 42% in 2004 to 19% in 2030 slowing down the capital deepening (increasing capital/output ratios) typical for the previous decades. At the same time the inclusion of a proxy for the real estate market with the fixed factor in the production of services results in a dramatic structural change, much higher than would normally have been predicted with the standard model setup where the shift towards services is mainly driven by the increasing demand from households and also as inputs to industry since technological change is slow. The share of series in the total economy value added more than doubles over the period increasing from 32% in 2004 to over 67% by 2030. This is mainly driven by a substantial increase of prices, as the growth of volume share of services in value added increases only by 2 percentage points of total value added. At

the same time the share of manufacturing in total value added decreases from 37% to 10.5% (see Table 2).

Table 2 Sectoral value added shares in China over 2005-2030.

	2005	2010	2015	2020	2025	2030
Crops	5.1	4.7	4.3	3.9	3.5	3.3
Livestock	2.2	2.5	2.6	2.8	2.8	2.8
Coal	1.4	1.3	1.2	1.1	1.0	0.9
Oil	1.3	0.9	0.8	0.7	0.5	0.4
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0
Minerals n.e.s.	1.8	2.2	2.4	2.5	2.6	2.5
Food products	3.7	2.2	1.4	1.0	0.7	0.6
Textiles	1.6	1.2	0.8	0.5	0.4	0.3
Wearing apparel	1.6	1.2	0.8	0.5	0.3	0.2
Chemicals	6.0	4.8	4.2	3.4	2.8	2.4
Mineral products	8.7	8.2	6.5	4.9	3.9	2.9
Motor vehicles	2.0	1.9	1.5	1.0	0.8	0.6
Electronic equipment	2.4	1.6	1.2	0.8	0.6	0.5
Other manufacturing	10.4	9.6	7.4	5.4	4.0	3.1
Petroleum, coal products	5.3	4.5	4.4	4.0	3.7	3.4
Coal based electricity	2.8	2.6	2.3	2.1	1.9	1.8
Gas and oil based electricity	0.2	0.2	0.2	0.2	0.2	0.2
Hydro electricity	0.5	0.5	0.7	0.7	0.7	0.7
Nuclear electricity	0.1	0.1	0.1	0.1	0.1	0.1
Other electricity	0.0	0.0	0.0	0.0	0.0	0.0
Gas distribution	0.1	0.1	0.1	0.1	0.1	0.1
Construction	5.0	5.4	4.6	3.8	3.3	2.2
Transport	6.2	5.8	4.9	4.3	3.9	3.6
Services	31.6	38.5	47.6	56.2	62.1	67.3

Source: World Bank Envisage model.

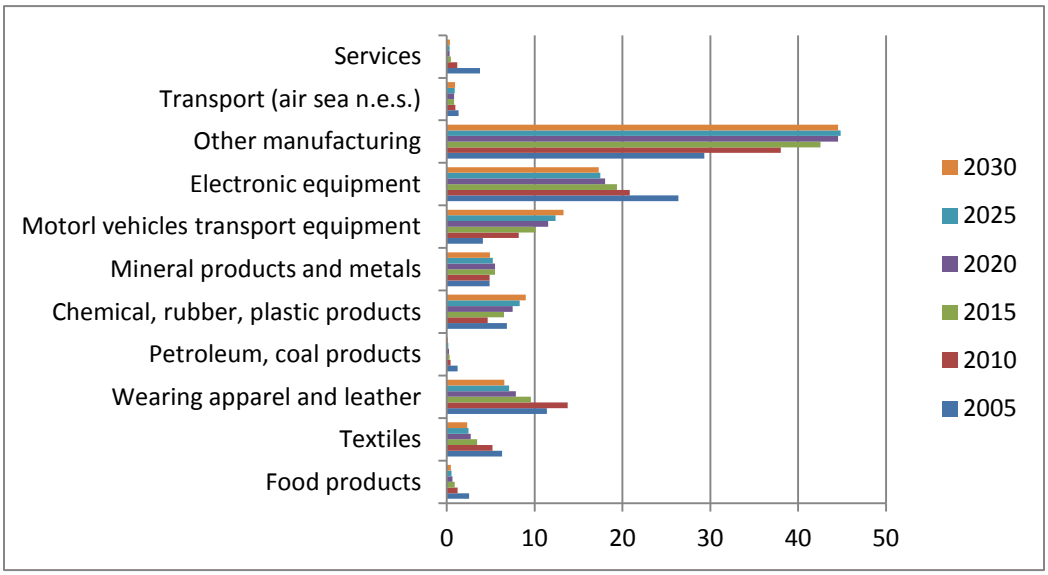
5.3.International trade

Higher productivity growth in Chinese manufacturing sector as compared to other developing countries leads to a reduction of relative prices of manufacturing goods relative to manufacturing goods from other developing country competitors. Hence exports of manufacturing expand faster than exports of other sectors. Among the manufacturing sectors, the highest increases in the volume of exports are recorded in motor vehicles and transport equipment; other manufacturing and chemicals, rubber and

plastic products (see Figure 9). Given the level of aggregation of the model it is difficult to assess the level of sophistication of Chinese exports, however motor vehicles and transport equipment are relatively skilled-labor intensive as compared to other manufacturing sectors indicating a possible shift towards products more technologically advanced products.

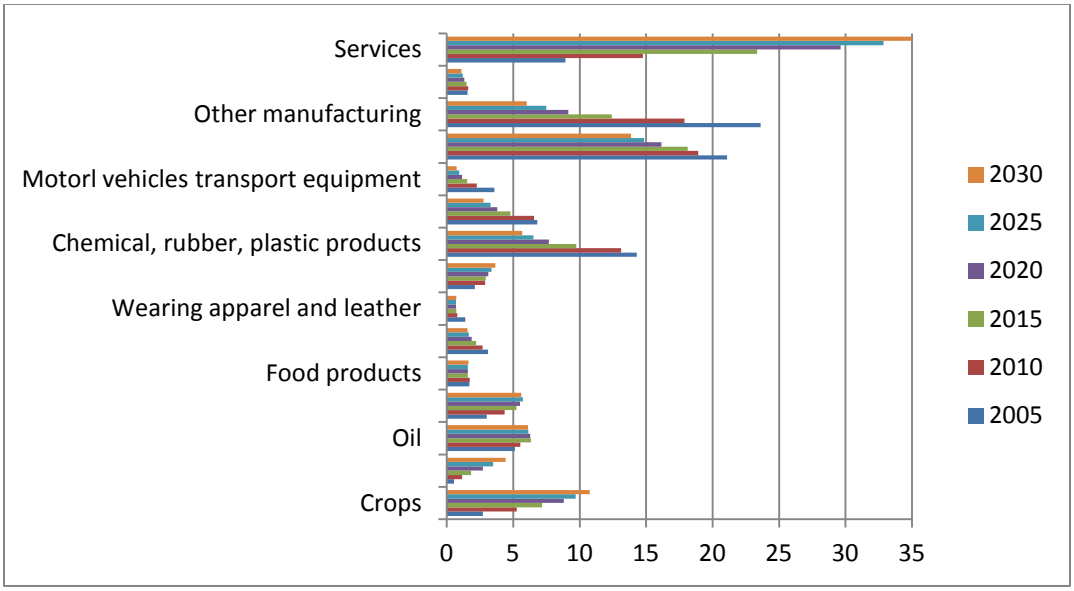
As Chinese services are becoming relatively more expensive their exports drop from already small values to only 18% of their original level by 2030. China's imports of services expand substantially (Figure 10). Their share of total imports is expected to more than triple to 36% in 2030. Strong increases in imports are also expected in the case of agricultural products and their share of total imports increases five fold up to 15% in 2030. Overall the expansion of services expected to occur in China is not consistent with its comparative advantage leading to an even greater import dependence.

Figure 9 Sectoral structure of Chinese exports (percentage share of total exports).



Source: World Bank Envisage model.

Figure 10 Sectoral structure of Chinese imports (percentage share of total imports).



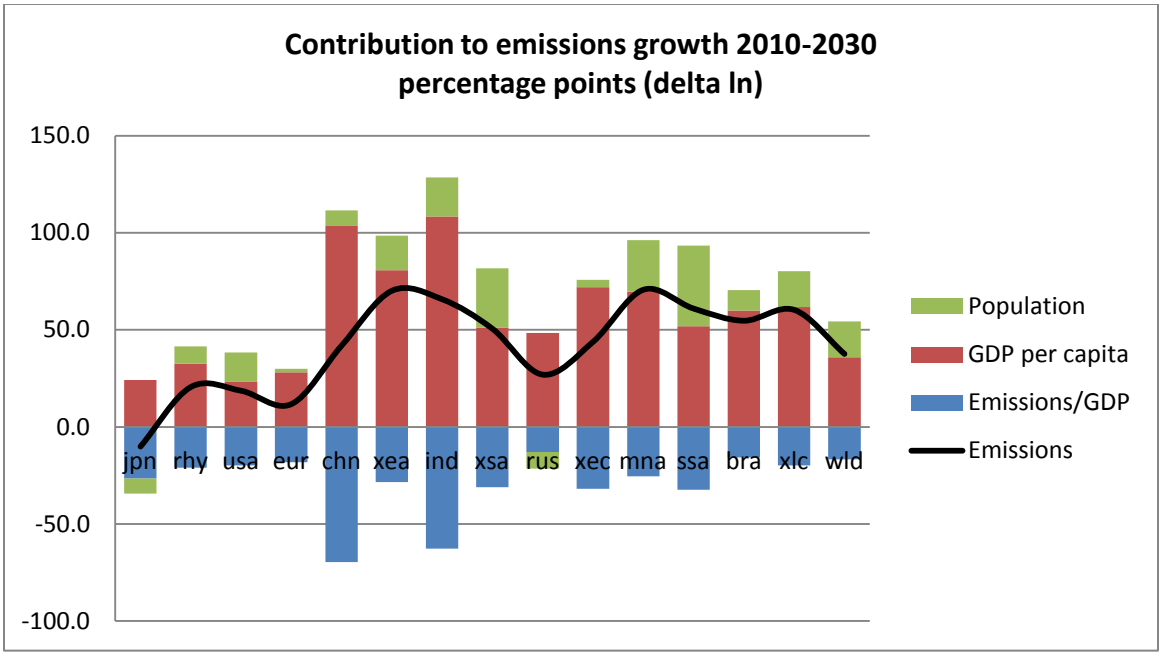
Source: World Bank Envisage model.

With further expansion of the Chinese economy and trade, Chinese share in world exports expands from 8% to 20% by 2030, while its share of world exports of manufacturing products expands even faster from 10% in 2004 to 29% in 2030. The share of China in world total imports expands from 6% to 14% over the same period. The relative weights of different trading partners are also expected to change with the fast growing developing regions such as Sub-Saharan Africa; South Asia and Middle East and Africa playing an increasing role as a destination for Chinese exports. Despite a slowdown in the expansion of exports over time, trade directed to the Sub-Saharan Africa is expected to register the annual growth rate of 8% over 2005-2030.

6. Climate Change

In the baseline scenario global annual emissions are expected to increase around 50 percent over the next 20 years. This is largely due to growth in GDP per capita and to a lesser extent to population growth, while emissions per unit of GDP are expected to decline (Figure 11).

Figure 11 Determinants of emissions growth (percentage points).



Where:	Japan
rhy	Remaining high-income countries
usa	United States
eur	EU27 and EFTA
chn	China
xea	Rest of East Asia
ind	India
xsa	Rest of South Asia
rus	Russia
xec	Rest of Europe and Central Asia
mna	Middle East and North Africa
ssa	Sub-Saharan Africa
bra	Brazil
xlc	Rest of Latin America and the Caribbean

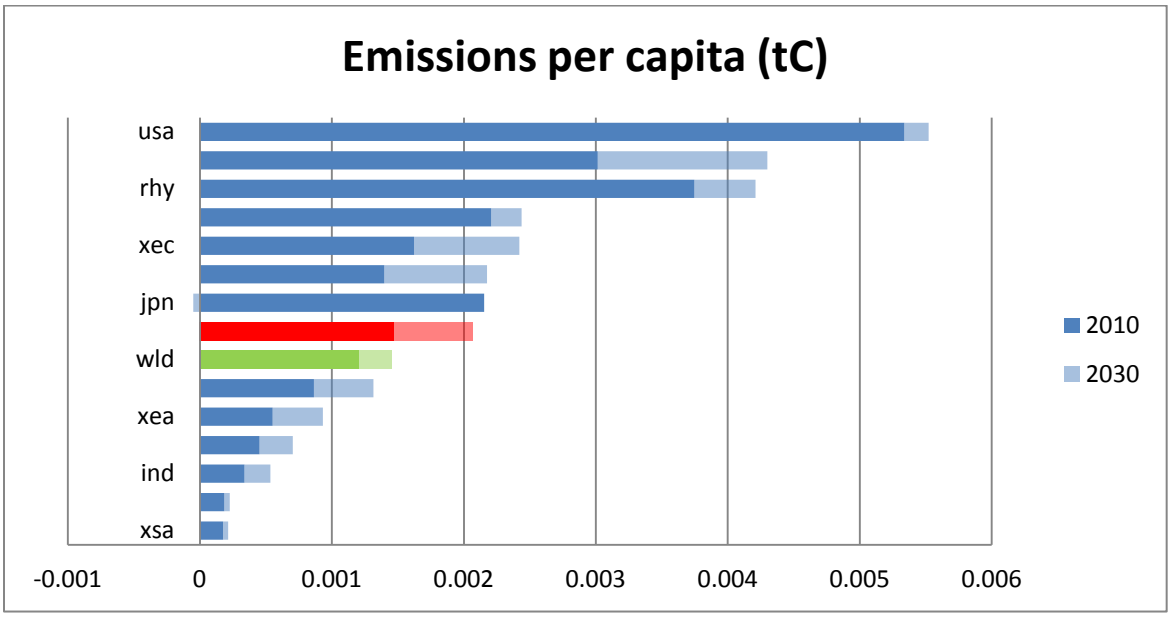
Source: Envisage model based simulations, DECPG.

In that baseline scenario developing countries are the origin of 85 percent of the increase in global emissions, much larger than their share of 57 percent in global emissions. A quarter of the global increase will come from China. The large share of developing countries in the global increase during the next 20 years reflects higher population growth and higher per-capita GDP growth than in high-income countries, although the relation between growth in developing countries and global emissions is rather intricate.

Developing countries' share in future global population growth is 95 percent, larger than the 83 percent share in future growth of global emissions. On the other hand, developing countries' share in future global GDP growth is 41 percent, smaller than their share in emission growth. These numbers reveal two important realities. Emissions per capita are still relatively low in developing countries. Therefore, population growth in the developing world does not translate in a proportional growth of global emissions, even as the per-capita emissions are expected to rise somewhat (Figure 12). However, emissions per unit of GDP are relatively high in developing countries and China is among the countries with highest emission intensity in the world. A key reason for the high emission intensity in the developing world is the low valuation of non-tradable products in those countries, which makes GDP

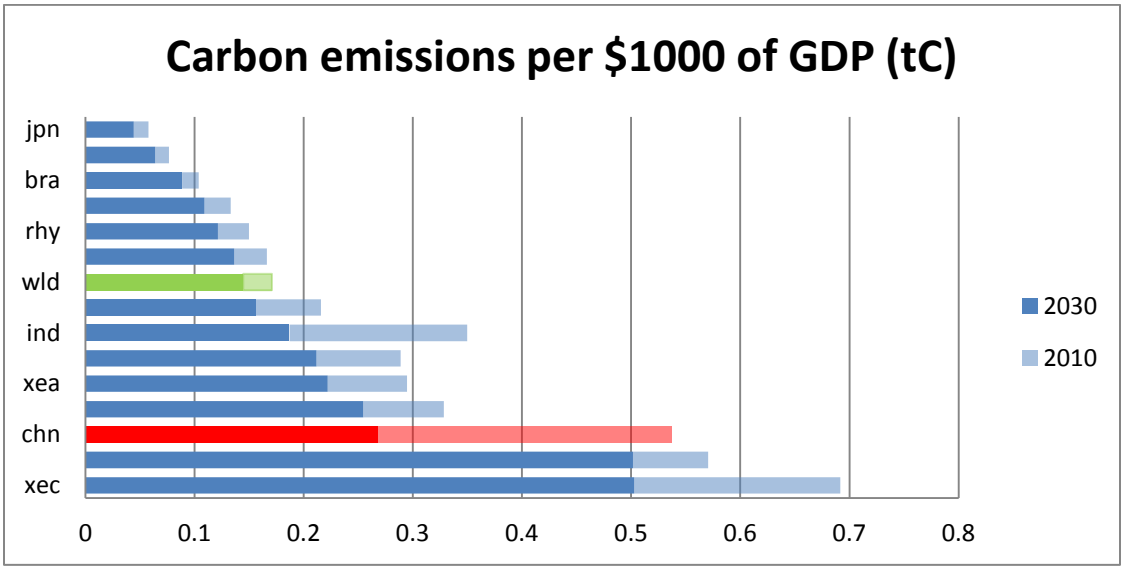
relatively small. Especially in China another reason is the small share of services and the large share of manufacturing. As a consequence of the high emission intensity, GDP growth in the developing world leads to more than proportional growth in global emissions, even as the emission intensity is expected to decline sharply (Figure 13) along with the shift to services and the rise in the relative price of non-tradable products.

Figure 12 Carbon emissions per capita in the baseline (tC).



Source: Envisage model based simulations, DECPG.

Figure 13 Carbon emissions in the baseline (tC/$1000 of GDP)..



Source: Envisage model based simulations, DECPG.

This scenario highlights several reasons for China to participate in, and indeed help shape, global climate change policies. Currently 24 percent of global CO2 emissions come from China, making China the largest emitter and also during the coming decades China is expected to be responsible for a quarter of the increase in emissions, even in a baseline that assumes a significant shift towards the service sectors in China. This means that effective global policies are not feasible without China's participation.

China's production is already energy-intensive and energy supply has become one of the key bottlenecks for future growth. If China does not participate when other countries increasingly implement climate-change policies, it would be forced into an artificial comparative advantage of energy-intensive production, making the country even more dependent on future energy supply.

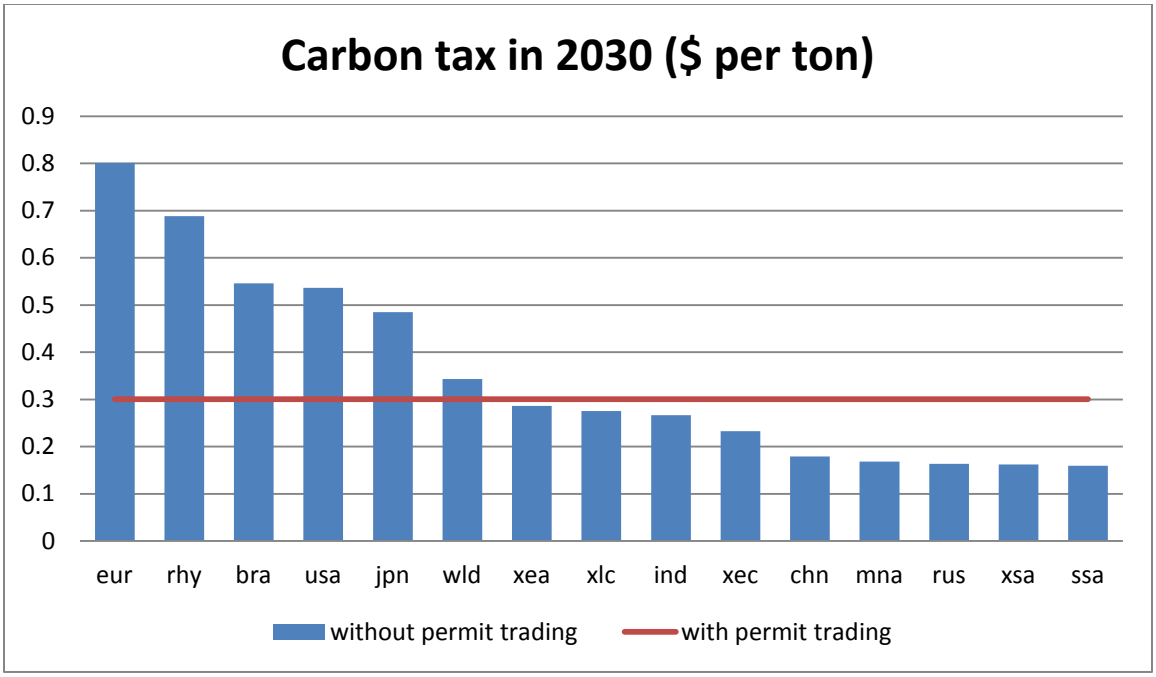
Mitigation costs are relatively low in China. When energy intensity is high to start with, it is relatively easy to economize on energy. Moreover, the large share of coal use in China implies an opportunity to reduce carbon emissions through fuel switching. Perhaps the most important reason for the low mitigation costs in China is its high investment rate. Only a small part of future production capacity is already locked-in and China has, in comparison with other countries, ample opportunities to choose appropriate technologies. The low mitigation costs imply that China can achieve emission target with relatively low carbon taxes. It also implies that China is likely to benefit from a global permit trading system.

There are not only compelling reasons for China to participate in global climate-change policies, but it is also important that China helps shape a global agreement. Current proposals are strongly colored by vested interests in developed economies, which produced historically high emissions and which are not expected to grow rapidly in coming decades. Many of the proposals contain therefore targets that are based on historical emissions. In China, and other developing countries, historical per-capita emissions are low and the need for future growth is paramount. From that perspective targets should take future growth into account.

Two policy scenarios can illustrate these points. Both scenarios are based on so-called 30-30-30 targets. In 2030 developed economies reduce their emissions to 30 percent below their 2005 levels and developing countries reduce their emissions 30 percent below the 2030 baseline emissions. This means that global emissions in 2030 would be 34 percent below the baseline levels, but still9 percent above the 2005 levels.

In the first policy scenario each country reaches its own target by imposing a local carbon tax. Because mitigation costs differ across countries these local taxes differ too (Figure 14).

Figure 14 Carbon tax in 2030 ($ per ton) in the scenarios with and without trading of emission permits.



Source: Envisage model based simulations, DECPG.

In this first scenario the share of developing countries in global emissions is allowed to rise further, to 70 percent in 2030, compared with 57 percent now and 65 percent in the baseline in 2030. In China exports are energy intensive, carbon emission quotas work similarly to carbon taxes increasing the price of energy-intensive products worldwide. This allows China to obtain higher prices for its exports, which are more energy-intensive than its production and therefore to produce less and to consume more (of products that are less energy intensive). Hence even though the impact on GDP is negative (by 2030 the GDP in China is 1.5% smaller than in the baseline), the impact on household and government consumption is positive. The revenue from carbon taxes is transferred as a lump sum to households and their consumption over 2010-2030 is 0.6% higher, while the government consumption is 0.8% higher than in the baseline. The volume of investment decreases by 0.8% as compared to the baseline. The volume of exports and imports decreases, but the drop in the volume of exports is faster (4.3% as compared to 2.6% for imports). China moves away from the production of coal and gas-based electricity and towards less carbon-emission intensive methods of generating electricity (hydro, nuclear and other).

In the second policy scenario we allow for trading of the emission permits. Global agreement with permit trading is much more efficient from the global perspective, as the global tax is smaller than the average global tax in the first policy scenario and the global GDP is larger. Due to lower mitigation costs, China can sell its permits and use that income to increase household consumption. With tradable emission permits the increase in household consumption is 23% higher than in the first policy scenario.

The global agreement works like a double divided to China, it allows it to move away from energy-intensive production mainly consumed by foreigners (domestic consumption is less energy-intensive than exports) and it allows China to increase domestic consumption thanks to the income from the sale of emission permits.

Global agreement would be also more beneficial to China than if China tried to reduce the carbon emissions alone. In the third policy scenario we reduce the carbon emissions in China to the same extent as in the first scenario (30% relative to the baseline emissions), but not imposing any emission quotas on other countries. The third option is the least beneficial to China, halving the real consumption gains as compared to the first policy scenario. The impact on GDP is slightly positive through higher demand from other regions, but the overall impact on the national income is negative as compared to the scenario where all countries reduce their carbon emissions.

7. Concluding remarks

Several striking features emerge from the baseline scenario presented in this paper. First, we expect a further rise of developing countries' role in the world economy along with the continuing importance of China. Rapid growth along with the appreciating exchange rates of developing countries will make them the main destination of world exports. The developing countries outside China will contribute more than 40 percent to global growth by 2030. China is expected to contribute between 20 to 30 percent to the growth of the global economy over this time horizon.

Second, ageing populations, declining investment rates and a shift towards low-productivity services is going to slow down economic growth across the world. High income countries will see their growth halve over the next decades, while according to various scenarios for developing countries their growth will be also significantly slower dropping from an average 6.5 percent to 4.5 percent. Despite the slowdown in economic activity the environmental pressures will not ease. The anticipated greenhouse gas emissions in India and China are expected to double between now and 2030.

Third, middle income countries will dominate international trade in manufacturing goods, but we expect to see across-the-board shift towards production of services. Globally their share of value added is expected to increase from current 56 percent to 65 percent by 2030. The rebalancing of the growth in China towards services and domestic consumption results in a growth that is much more labor intensive as opposed to the investment-intensive growth of the previous decades.

Finally, when analyzing different policies to reduce the CO2 emissions we note that the global agreement with permit trading is the most efficient from the global perspective and it would also increase the household consumption in China through the revenue from the sale of tradable emission permits.

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