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Capital Flows in the XXIst Century: A
prospective analysis with the INGENUE 2 model

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**ASIAN CATCH UP, WORLD GROWTH AND INTERNATIONAL CAPITAL
FLOWS IN THE XXIST CENTURY: A PROSPECTIVE ANALYSIS WITH
THE INGENUE 2 MODEL**

NON-TECHNICAL SUMMARY

The world has been trapped in a paradox for a few years. The world saving investment balance defies the teaching of international economics. Whereas rich aging countries should provide financing to poorer and younger ones, the opposite has arisen, at least as far as the US is concerned. Controversy has raged on the sustainability of this pattern of world financing. Opinions diverge on the timing of adjustment to “a more normal pattern”. Macroeconomists talk about a sustainable US deficit of 3% of GDP. But why should the US carry a deficit forever?

The present paper takes a different view. It does not try to make prediction on the adjustment being smooth or bumpy. But it attempts to define what might be the “normal pattern” in XXIst century global capitalism. Such an approach cannot obviously be that of a single country, be it the US. Only the perspective of a world growth regime is valid. This regime should encapsulate the most salient long-run trends in the world economy for the next fifty years or so. These trends are the demographic transition and the catching up of very large emerging market countries.

The proper tool to investigate a world growth regime based upon such trends is a worldwide dynamic computable general equilibrium model, embodying a meaningful breakdown of the world and overlapping generations. The INGENUE2 model fits with these requirements. It divides the world into ten regions based on both demographic and geographic criteria. With twenty-one overlapping generations in each region, differences in aging amongst the different parts of the world can be captured in detail. Since long run saving depends essentially on the optimal behavior of households in their life cycle, the age structure of the population is a primary determinant of the saving patterns in the ten regions of the world. This is the underlying factor in the supply of capital. On the demand side, capital investment will depend essentially on the catching up process that modulates growth differential between the ten regions. Therefore the “normal pattern” of current account balances and net foreign asset positions is endogenous and can be traced from the basic assumptions that foster population forecasts and speed of technological catching up.

A baseline scenario is investigated using the UN central demographic projection until 2050 prolonged by a demographic model, which computes the change in the age structure for the ten regions under the hypothesis of a convergence to a stationary population some time after 2100. The process of technological diffusion, which is the engine of the catching-up, is based upon an assumption of convergence in total factor productivity. In the baseline scenario these assumptions are somewhat conservative, with only China, India and Eastern Europe on a fast track.

In the baseline scenario, the most salient feature is the return of the US current account balance to sustained surplus after 2010. This ensues from the dynamic equilibrium of the model. Real interest rates are neutral rates in so far as they are compatible with the intertemporal budget constraint of every region of the world. Being a high income and ageing country, the US is to improve households saving, so that they generate enough future surpluses for their foreign debt to be sustainable in the long run. This is what we call the “normal pattern”.

In this scenario, Europe is a slow-growth region and a pervasive world creditor with an appreciating real exchange rate. Such a rentier position in the world growth regime may be suitable for European households who will enjoy capital income and gains in purchasing power on imported goods. But the continuous slowing down of growth entails mounting financial constraints on the pay-as-you-go retirement system and risks of more adverse developments than anticipated in the baseline scenario.

The baseline scenario is somewhat conservative about the speed of catching up in the developing regions, as compared to the historical experience of Asian countries that took off in the 1960's and 1970's. The historical record vindicates our investigation of alternative scenarios, whereby the driving force in world growth are the catching-up in China and in India throughout the first half of the XXIst century. They are socio-economic scenarios that combine productivity enhancement and the redeployment of growth towards domestic demand. The latter can be stimulated by the containment of widening inequality. We have supposed that the best way is to vastly improve social welfare systems and, above all, to extend their coverage. Such a compounded scenario of supply-side and welfare reforms in the two most populated countries raises real consumption per capita substantially.

ABSTRACT

The ongoing pattern of capital flows is quite unusual. Emerging market economies finance US consumers who are living beyond their means. This is clearly a misallocation of world saving that is unsustainable in the long run.

The present paper uses the INGENUE 2 worldwide growth model to shape the conjecture of a growth regime for the first half of this century. The engine of growth rests on demographic and technological forces tied up together in a catching-up process involving very large countries. In this process, capital flows substantiate an intergenerational saving transfer to the huge number of people who aspire to get access to Western standard of life.

Two scenarios explore the consistency of this prospect: a baseline scenario with relatively conservative hypotheses and a fast-growth scenario in China and India. In both scenarios Western Europe and Japan appear to be structural capital exporters with appreciating real exchange rates. The US progressively saves more and recovers a strong foreign net asset position. No scenario prevents world growth from decelerating with demographic trends.

J.E.L. Classification : C68, F21, D91, F43.

Keywords : Computable General Equilibrium Models, International capital flows, Life cycle models and saving, Economic growth of open economies.

RATTRAPAGE EN ASIE, CROISSANCE MONDIALE ET FLUX DE CAPITAUX AU XXI^{ÈME} SIÈCLE : UNE ANALYSE PROSPECTIVE À L'AIDE DU MODÈLE INGENUE 2

RÉSUMÉ NON TECHNIQUE

L'économie mondiale est depuis quelques années dans une situation paradoxale. L'équilibre épargne investissement mondial défie les enseignements théoriques en économie internationale. Alors que les pays riches et vieillissants devraient apporter leurs capitaux aux pays plus pauvres et plus jeunes, le contraire s'est produit, du moins à l'avantage des Etats Unis. Des controverses font rage sur la soutenabilité de cette structure de financement.

Les arguments s'opposent sur le rythme de l'ajustement vers une structure de financement « plus normale ». Les macro économistes parlent d'un déficit soutenable de 3% du PIB. Mais pourquoi les Etats-Unis devraient-ils indéfiniment être en déficit ?

Notre étude adopte un point de vue différent. Elle ne cherche pas à pronostiquer si l'ajustement va être lisse ou heurté. Mais elle essaye de définir ce que pourrait être un schéma de financement « normal » dans le capitalisme mondial du XXI^{ème} siècle. Selon toute évidence cette approche ne peut prendre le point de vue d'un seul pays, fût-il les Etats-Unis. Seule la perspective d'un régime de croissance mondiale est valable. Ce régime doit englober les traits les plus saillants dans les tendances de l'économie mondiale pour les cinquante prochaines années. Ces tendances sont la transition démographique et le rattrapage des pays émergents de grande taille.

L'outil d'analyse adapté pour explorer un régime de croissance mondiale fondé sur ces tendances est un modèle mondial d'équilibre général calculable à générations imbriquées et reposant sur un découpage approprié du monde. Le modèle INGENUE 2 répond à ces exigences. Il divise le monde en dix régions selon des critères démographiques et géographiques. Dans chaque région, la population est structurée en vingt et une générations imbriquées. Par conséquent, les disparités dans la transition démographique entre les différentes régions du monde peuvent être décrites en détail. Puisque l'épargne à long terme dépend essentiellement de l'optimisation de la consommation des ménages dans leur cycle de vie, la structure par âge de la population est un déterminant majeur des évolutions de l'épargne globale dans les dix régions du monde. C'est le mode de formation de l'offre de capital. Du côté de la demande de capital, l'investissement dépend avant tout du rattrapage technologique par rapport aux économies avancées qui module les croissances relatives entre les régions. Par conséquent, la « structure normale » des balances courantes et des positions extérieures nettes des régions est endogène et découle des hypothèses concernant les prévisions de population et la vitesse du rattrapage technologique.

Nous établissons un scénario de référence à l'aide des projections démographiques centrales des Nations Unies jusqu'à 2050. Nous les prolongeons grâce à un modèle démographique qui calcule l'évolution de la structure par âge de la population pour les dix

régions sous l'hypothèse d'une convergence générale vers une population stationnaire après 2100. Le processus de diffusion technologique, qui est le moteur du rattrapage, est fondé sur l'hypothèse de convergence de la productivité globale des facteurs. Dans le scénario de référence, ces hypothèses sont quelque peu conservatrices, la Chine, l'Inde et l'Europe de l'Est étant les seules régions à rattrapage rapide.

Dans ce scénario de référence, le trait le plus saillant est le rétablissement de la balance courante des Etats-Unis qui devient durablement excédentaire après 2010. Ce résultat découle de l'équilibre dynamique du modèle. Les taux d'intérêt réels y sont des taux neutres en ce qu'ils sont compatibles avec la contrainte budgétaire intertemporelle de chaque région du monde. En tant qu'agents économiques d'un pays vieillissant et à haut revenu, les ménages américains sont incités par ce taux d'intérêt à élever leur épargne. Il en résulte que le pays génère assez d'excédents dans l'avenir pour ramener la dette extérieure à un niveau soutenable à long terme. Telle est notre définition de la « structure normale » de l'épargne.

En outre, l'Europe est, dans ce scénario, une région à croissance basse et durablement créancière du reste du monde avec un taux de change réel qui s'apprécie tendanciellement. Cette position de rentier dans le régime de croissance mondiale peut être favorable aux ménages européens qui vont bénéficier des revenus de leurs avoirs à l'étranger et gagner en pouvoir d'achat sur les biens importés. Mais le ralentissement continu de la croissance va entraîner des contraintes financières sur le système de retraites par répartition qui pourraient être aggravées par des évolutions plus défavorables que prévu sur les hypothèses exogènes à la base du scénario de référence.

Le scénario de référence est conservateur quant à la vitesse de rattrapage des régions en développement comparée à l'expérience des pays asiatiques qui ont décollé dans les années 1970 et 1980. L'observation historique justifie l'exploration de scénarios alternatifs, où le ressort de la croissance mondiale serait le rattrapage accéléré de la Chine et de l'Inde au cours de la première moitié du XXI^{ème} siècle. Ce sont des scénarios socio-économiques qui combinent l'amélioration de l'efficacité productive et le redéploiement de la croissance en direction de la demande intérieure. Celui-ci peut résulter de politiques à l'encontre de l'élargissement des inégalités. Nous supposons que la meilleure manière est l'amélioration des systèmes de protection sociale et surtout l'extension de leur couverture. Ce scénario combiné de réformes économiques et sociales dans les deux pays les plus peuplés du monde devrait y élever la consommation par tête significativement.

RÉSUMÉ

La structure des flux de capitaux est insolite. Les pays à marchés émergents financent les consommateurs américains qui vivent au-dessus de leurs moyens. C'est une mauvaise allocation de l'épargne mondiale, insoutenable à long terme.

Notre étude utilise le modèle mondial de croissance INGENUE 2 pour formuler la conjecture d'un régime de croissance pour la première moitié du siècle. Le moteur de la croissance repose sur l'association de facteurs démographiques et technologiques dans le rattrapage des très grands pays en développement. Ce processus de rattrapage est soutenu par des flux de capitaux qui constituent un transfert intergénérationnel vers le très grand nombre de gens qui aspirent à accéder au niveau de vie occidental.

Deux scénarios explorent la cohérence de cette perspective. Un scénario de référence incorpore des hypothèses volontairement conservatrices. Un second scénario décrit une croissance rapide en Chine et en Inde. Dans les deux scénarios, l'Europe de l'Ouest et le Japon sont des zones exportatrices de capitaux dont les taux de change réels s'apprécient. Les Etats-Unis épargnent plus et recouvrent une forte position extérieure nette. Toutefois la croissance mondiale diminue progressivement dans tous les scénarios, du fait notamment du ralentissement de la croissance démographique.

Classification J.E.L. : C68, F21, D91, F43.

Mots clés : Modèles d'équilibre général calculable, mouvements internationaux de capitaux, modèle de cycle de vie et épargne, croissance en économie ouverte.

**ASIAN WORLD GROWTH AND INTERNATIONAL CAPITAL FLOWS IN THE XXIST
CENTURY: A PROSPECTIVE ANALYSIS WITH THE INGENUE 2 MODEL**¹

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1. INTRODUCTION

After the Asian crisis, the pattern of growth in emerging market countries has changed drastically. They have shifted from deficit to surplus countries. Correlatively, the inversion of capital flows has altered financial conditions in developed countries. Globalization has reached the stage whereby the macroeconomic equilibrium is truly worldwide.

However the present growth regime is less than satisfactory regarding the allocation of world saving. The financing gap of consumers in the wealthiest country by the saving of countries with much larger and growing human resources comes as a mockery of the Washington consensus. The misallocation of saving, which has led to the so-called saving glut, stems from the malfunctioning of the international financial system illustrated by the repeated crises from the mid-1990s onwards.

Nevertheless, the ongoing pattern of capital flows is clearly not sustainable in the long run. The engine of growth in this opening century rests on demographic and technological forces tied up together in a catching-up of huge populations.

The present paper shapes this conjecture. For this purpose, it uses the INGENUE 2 worldwide growth model. This is a computable general equilibrium overlapping-generations model dedicated to studying the pattern of financial flows and prices underpinning the sustainability of alternative growth scenarios.

First, we present a baseline scenario, focusing on the international financial position of the main regions of the world. Europe appears as a likely low-growth, permanent world creditor region with an appreciating currency.

Then, we make alternative hypotheses on the dynamics of growth in Asia. Shaping a scenario of faster catching-up in China and India, the model underlines the pattern of international capital flows and the structure of real exchange rates impacted by the momentum of development in Asia.

¹ We thank Agnès Benassy-Quéré for her valuable remarks and suggestions on a previous version of the paper.

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Contrasting the actual and prospective allocation of saving, one can attempt to figure out in conclusion the changes in the international financial system to go from here to there.

2. THE PARADOX OF WORLD SAVING IN THE EARLY YEARS OF THE XXIST CENTURY

Starting after the Asian crisis, world growth has changed its course. The shift has gained momentum since 2001. All emerging market economies except the CEECs have piled up current account surpluses. Amongst developed economies, Japan stands out in augmenting substantially an already high surplus in the 1990s. The abyssal US deficit has been virtually the single counterpart of all the cumulative surpluses (Table 1).

Table 1. Current Account Balance in the Main Regions of the World

Countries or regions	(US \$ billions)			
	1990s average	2001	2004	2004-1990s average
<i>United States</i>	-153	-388	-666	-513
<i>Euro Zone</i>	20	13	36	+16
<i>Japan</i>	107	88	172	+65
<i>Other industrialized</i>	-7	36	42	+49
China	13	17	69	+56
Other emerging Asia	9	74	124	+115
Latin America	-49	-54	16	+65
CEEC	-12	-17	-51	-39
Russia	10	34	60	+50
Rest of the world	-22	34	117	+139

Source: BIS, 75^o Annual Report, chap.II, p.21. Because of unrecorded flows and other adjustment problems, the algebraic sum of current account balances does not amount to zero.

In all countries struck by a financial crisis, domestic demand has never recovered. Chronic excess production capacities have found their outlets in exports thanks to huge devaluations, which have wiped out the former overvaluation of their currencies. Primary commodity producers have benefited from the boost in US and Chinese demand.

The rise of the Chinese economy is tantamount to a structural supply shift. China generates higher and higher saving and exploits a huge pool of labor to generate excess capacities in a large range of industries. In order to sustain the high growth rate needed to absorb the migrant rural workers year after year, China exports across the whole spectrum of industrial

products. Being a very open country for its size, China exerts drastic competitive pressures on prices and wages all over the world.

These structural changes show up in the saving investment balances (Table 2). One can see plainly that emerging market economies finance advanced economies more and more.

Table 2. Sources and uses of World Saving: Financial Balances (saving less investment):

(as a percentage of country or region GDP)

Countries or regions	Average 1990-99	Average 2000-02	2004
Advanced Economies	-0.5	-0.4	-1.3
United States	-2.4	-3.2	-6.0
Euro Zone	+0.4	+0.4	+0.7
Japan	+2.3	+2.5	+3.7
Emerging Economies	-1.9	+1.7	+2.3
China	+1.8	+2.0	+4.1
Other Asia	-1.2	+1.8	+2.7
Latin America	-2.6	-2.0	+1.2
PECO	-2.7	-4.3	-4.7

Source: BIS, 75^o Annual Report, chap II, p24.

The pattern of saving and investment is definitely at odds with the teachings of both history and theory. There is a sustained transfer of resources from the younger and poorer people of the world to the older and richer. If long-run trends are a guide for the future, the growth regime of the last few years is not sustainable. The opposite should be the basis of world growth in the decades ahead.

3. THE POTENTIAL FOR CHANGE IN THE DEMOGRAPHIC TRANSITION

Growth in the world economy is shaped by secular trends in its most structural long-run determinants. Two factors stand out. The first is the change in the demographic structure in the different parts of the world. The second is the diffusion of technological progress, as expressed by trends in total factor productivity growth. These factors have always been prevalent in the rise of capitalism worldwide.

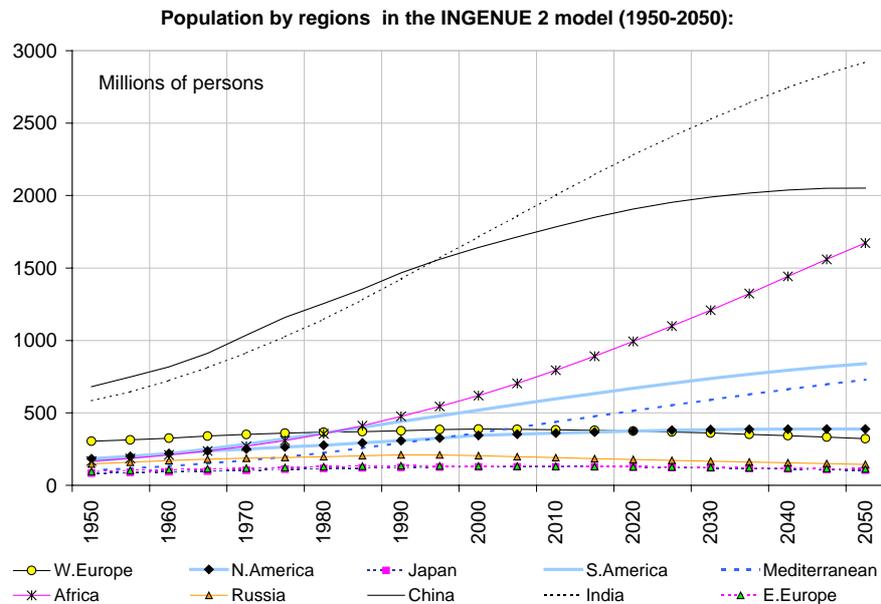
- *New Prospect between demography and economy in the XXIst century*

In the INGENUE 2 model, population evolution is calculated according to a standard population projection method on the basis of historical and prospective UN data until 2050. We use our own demographic model thereafter. We aggregate the population structure across the countries of each region with UN data from 1950 to 1995³. We project fertility and mortality trends (for both genders) at the region-aggregate level so that our own demographic profiles fit with UN central projection until 2050. Then our trends converge to a stationary population structure in the very long run in each region.

According to these demographic forecasts, the world population reaches 9.3 billions in 2050. Population of the 'Indian world' grows at a sustained pace and reaches 2.9 billions of persons in 2050 (31% of the world population against 28.3% in 2000). Population of the 'Chinese world' increases at a very low pace between 2030 and its culmination in 2050 (see Figure 1a). As a consequence, the share of the population of this region in the world population decreases all along the first part of the 21st century, from 27% in 2000 to 22% in 2050. According to our demographic forecasts, in the next 50 years, the population of the 'Indian world' will grow by 70% whereas the population of the 'Chinese world' will grow by 25%. One must note that the population of the African region is growing at the highest pace in our projections. This comes from high fertility rates.

³ In the INGENUE 2 model, the world is divided in 10 regions according mainly to geographical and demographic criteria. These regions are labelled : Western Europe, Eastern Europe, North America, Latin America, Japan, Mediterranean World, Chinese World, Africa, Russian World and Indian World. The content of each region is detailed in Appendix.

Figure 1a

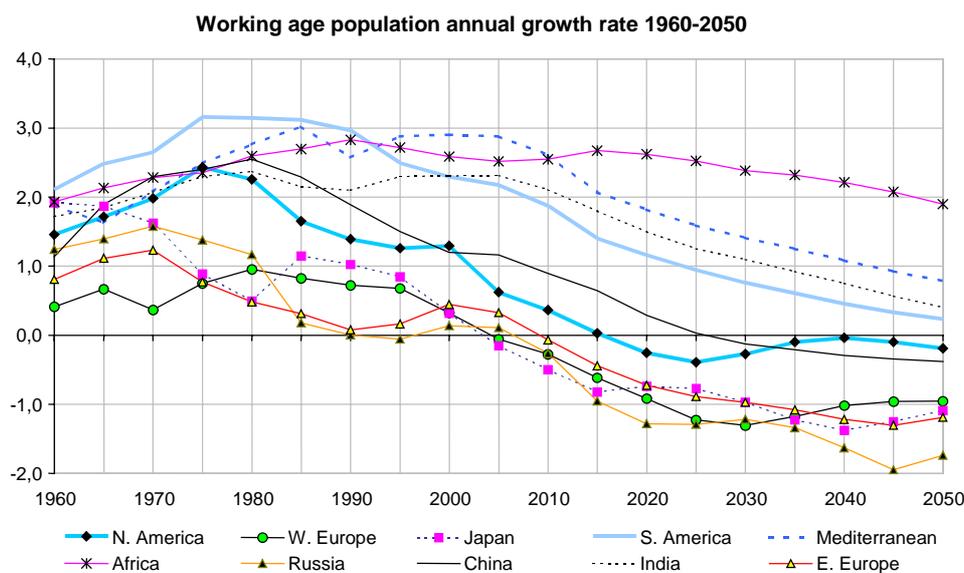


Source : INGENUE 2.

After the European demographic expansion of the XIXth century and the speed-up of population growth in the second half of the XXth century, the demographic transition will imprint the first half of the XXIst century. It is a sequential and lengthy process of aging. The developed countries, the Eastern European countries, Russia and a decade later China, are aging from the top of the age structure. Most of the developing world is aging from the bottom of the pyramid.

When the world is broken into ten regions, according to the nomenclature adopted in INGENUE 2, a sharp contrast arises in the rate of growth of the labor force (see Figure 1b). It declines throughout the half century in Russia (very fast), Eastern Europe, Western Europe and Japan. It declines more moderately in North America (after 2010) and China (after 2020). It decelerates but grows until 2050 in South America, India and the Mediterranean countries (outside Europe). The most atypical region is Africa where the labor force hardly decelerates at all. This pattern differs significantly from the past. In the XIXth century Europe possessed both the capital and the human resources to conquer the world. In the post-World War II era, OECD countries were leaders in the growth regime and attracted Third World population. In the upcoming decades, emerging countries will have the human resources for a new growth regime based upon a widespread, albeit not generalized, catching-up.

Figure 1b



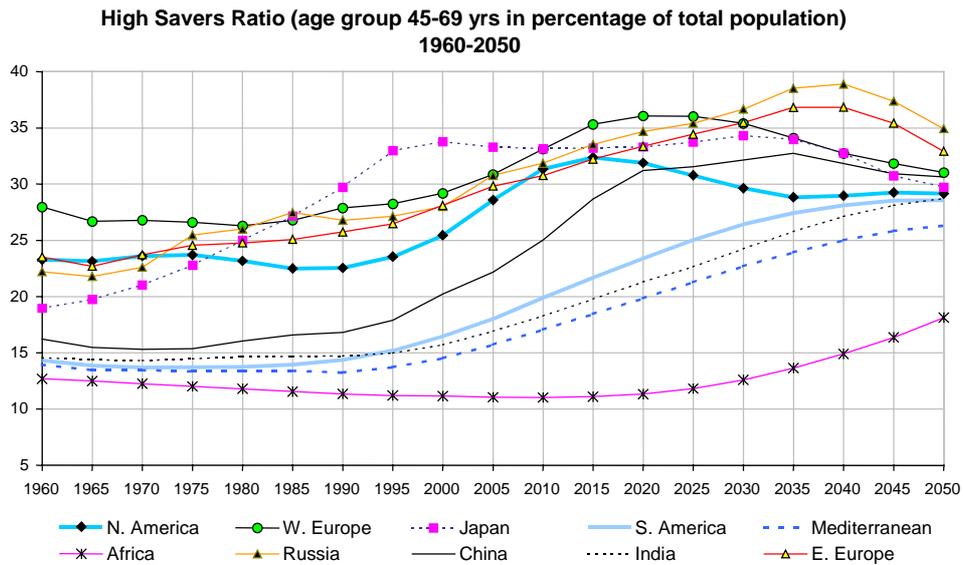
Source : INGENUE 2.

The conjecture is that the size and the dynamism of the population in large continental countries will become the preponderant factor in domestic development because their governments are aware of the need for investing in infrastructure, health and education.

Because leading OECD countries concentrate the bulk of world capital, the growth regime will depend on international capital rather than labor mobility. An intergenerational transfer of resources via capital export from wealthy aging countries to the labor force growing countries will make the world regions strongly interdependent. Figure 2 illustrates why this intergenerational exchange will arise.

One can see that the proportion of high savers in total population follows a wave pattern that propagates from one region of the world to the next one through the decades. The ratio culminates first in Japan as soon as 1995 and remains on a high plateau until 2030. Then North America will have its maximum in 2015 and Western Europe in 2020, Eastern Europe, Russia and China in 2035. They are regions where the labor force will decline and thus hamper growth in the future. By contrast, the regions found on Figure 1a as the potentially fast-growing regions will see a progressive aging leading to an increase of the high savers ratio which will not culminate before 2050. It follows that saving should flow from early high savers to late high savers in the coming decades. However, for this scenario to arise, an engine of growth is required. This is the international diffusion of technological progress.

Figure 2



Source : INGENUE 2.

4. TECHNOLOGICAL CATCHING-UP: CONJONCTURE OF A WORLD GROWTH REGIME

History teaches the importance of mobility in labor, capital and ideas for the development of capitalism. In the forty years of the XXth century following the breakdown of colonies, growth per capita in developing countries was faster than in the one hundred prior years. It was very unequal however. Abramovitz [1986] pointed out that convergence to the higher level of real income, enjoyed by developed countries, was conditional. It was circumscribed to countries that had created the institutions capable of assimilating technological progress.

The evidence that growth per capita is a complex social process, mediated by institutions and related ambiguously to demographic trends, has been portrayed in different stages of capitalism since the worldwide expansion in the late XIXth century. Before World War I, growth took off successfully in “new” countries where immigrants brought market institutions, a quest for personal wealth, the skill and discipline of industrial labor. At the turn of the XXth century, the US emerged as a dominant economic power.

Growth in the thirty years or so after World War II was of a different flavor. With the advent of a wage labor society, a powerful upward trend in productivity was sustained by a

huge migration from the countryside to the big cities of the developed countries. In Third World countries, a parallel migration had mixed effects. In Latin America, for instance, poor and insecure people gathered in slum suburbs. Growth was very unbalanced. Inward-looking domestic industries were not often competitive and inequalities spread with the lack of infrastructures, education and social safety net. Only East Asia depicted a success story in the wake of the “Green Revolution”, albeit authoritarian regimes which had stifled the claims of labor for a larger share of income for a considerable time. Despite the late suspicion of Western scholars about the low efficiency of Asian productive investment, the World Bank heralded the long-run export-led growth prodded by very high national saving rates. This growth regime came temporarily to a halt in the countries that suffered the financial crisis of the late 1990’s.

- *The spread of technological progress*

A synthetic measure of technological progress for a whole economy is total factor productivity (TFP) at constant prices. Estimating TFP is an appallingly difficult task for the ten world regions of INGENUE 2. We define TFP as a Hicksian-neutral technological progress in a Solow growth model. It means that there exists a production frontier shifting over time. In such a framework, the aggregate product is a function of the services of capital and labor and of technological progress defined as TFP. Therefore the latter is computed with the use of the production function.

The method used to compute the historical profiles of TFP for the ten regions of INGENUE2 is outlined in Box 1. Average growth of TFP for the decades compounding the second half of the XXth century is then compared with the results of two other studies by Bosworth and Collins [2003] and by Baier, Dwyer and Tamura [2004] whose results were aggregated in the ten regions of INGENUE2. The comparison is presented for the three developed regions (North America, Western Europe and Japan) in Table 3 and for the two Asian regions (Chinese World and Indian World) that will be the engine of the fast-growth scenario.

There is considerable uncertainty in computing TFP levels and growth rates. It is illustrated in the range of estimates shown in the tables. However if one concentrates on the last two decades when financial liberalization arose and structural reforms started in both China and India, our figures are most often within the range of those given by the authoritative researches mentioned above or close to one of them. Only for Japan in the decade 1990-2000 is our estimate much lower than both of them. Our figures show a steady trend of TFP in Western Europe, a speedup in North America and a slump in Japan in the deflationary decade. A robust growth is sustained in India and the most impressive takeoff arises in China.

The INGENUE 2 TFP profiles are portrayed on Figure 3. Several features are worth mentioning. The long productivity slowdown from the mid-1960’s to the early 1980’s shows off plainly followed by the sharp rebound prolonged by the powerful diffusion of IT. The Post-War sustained catching-up until 1990 in Western Europe and Japan was reversed

because of the political shocks in Europe and the financial crisis in Japan that occurred in the 1990's. One can also plainly see the severe setbacks in the Russian world after the breakup of the Soviet Union where productivity collapsed, and in Latin America where the two lost decades have caused TFP to stay put since the late 1970's. The gloomy outlook in Africa where no takeoff has ever started adds to the massive failures of development. In this mixed picture, the performance of Asia since the early 1980's stands out. A powerful dynamism, unleashed by economic reforms and trade opening, makes both India and China the only two continental countries to supersede US TFP growth in the 1990's.

The hypotheses for a world growth regime

The insight delivered by the above short review on world growth is that countries catch up unequally. The conditions of catching-up depends on social conditions that cannot be embedded in macroeconomic models [Abramovitz, 1987]. However demographic structures and the process of differential convergence in TFP must be depicted in models dedicated to explore the long run.

It is not that easy to encompass all success stories and blips in a single explanation of catching-up and failure. Nevertheless two broad and intertwined processes are worth considering. Furthermore they are liable to modeling.

First, the speedup of technological revolutions is a stylized fact that shapes trends of productivity gains. The diffusion of generic innovations has been taking less and less time from one revolution to another. A suggestion to model this feature is the following: the probability that a particular country takes off at a particular time is an increasing function of world income per capita. The latter is a proxy for the stock of technological knowledge already accumulated by the countries that preceded newcomers in the technological age [Temple, 1999]. The rationale for this hypothesis is the decreasing cost of acquiring new technology as much as the stock of technological knowledge available is accumulating.

Second, whenever a particular country has seized the chance to capture and mobilize the opportunity to raise productivity at a sustained pace, one can make the simple hypothesis that it follows a growth regime *à la Solow*. The trend of its total factor productivity is the faster, the larger the distance of its income per capita to that of the leader. This dynamics leads to a convergence toward the productivity level of the leader. Therefore, the later a country begins its takeoff, the faster it can grow. World growth is just a weighted average of individual trajectories [Lucas, 2000].

Table 3: Comparison of TFP estimates for the developed regions:

(average annual growth)

Western Europe	INGENUE			TFP	
	Output per worker	Capital per worker	TFP	Bosworth & Collins (2003) (*)	Baier, Dwyer & Tamura (2004)
				(1)	(2)
1950-60	4.0%	1.8%	2.2%		2.6%
1960-70	4.5%	2.0%	2.5%	2.5%	2.5%
1970-80	2.2%	1.1%	1.1%	0.8%	1.6%
1980-90	1.8%	0.8%	1.0%	1.1%	1.0%
1990-2000	1.5%	0.4%	1.0%	0.7%	1.0%

Northern America	INGENUE			TFP	
	Output per worker	Capital per worker	TFP	Bosworth & Collins (2003)(*)	Baier, Dwyer & Tamura (2004)
				(1)	(2)
1950-60	1,9%	0,7%	1,2%		0,2%
1960-70	2,4%	1,4%	1,7%	2,5%	1,2%
1970-80	1,3%	1,1%	0,3%	0,8%	0,2%
1980-90	1,9%	0,8%	1,1%	1,1%	0,6%
1990-2000	1,8%	0,3%	1,5%	0,7%	1,7%

Japan	INGENUE			TFP	
	Output per worker	Capital per worker	TFP	Bosworth & Collins (2003) (*)	Baier, Dwyer & Tamura (2004)
				(1)	(2)
1950-60	6.6%	4.0%	2.7%		2.5%
1960-70	8.9%	5.1%	3.9%	2.5%	3.4%
1970-80	3.4%	3.1%	0.4%	0.8%	1.9%
1980-90	3.3%	1.7%	1.7%	1.1%	3.7%
1990-2000	1.0%	0.9%	0.1%	0.7%	0.8%

(1) 22 industrial countries (including Western Europe, USA and Japan

(2) INGENUE computations by aggregating data of Baier, Dwyer and Tamura (2004).

(*) TFP = Factor productivity + Education

Table 4. Comparison of TFP Estimates for Asia:

Indian World	INGENUE			TFP	
	Output per worker	Capital per worker	TFP	Bosworth & Collins (2003) (*)	Baier, Dwyer & Tamura (2004)
				(1)	(2)
1950-60	3.0%	1.5%	1.4%		1.6%
1960-70	2.9%	1.1%	1.8%	1.0%	1.4%
1970-80	2.0%	0.7%	1.3%	0.1%	-0.6%
1980-90	3.6%	0.8%	2.8%	2.6%	2.7%
1990-2000	3.3%	1.4%	1.9%	1.6%	0.4%

(1) South Asia (Bangladesh, India, Pakistan, Sri Lanka)

(2) INGENUE' computations by aggregating data of BDT(2004).

(*) TFP = Factor productivity + Education

Chinese World	INGENUE			TFP	
	Output per worker	Capital per worker	TFP	Bosworth & Collins (2003) (*)	Baier, Dwyer & Tamura (2004)
				(1)	(2)
1950-60					-2.3%
1960-70	2.9%	0.6%	2.3%	1.4%	0.0%
1970-80	3.0%	2.0%	1.0%	1.3%	0.2%
1980-90	4.2%	1.8%	2.4%	3.3%	0.6%
1990-2000	5.7%	2.3%	3.4%	3.2%	1.2%

(1) East Asia (including China, Indonesia and Korea)

(2) INGENUE computations by aggregating data of Baier, Dwyer and Tamura (2004).

(*) TFP = Factor productivity + Education

BOX 1. COMPUTATION OF HISTORIC TFP TRENDS IN INGENUE 2.

To compute the historical profiles of TFP in the INGENUE regions, we use data from Vikram and Dhareshwar [1993] and from the Penn World Tables [Heston and al., 2002]. On the period 1950 - 1990, Vikram and Dhareshwar [1993] provide series of capital stock and of GDP in local currencies for 93 developing and developed countries. The Penn World Tables provide main macroeconomic series from 1950 to 2000 for 209 countries.

To describe the construction of our series, we use the following notations:

- Y = GDP in \$ 1996 [Heston *and al.*, 2002];
- K/Y = coefficient of capital. [Vikram and Dhareshwar, 1993];
- N = working age population (Heston *and al.*, 2002);
- ki = investment rate [Heston *and al.*, 2002];
- α = share of capital in the production function = 1/3;
- δ = depreciation rate of capital = 1% (per year).

These data are not available for some important countries of the Russian world and Eastern Europe. So for these regions, we use estimations from Baier *et al.* (2004).

To compute the past series of capital, we use the following formula :

Before 1990:

$$K_t = (K/Y)_t Y_t$$

After 1990:

$$K_t = (1 - \delta) K_{t-1} + ki_t Y_t$$

For each country, the TFP profile can be deduced as follows:

$$\log(TFP_t) = \log\left(\frac{Y_t}{N_t}\right) - \alpha \log\left(\frac{K_t}{N_t}\right)$$

For each region, the list of available countries to estimate regional TFP series is the following:

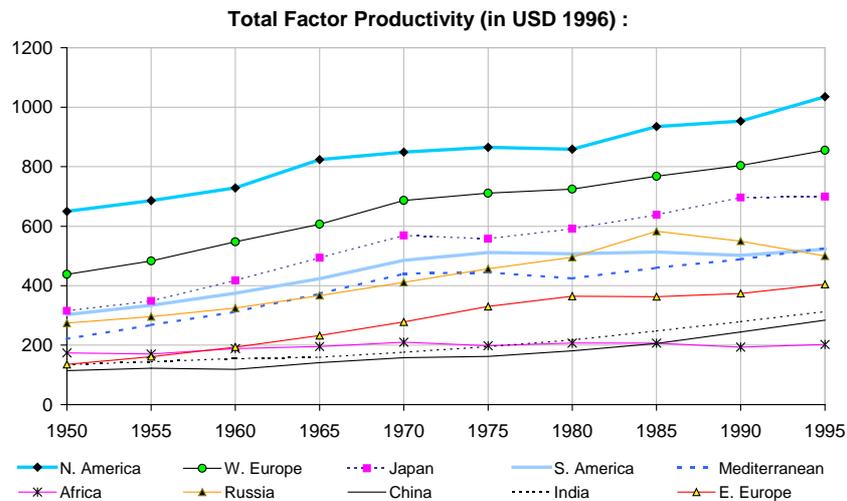
- **Western Europe:** Denmark, Finland, Iceland, Norway, Sweden, United Kingdom, Greece, Italy, Portugal, Spain, Austria, Belgium, Switzerland, France, Luxembourg, Netherlands, Ireland.

- **Northern America:** Canada, USA, Australia, and New Zealand.

- **Japan**

- **Indian World:** India, Bangladesh (>1958), Sri Lanka, Indonesia (>1959), Pakistan.
- **Chinese World:** China (52-00), Republic of Korea, (53-00), Singapore (60-96), Thailand, Philippines, Taiwan (51-98).
- **Mediterranean World:** Egypt, Morocco, Tunisia (61-00), Turkey, Cyprus (50-96), Israel, Jordan (54-00), and Iran (55-00).
- **Latina World:** Argentina, Bolivia, Brazil, Chile (51-00), Paraguay (51-00), Colombia, Ecuador, Guyana (50-99), Peru, Venezuela, Costa Rica, El Salvador, Guatemala Honduras, Mexico, Nicaragua, Panama, Dominican Republic (51-00), Jamaica (53-00), Trinidad & Tobago.
- **African World:** Angola (60-96), Cote d'Ivoire (60-00), Cameroon (60-00), Ethiopia, South Africa, Congo, Dem, Rep, (55-97), Zambia (55-00), Zimbabwe (54-00), Mozambique (60-00), Mauritius, Malawi (54-00), Tanzania (60-88), Uganda, Ghana (55-00), Rwanda (60-00), Senegal (60-00), Kenya, Sierra Leone (61-96), Nigeria, Mali (60-00), Madagascar (60-00).
- **Eastern Europe:** Yugoslavia, Hungary, Poland, and Romania (50-00).
- **Russian World:** Russia.

Figure 3



Yet there are impediments to this process from the point of view of particular countries. The distribution of economic power between the social strata that compound the domestic economy may hamper the development of a class of entrepreneurs. Corruption and cronyism may hinder the political will and ability of the state to undertake basic investment in education, public health and infrastructures. The political elite may fail to create the market institutions necessary to benefit from the opening to foreign influence. These considerations mean that there is no one best way from technological diffusion to social

change. The process is interactive and mediated by politics. The lack of a political leadership dedicated to modernization in embracing capitalism has often thwarted opportunities to start or thereafter to gain momentum in economic development. But a successful rooting of capitalist development is by no means tantamount to Western-style political democracy, at least for a very long time to come.

How can we accommodate these ideas in the INGENUE framework? We assume that North America will remain the technological leader in the XXIst century, that the diffusion of IT will be completed in the whole economy and that there will be no further technological revolution in the baseline scenario. Therefore North America TFP will return to its long-run growth trend of 1.1% per year. With a 2/3 share of labor income in GDP, it means a 1.65% steady growth in labor productivity. This assumption may be dubbed too pessimistic. There is no compelling basis to make another one however. It should be understood that it is the reason why growth in our baseline scenario looks lower than other projections.

For the rest of the world, there is a region-specific catching-up process in TFP. The differential speed of catching up reflects the discrepancies in the social and institutional conditions of assimilating IT in different parts of the world, combined with the levels of TFP already reached.

The level of total factor productivity in the zone at the technological frontier (North America) is $A_{1,t}$. It is supposed to grow by 1.1% per year: $A_{1,t} = (1 + g)A_{1,t-1}$ with $g = 1.1\%$. There is a caveat however. To account for the attractiveness of Europe upon its neighbor regions we assume that these regions will converge to the European target ($A_{2,t}$). Therefore Western Europe, Japan, Chinese world, Indian world and South America will converge to North America; Eastern Europe, Russian world, Mediterranean world; Africa will converge to Western Europe. The diffusion of technological progress to a zone i is given by the following equations:

$$\frac{A_{i,t}}{A_{i,t-1}} = [1 + \lambda^t] \frac{A_{1,t}}{A_{1,t-1}} \left[\mu_i^t + (1 - \mu_i^t) \frac{A_{1,t-1}}{A_{i,t-1}} \right]$$

$i =$ Western Europe, Japan, Chinese world, Indian world, South America.

$$\frac{A_{i,t}}{A_{i,t-1}} = [1 + \lambda^t] \frac{A_{2,t}}{A_{2,t-1}} \left[\mu_i^t + (1 - \mu_i^t) \frac{A_{2,t-1}}{A_{i,t-1}} \right]$$

$i =$ Eastern Europe, Russian world, Mediterranean world.

The first bracket captures the speed-up in the rate of technological progress due to shortening the time of diffusion in technological innovations. It means that λ is an accelerator to the convergence in the growth rates (the chosen value is 0.001). The second

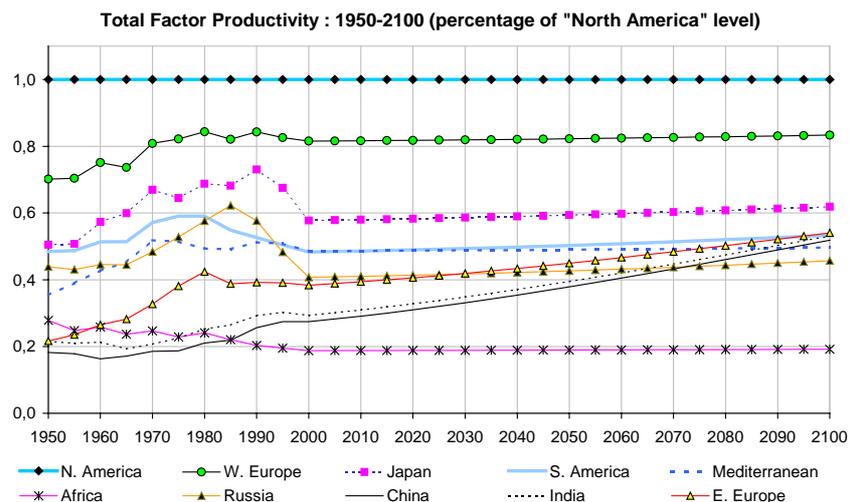
bracket embodies a brake due to the difficulties to create the social conditions proper to assure a speedy diffusion. μ is the brake factor to the convergence in level (see the values in Table 5).

Table 5: Exogenous Catching up (μ values): Baseline Scenario

W.Europe	E.Europe	Russia	Africa	Med.	Japan	China	India	S.America
0.99975	0.999	0.99975	1.000	1.000	0.99975	0.999	0.999	0.99975

Figure 4 gathers the profiles of TFP assumed in the baseline scenario in the regions of the INGENUE2 model. It shows that Western Europe and Japan resume their slow catching-up, meaning that they absorb the IT revolution after North America. The takeoff in China and India, which had already started in the 1990's, gains momentum. The rise of these continental countries to the status of prominent powers attract the whole region (Chinese and Indian worlds) into commercial and financial integration. Eastern Europe is also a fast-growing region due to its participation to the European Union. We take a dimmer view of the other regions. A relatively slow catching up is assumed in South America and the Mediterranean countries where there are perennial difficulties in establishing efficient market institutions, in promoting a large class of entrepreneurs and in generating non-corrupt and competent governments. The same arises more seriously in Russia where the catastrophic decline of the population is a further handicap to growth. Finally we are more pessimistic about Africa where we assume no catching-up in level of TFP. Yet the rise in TFP at the same rate of the leading region, even if it entails no catching-up, is a marked improvement on the last quarter of a century which has seen no progress at all, and thus a setback relative to the rest of the world.

Figure 4



5. MAIN CHARACTERISTICS OF THE BASELINE SCENARIO

The dynamic path portrayed in the forthcoming figures is the outcome of the overlapping generations rational expectations general equilibrium model INGENUE 2. A short non-technical overview of the model is outlined in Box 2⁴.

BOX 2. NON-TECHNICAL OVERVIEW OF THE INGENUE 2 MODEL

The world is compounded of 10 regions: ‘*North America*’ (including Australia and New Zealand), ‘*Western Europe*’, ‘*Japan*’, ‘*Eastern Europe*’, ‘*Russian World*’ (including Ukraine, Bielorussia and Central Asia), ‘*Chinese world*’ (China and other East Asian countries excluding Japan), ‘*Indian World*’ (India, Indonesia, Pakistan, Bangladesh, Sri Lanka), ‘*Latin world*’ (South and Central America and the Caribbean), ‘*Mediterranean*’ (Non-European Mediterranean countries, Near and Middle East countries), ‘*Africa*’ (Sub-Saharan Africa).

INGENUE 2 is an overlapping-generations model of Auerbach and Kotlikoff (1987) type. The model has 21 generations. The time unit is 5 years and the maximum life span is 105 years. The model includes 17 cohorts of adults (ages 20+) and 4 cohorts of young (ages < 20). Cost per child is proportional to the consumption of their parents. Labour supply is exogenous and adjusted for an age-specific participation ratio to the labour market in each region. The model does not distinguish between gender, the young do not optimise their behaviour, and household behaviour is reduced to behaviour of individuals who progress from working age to retirement age according to region-specific patterns.

Macroeconomic framework:

- *Household behavior.* Individuals make economic decisions according to the life cycle hypothesis. A voluntary bequest is left to children at age 80 (in the baseline version of INGENUE 2) subject to survival until 80. In the budget constraint, the expenditure side encompasses the consumption (costs of children included) and saving of each individual of age a at period t . On the income side there is the financial income on accumulated saving (if the individual of age $a-1$ at time $t-1$ has survived between $t-1$ and t). This adjustment amounts to the mechanism of a perfect annuity market that pools death risk due to the uncertain lifetime of individuals. There is also a non-financial income which depends on the age of the individual respective to threshold ages: net labor income (after social security taxes) modulated by an age-efficiency profile for people in full labor activity (effective labor); a mix of labor income and pension benefits for people partially retired (reduced labor activity); full pension benefits for people entirely retired. The lifetime utility program is maximized under the intertemporal budget constraint, taking prices, social contributions and benefits as given [Modigliani, 1986].

⁴ See Ingenu (2007) for a description of the technical features of the model.

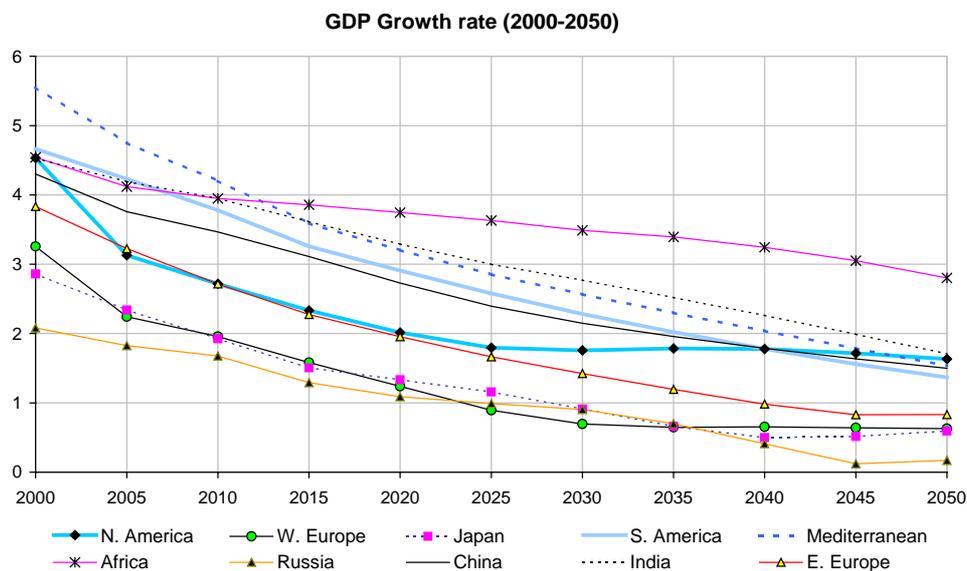
- *Public sector.* It is confined to a public Pay As You Go (PAYG) pension scheme in all regions. It operates under a defined-benefit rule. It pays a proportion of the current net wage (replacement ratio) to retirees. It is financed by a payroll tax on labor income. The exogenous parameters are the retirement age and the replacement ratio. They are region-specific. The contribution rate is determined so as to balance the budget period by period.
- *Production system.* Goods are heterogeneous. In each region there is an intermediate goods sector. It uses labor and capital to produce a region-specific intermediate good with a constant return-to-scale Cobb-Douglas production function. The final goods sector is the product of a CES combination of a domestic intermediate good and a foreign intermediate good imported by the region from a world market [Backus and al., 1995]. This homogenous world good is “produced” by a fictive world producer as the output of a CES combination of all intermediate goods exported by the regions. All production functions are augmented by TFP coefficients.
- *Firm behavior.* In each sector (final/intermediate), firms act on competitive markets. They maximize their profit under their production constraint, taking prices as given. In the domestic intermediate good sector the constraint is intertemporal, since the production function depends on the stock of capital which is depreciated and accumulated. Intermediate goods producers thus maximize net present value of future cash flows, i.e. production value minus wage cost and capital cost. The latter depends on the depreciation rate, which is itself affected by international capital market imperfections. The depreciation rate is higher in debtor regions. More precisely the higher their net foreign debt ratio to their stock of capital, the higher the depreciation rate in those regions. Therefore this debt constraint increases the required gross rate of return on capital in debtor regions, which in turn lowers the demand for capital and thus the equilibrium capital/ labor ratio resulting from the first-order condition. Other type producers face a more simple maximization problem. Domestic goods producers and the world producer maximize current profit subject to their CES production functions
- *General equilibrium.* The capital stock in each region, the age distribution of saving in each region, the initial prices of domestic commodities are the initial conditions. Exogenous variables and parameters are: the demographic profiles in each region that are outputs of the demographic upstream model, the coefficients of the TFP determination in intermediary and final sectors of each region, the social security policy parameters in each region. The competitive world equilibrium stems from five set of equations: intertemporal utility maximization of households, intertemporal profit maximization of firms in intermediate goods sectors, period profit maximization of firms in final goods sectors, period profit maximization of the world producer, market clearing conditions. The markets for intermediate goods, final goods, labor in each region and the market for the world intermediate good are cleared in each period . These equations determine all relative equilibrium prices expressed in a common numeraire, which is the price of the intermediate good in North America set equal to one. This convention allows us to express values in constant dollars. Finally Walras’s law implies that the world financial market equilibrium is the redundant equation. This market is automatically cleared.

• **Regional growth**

As detailed in the previous section, our assumptions regarding technological convergence are conservative in the baseline scenario. In addition, the parameters that define public pension systems are assumed to perpetuate existing policies in the beginning of the XXIst century. Therefore GDP regional growth rates largely follow regional labor force growth rates. Two characteristics stand out (see Figure 5). Firstly, there is a general slowdown in growth because the growth rate of the working age population diminishes in all regions but Africa after 2000. Secondly, the dispersion in growth rates is almost as large in 2050 as in 2000, because aging is a lengthy process with countervailing impacts on the labor force of less-developed countries.

North America and Europe have growth profiles that partly differ from the general pattern. In North America, growth decelerates precipitously in the first decade after 2000, because both the labor force and productivity do so. But the working age population stops declining in 2025, recovers and grows at constant rate thereafter. It ensues that GDP growth rate converges to nearly 2% per annum, one of the highest growth rates in 2050. Europe (both West and East) and worse Russia have a somber future. Western Europe follows a similar profile as North America but at much lower growth rates. GDP growth decelerates fast after 2000 until 2030 from 3.2 to 0.7% and keeps this mediocre performance until 2050. Russia is the region with the lowest growth rate almost throughout the half-century and ends up in complete stagnation.

Figure 5



Source : INGENUE 2.

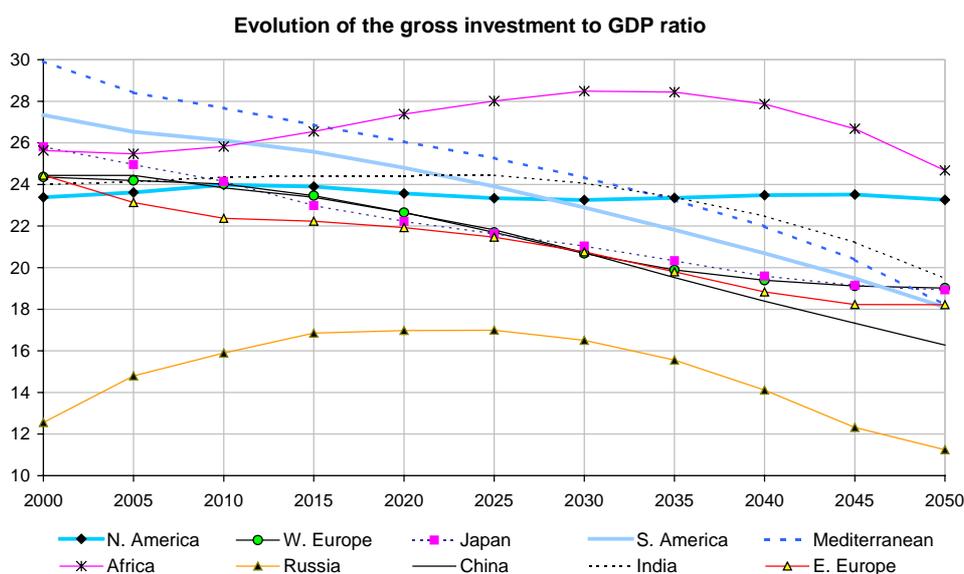
- *Investment and saving*

Because the model works at full employment with an exogenous labor force, the stock of capital in each period is a rising function of employment adjusted for labor efficiency and of capital intensity (capital/effective labor). The ratio of capital intensity is itself increasing with TFP and decreasing with the gross return to capital. The latter is the sum of the regional real interest rate and the depreciation ratio.

The regional net rate of interest is the sum of the world interest rate, which clears the world financial market, and of the rate of change of the region's real exchange rate against the dollar. Those relationships proceed from the risk-neutral arbitrage in financial markets. The depreciation ratio is asymmetrically dependent on the ownership ratio (total wealth of households/ capital stock). An ownership ratio less than one indicates that the region is a net debtor. In those regions, the imperfections of international financial markets raise the cost of capital depending on the amount of foreign debt. It shows up in a higher rate of economic depreciation of the capital stock, which ultimately raises the cost of capital. In creditor regions (ownership ratio above one), the rate of depreciation is a constant, thus independent on financial conditions.

Gross investment rises with net capital accumulation and with replacement, which is modulated by the change in the rate of depreciation in debtor regions. Therefore in regions with a fast growth of the labor force and high foreign indebtedness, raising markedly the rate of economic depreciation, the rate of gross investment to GDP will increase until 2030. Such conditions point out Africa whose capital starts from a low level. India follows a similar pattern albeit less strongly. With a constant depreciation ratio, and an interest rate declining with the world rate, North America keeps a rate of gross investment to GDP remarkably steady. This is not the case of Japan and Western Europe. Despite the lowest real interest rates due to the continuous appreciation of their real exchange rates, leading to a low cost of capital indeed, those regions have such a declining labor force that it impinges negatively upon capital accumulation. Yet the rise in capital intensity counteracts the effect of the labor force. It is why the rate of investment declines less than it does in faster growing regions like China and South America. Finally Russia has a peculiar profile. In the early 2000's investment recovers from the collapse of the 1990's, which led to the scrapping of more than half of the capital stock. A humped-shape curve ensues. Nonetheless, the Russian rate of investment remains by far the lowest of all regions (see Figure 6).

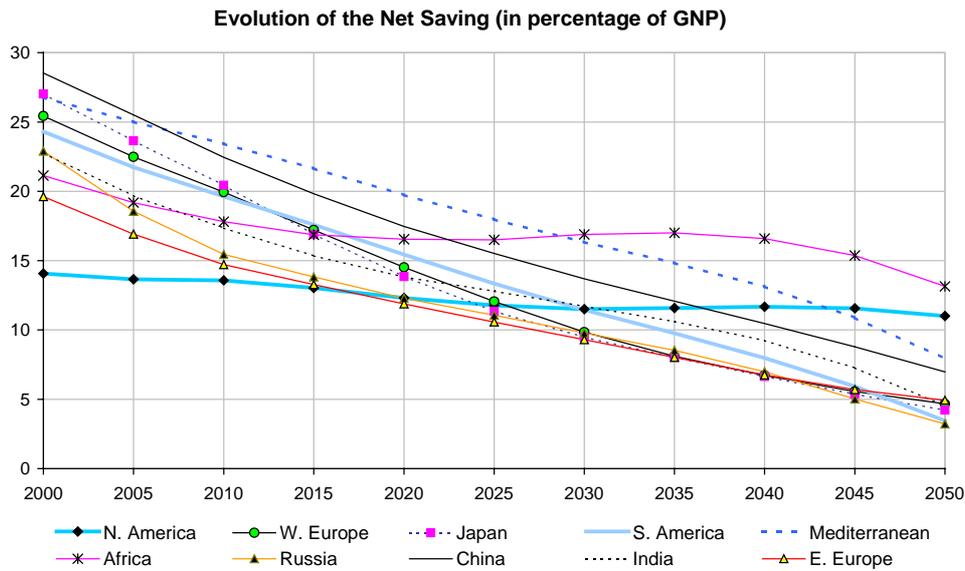
Figure 6



Source : INGENUE 2.

Net saving in each region is the aggregate of individual savings in the life cycle. It depends on the demographic structure (high savers ratio and dependency ratio), on the expectation of future income and on the parameters of PAYG pension systems. Demographic determinants are prevalent. Regions with the fastest-increasing dependency ratios are the ones with the fastest-decreasing net saving rates, namely Japan, Western Europe, Eastern Europe, Russia. Meanwhile, this gloomy demographic factor is compounded with a slow expected progression in income (Figure 7). In China, India, South America and the Mediterranean, the high saver ratio and the dependency ratio rise in tandem. In the early decades, while the population is still young, those regions grow faster than more demographically mature ones. It follows that young people expecting higher future income indulge in debt, reducing the overall saving rate. Alike for investment, North America has a more steady saving ratio throughout the half century.

Figure 7

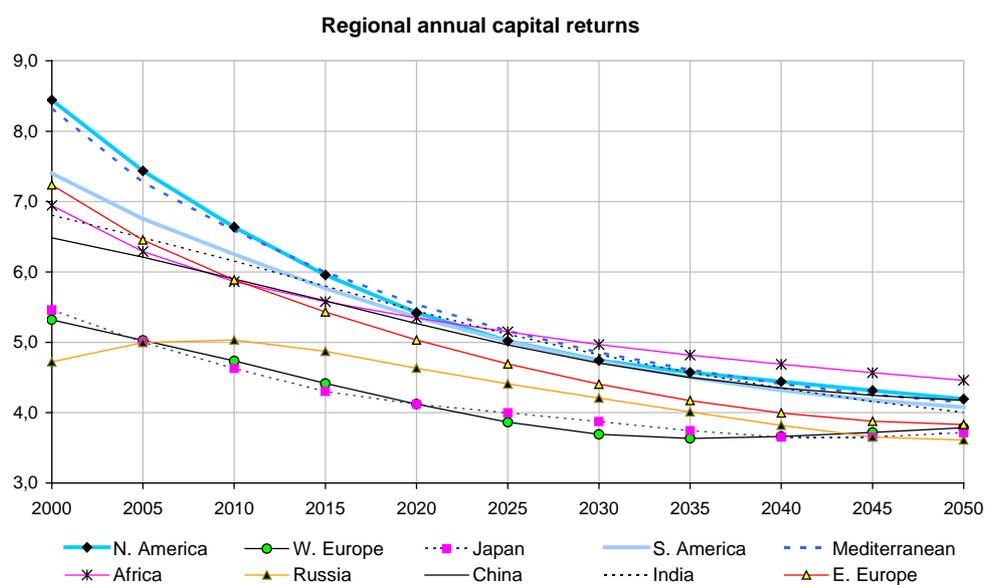


Source : INGENUE 2.

- *Interest rates and exchange rates*

The world real interest rate is declining over the fifty-year period. This is due to global aging and the world saving-investment equilibrium is tilted more and more toward a lower equilibrium rate. This downward trend provides the general profile of regional real capital returns (Figure 8). The hierarchy of regional real interest rates is linked to the rate of change of the real exchange rates. Real interest rates regulate investment and saving flows. The gap between investment and saving is the current account balance of each region. It is financed by capital flows whose amounts are such that yield differentials between different regions cancel out in every period.

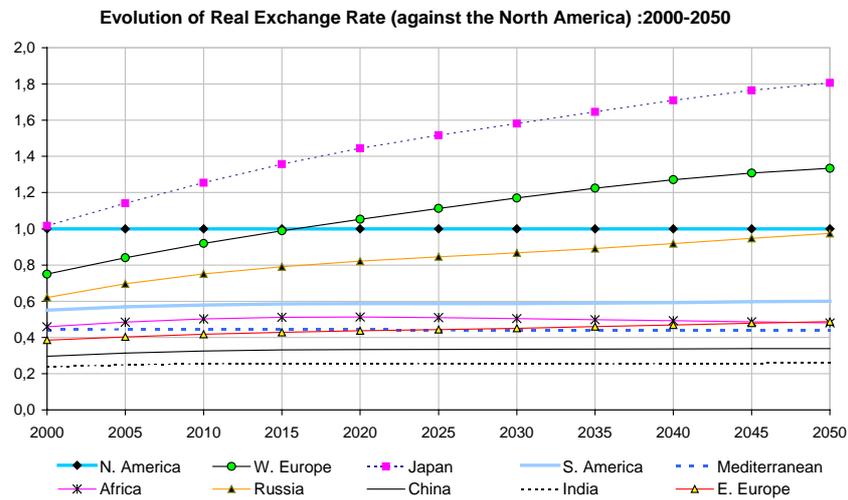
Figure 8



Source : INGENUE 2.

The world financial equilibrium allocates capital flows that finance current account imbalances modulated by real exchange rate changes (defined as the price of the final good of region i divided by the price of the final good of North America). Net foreign assets affect exchange rates. They move with the net financial positions of the regions to create future surpluses or deficits, so that current accounts are balanced in the very long run, i.e. there is no more accumulation of net foreign assets or debts. Real exchange rates against North America appreciate relatively in the two regions that have consistently an ownership ratio higher than North America (Figure 9). Nevertheless, except in these two regions and in Russia, the latter due to terms of trade effects, exchange rate changes are not much sensitive to the stocks of financial assets. Furthermore, because Balassa effects are weak in the model, the paths of the exchange rates are mostly parallel to the one of North America.

Figure 9



Source : INGENUE 2.

- *Capital flows and stocks*

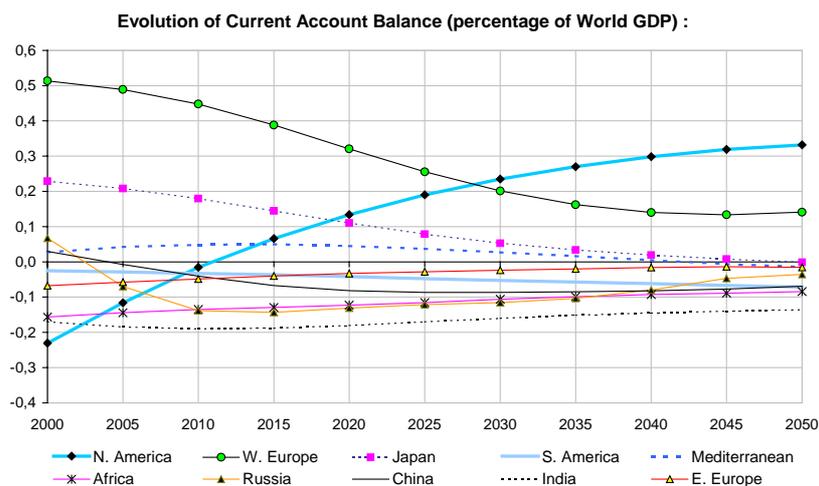
The ownership ratio is the ratio of the aggregate wealth accumulated by households in the region to the capital stock laid out in the region. Hence a ratio above one is tantamount to a creditor position against the rest of the world, a ratio less than one to a debtor position. The world interest rate is the price which equilibrates at each period the world financial market as a whole, matching total aggregate wealth and world capital stock.

Cumulative current account balances mainly determine the ownership ratios. The most striking feature is the different profile of the North American region. It is due to an assumed change in household behavior. The deficit in the early years of the century is known to be due mainly to the low saving rate of households in the US. It has been assumed that this behavior will not be sustainable in the long run. American households will converge to the saving behavior observed in other regions in the early decades. With this structural change and with a population consistently younger than in Japan and Europe, the rise in saving in North America is conveyed into a double improvement in the current account balance (Figure 10) and of the ownership ratio (Figure 11).

The main lesson for the other regions is a shrinking of the discrepancies in current accounts along the half-century. Japan and Western Europe remain continuously in surplus but less and less with the augmentation of their dependency ratio. The Mediterranean region is in surplus for most of the time but goes into a slight deficit in the last two decades. Africa, India and Eastern Europe, with large current account deficits at the start of the century, are

reducing them as long as their growth rate is diminishing and their households save more because they get older and richer.

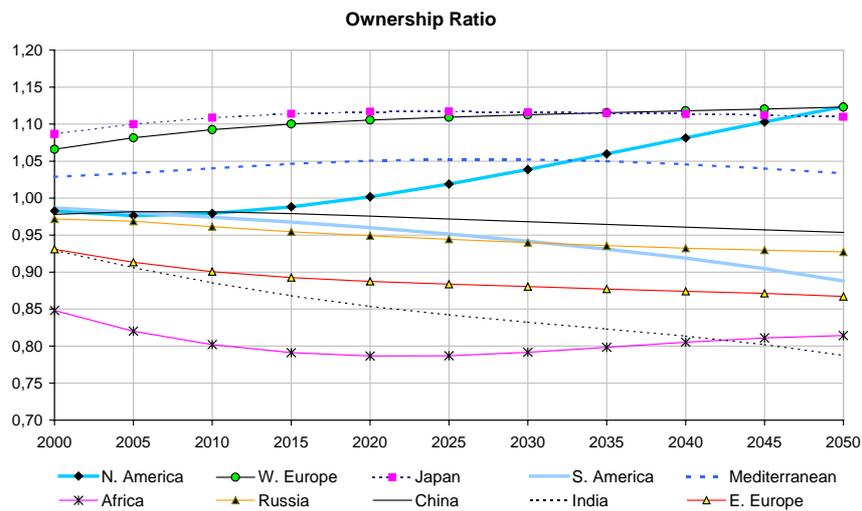
Figure 10



Source : INGENUE 2.

Ownership ratios do not show the same converging pattern. The building of a strong creditor position in North America stands out. The slight improvement in the debtor position of Africa and Eastern Europe stems from the steady reduction of the deficit in these two regions. In India, where the improvement is less pronounced, the ownership ratio is continuously deteriorating. India will become the largest debtor according to this measure in the last decade before 2050.

Figure 11



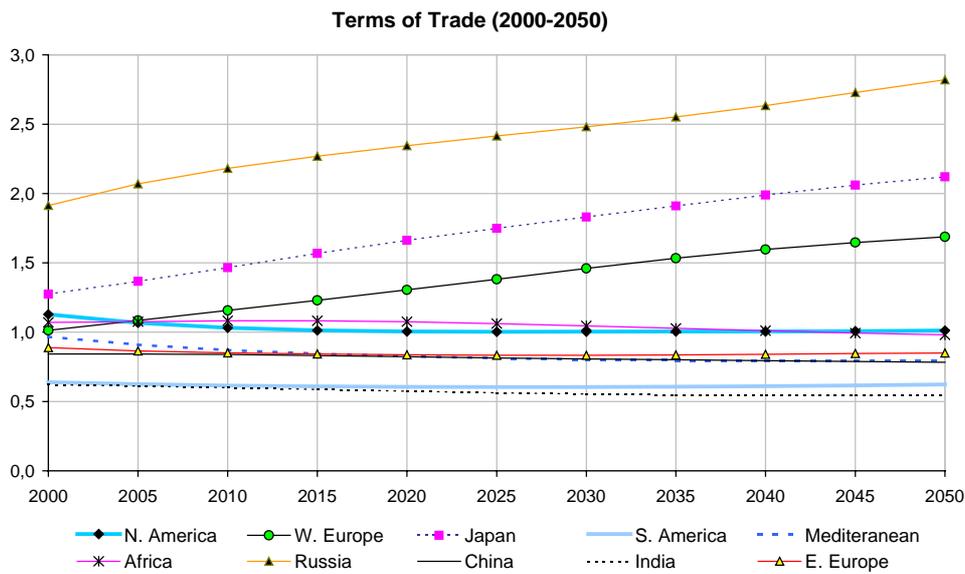
Source : INGENUE 2.

Foreign trade

In INGENUE, tradable goods are intermediate goods. Regions export their intermediate goods on a world market where a fictive world producer “produces” a world intermediate good (that is used by each regions to produce the region-specific final good). They compete on their domestic markets against imports of the world intermediate goods. Therefore the competitiveness of each region depends on the terms of trade against the world producer whose price is itself an average of intermediate goods prices in the different regions.

Three regions have ever-rising terms of trade, i.e. loss of competitiveness: Japan, Western Europe, Russia. The other regions have constant or slightly declining terms of trade (Figure 12). The weak growth in the three former regions (in relation noticeably with the deceleration or the decrease of their working age population) pushes prices upwards.

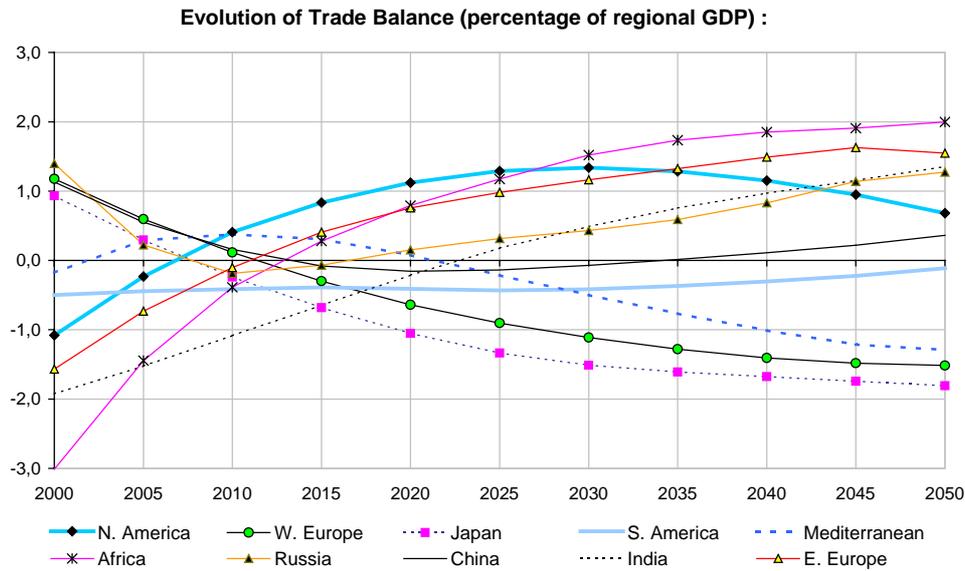
Figure 12



Source : INGENUE 2.

In Japan and Western Europe, these rising prices generate the widening trade deficit to match the demand of intermediate goods by the final goods sector (Figure 13). In Russia, intermediary products are primary commodities in strong world demand. It ensues that the valuing effect of the terms of trade takes over. After deteriorating alongside Japan and Western Europe, the Russian trade balance turns around to an increasing surplus thereafter. Most other regions with little change in competitiveness improve their trade balance, moving from deficit to surplus.

Figure 13



Source : INGENUE 2.

6. EXPLORING THE IMPACT ON INTERNATIONAL CAPITAL MARKETS OF FASTER CATCHING-UP IN CHINA AND INDIA

China and India have the long-run potential to be the world leaders in growth rate for a considerable time to come. Their huge human resources and their attractiveness to foreign investment as a vector of diffusion of technological progress will make these very large countries the engines of a world growth regime. It is worth studying scenarios grounded on this hypothesis to assess the magnitude of spillover in the rest of the world and to figure out what an accelerated development in China and India implies for the global saving investment balance.

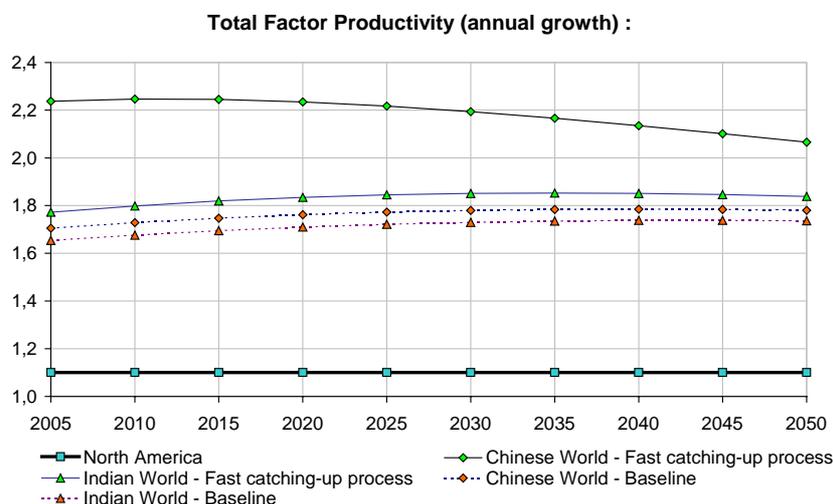
6.1 Hypotheses for a faster catching-up in China and India

A stronger momentum in the growth process is relevant because the baseline scenario is somewhat conservative. China and India are the centers of their respective INGENUE regions. Their momentum will benefit primarily the regions that integrate around them. Therefore the figures illustrating a stronger growth in TFP in China and India are calibrated for the regions we call “Chinese World” and “Indian World”. They are depicted in comparison to baseline on Figure 14.

In the first half century China is poised to higher TFP growth than its baseline profile. The Chinese government knows very well that an upgrading of the value-added content of production is required to sustain the same growth rate or so as in the last ten years for about twenty more years. Meanwhile, the growth of the labor force is fast decelerating and will turn negative in 2025. Structural reforms are in full swing to meet this challenge. If successful they will make China the second world economy twenty years onwards. It is why TFP growth is depicted on Figure 14 at 2.2% in the Chinese World area until 2025 before slowing down gently. Such a profile means catching-up the level of Japanese TFP in 2100.

India has much more time to spend so to speak. The Indian labor force will grow for a long time to come because the demographic transition is far from being completed, making India the most populous country in the second half of the century. Conversely, India is a laggard in structural reforms. Mass education is still very weak and social infrastructures are cruelly lacking. Furthermore, the decentralized political institutions do not tolerate abrupt turnarounds in policies. Therefore, we assume that Indian TFP growth is modestly enhanced above baseline but the higher rate will last well over 2100. Such a profile means catching-up the level of Japanese TFP in 2150.

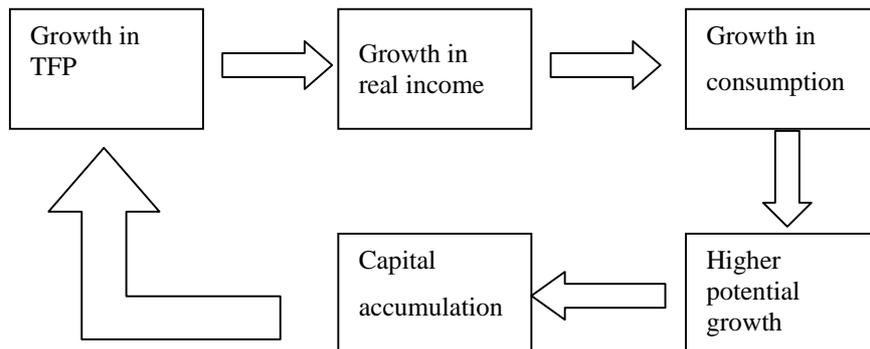
Figure 14



Source : INGENUE 2.

This alternative to the baseline scenario is clearly supply side. However growth is a self-sustaining endogenous process, as described in Figure 15.

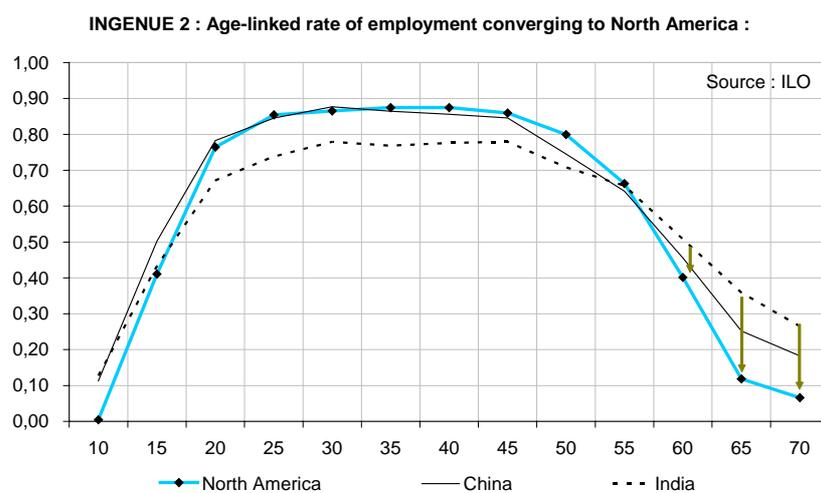
Figure 15



Therefore, an inward-looking growth regime will increase consumption per capita for a larger and larger share of the population, as long as the labor force is enrolled in the modernized productive structure. The development of capitalism in OECD countries has shown that mass consumption requires a socialization of income via a welfare system in order to share the risks associated with a dynamic economy and to redistribute income amongst social groups and generations. This is why we study another variant where the embryo of public welfare systems existing in China and India, which covers a tiny fraction of the population, is spread progressively as far as modern capitalism expands in both countries. For analytical reasons, this variant is studied separately, then the conclusions are merged with the faster growth scenario.

Because in INGENUE the social system focuses on retirement plans, we explore the consequences of a broadening of public pension systems in the Chinese and Indian regions of the model. In the baseline scenario, the participation rates in the labor market are based on the ILO data and are assumed to be constant after 2010. In the alternative scenario, we consider that the countries included in these regions will develop their public pension systems in relation with the strong economic growth that they will enjoy all along the 21st century. In the model, we choose a scenario that implies a convergence of the participation rate in the Chinese and Indian regions toward the level of North America for people aged between 60 years old and 70 years old (see Figure 16). This reform is implemented progressively between 2010 and 2050.

Figure 16



Source : INGENUE 2.

The ratio of the number of retirees to the people aged above 60 increases sharply during the first half of the 21st century. In 2000, this ratio represents 86% of the North America one in the Chinese world and 78% in the Indian world. As the number of retirees in these two Asian regions swells, the share of pensions to GDP climbs up as well. It does more so when social welfare broadens the public pension coverage (see Table 6).

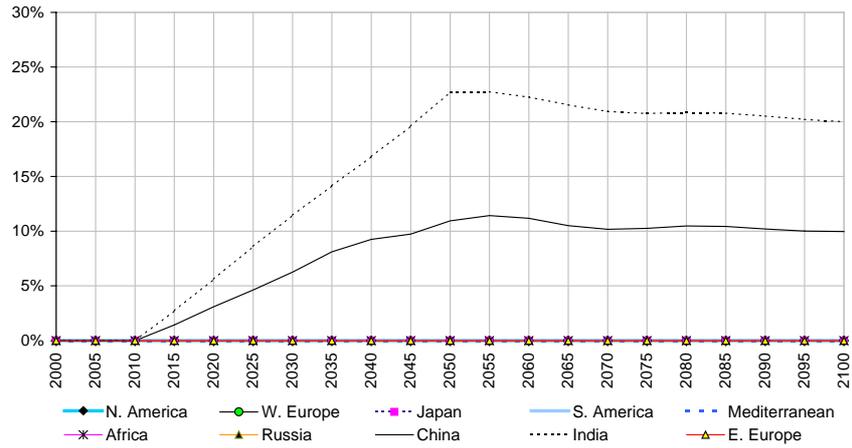
Table 6 : Share of Pensions in GDP

In %	2000	2050 (baseline)	2050 (expanded public pension)
China World	2.1	7.3	8.0
India World	3.2	7.7	9.2

Correlatively, the dependency ratio and the contribution rate weigh more than in the baseline scenario (Figures 17a and 17b). The rise is more pronounced in India than in China. The reason is that the participation rates of Indian people aged 60 to 70 are higher than the rates of their Chinese counterparts before the reform takes root. It is also true that participation ratios are relatively low in India from age 20 to 50. Policies not studied here can be implemented to raise the participation of women in the labor force. They would offset the effects of the broader coverage of retirement benefits.

Figure 17a

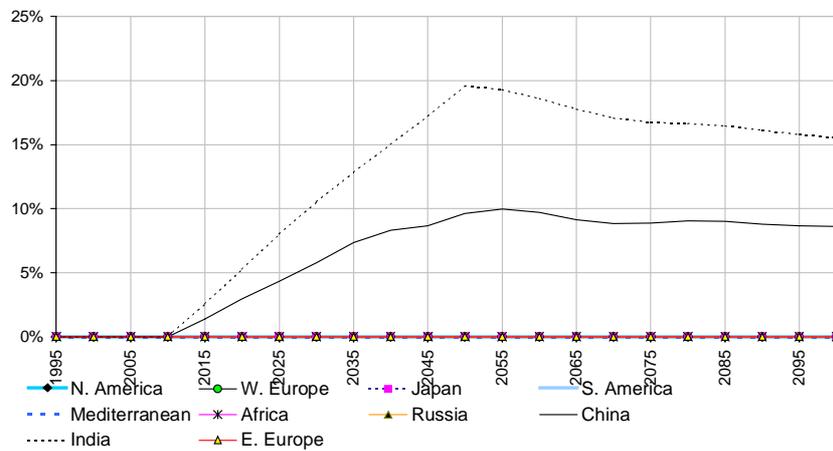
Dependency ratio (retirees in percentage of total active population):
(Percentage point difference from baseline scenario)



Source : INGENUE 2.

Figure 17b

Evolution of Social Security contribution Rate (2000-2050)
(Percentage point difference from baseline scenario)

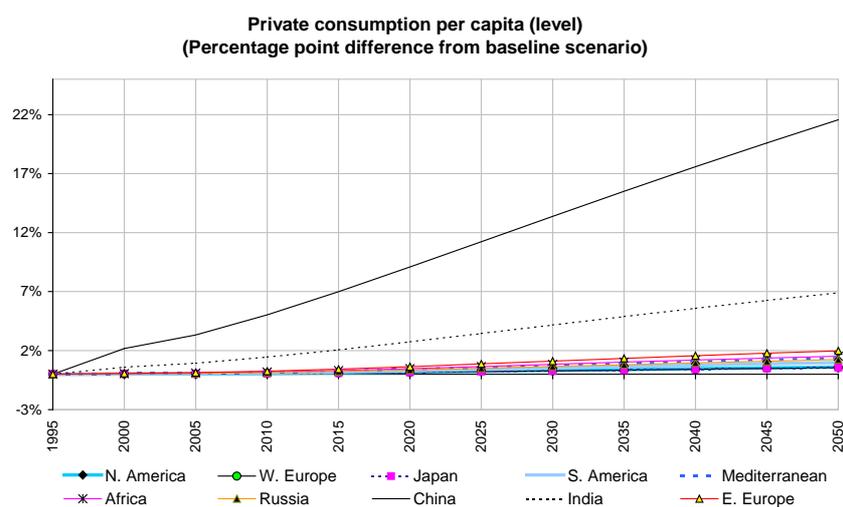


Source : INGENUE 2.

6.2 Scenario of faster GDP growth in China and India

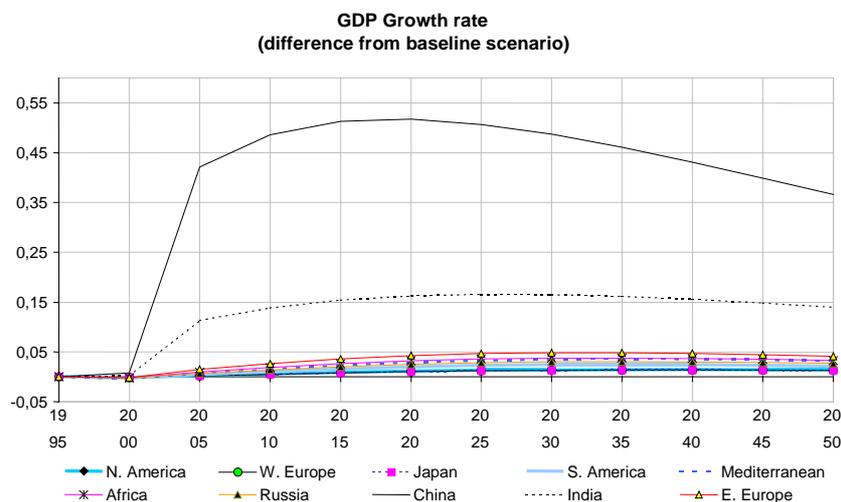
The growth impact of the speed-up in technological diffusion is straightforward. In the regions that experience the upward shift of the production frontier, people rationally expect a higher trend of future real income. Their intertemporal budget constraint becoming looser, they consume more from the beginning of the shift. The improvement in consumption per capita is stronger in China where the rise in TFP is larger (Figure 18). The higher trend in consumer demand boosts capital accumulation. The subsequent higher capital intensity gives a further upward twist to the productivity of labor. The result is a sharp acceleration in GDP growth in China and to a lesser extent in India to reach the new equilibrium in capital intensity. Then the growth profile in output follows the one in TFP (Figure 19).

Figure 18



Source : INGENUE 2.

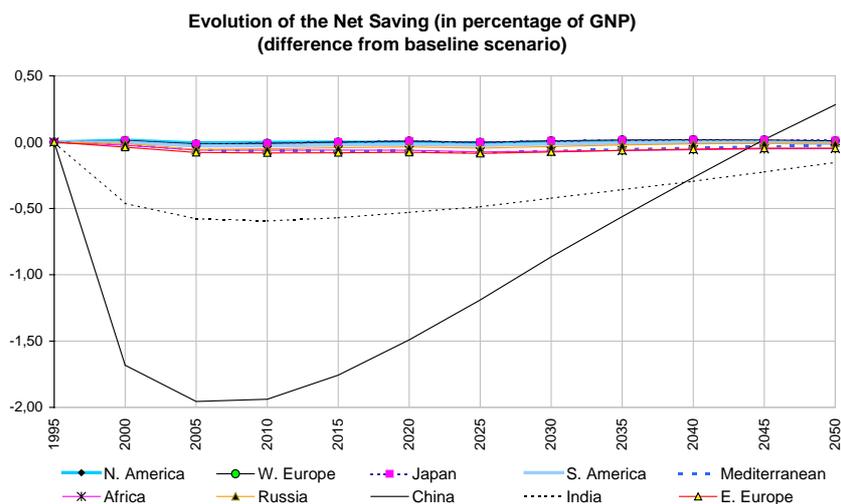
Figure 19



Source : INGENUE 2.

One can see on Figures 18 and 19 that the growth momentum in China and India spreads on the rest of the world. This impact finds its way through the change in the pattern of trade and financial flows and through the price structure.

Figure 20

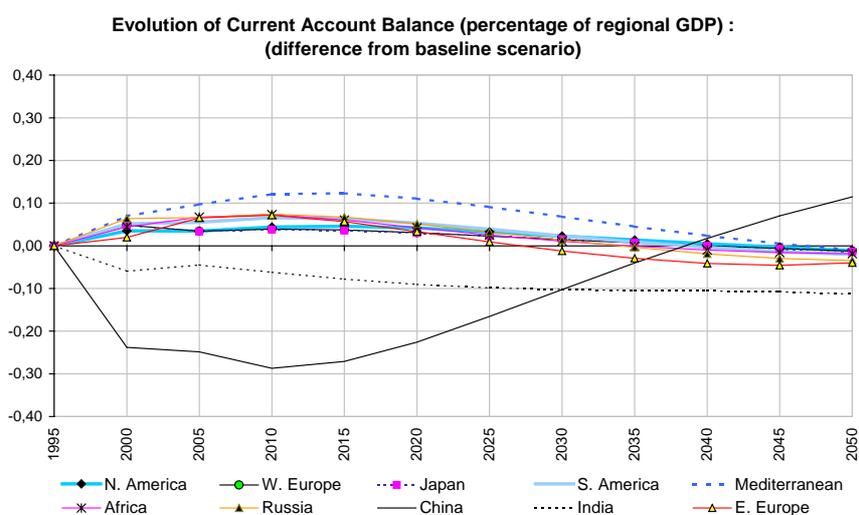


Source : INGENUE 2.

Because they expect persistently higher future streams of income, Chinese and, to a lesser degree, Indian households feel wealthier. Therefore they save less. The saving rate declines immediately, then recovers progressively as more people get more income. In the longer run, the higher productivity makes room for both more consumption and more saving, as aging is conducive to wealth accumulation (Figure 20).

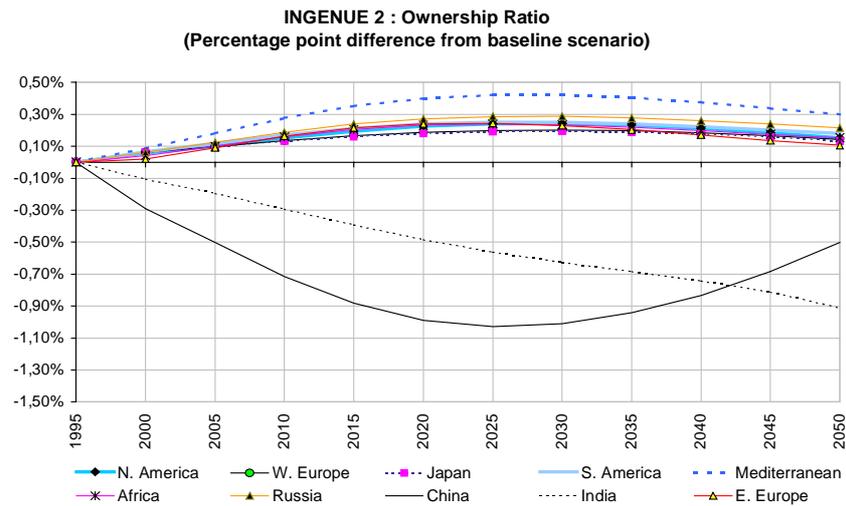
Less saving and more investment lead to a deterioration of the current account balance which slips into deficit. It is reversed in China before the end of the first half century. Then, the balance generates larger surpluses in the second half, while it remains in deficit in India (Figure 21a). The other regions mirror the Chinese profile so that, in the second half of the century, the “Chinese World” alone has a surplus relative to the benchmark scenario. The change in the world saving investment balance also impinges upon the net debtor or creditor positions measured by the ownership ratio. Relative to baseline, the Chinese and Indian regions get more into debt and other regions lend more in the first half of the century (Figure 21b).

Figure 21a



Source : INGENUE 2.

Figure 21b

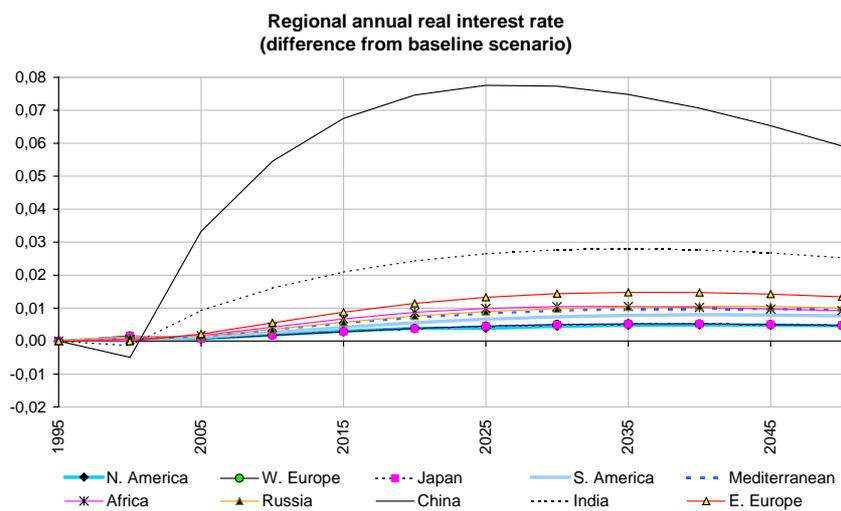


Source : INGENUE 2.

Finally, the technologically-induced capital accumulation cum lower saving in Asia drives the world interest rate upward. Because imperfection in credit markets entails a differentiation of regional real interest rates as a function of foreign indebtedness, the higher debt ratios in China and India widen the range of interest rate differentials amongst the world regions. Therefore there is a slightly upward trend in the world interest rate coupled with a widening of the spreads until 2025 (about the top of the growth rate in China) followed by a slow narrowing (Figure 22a).

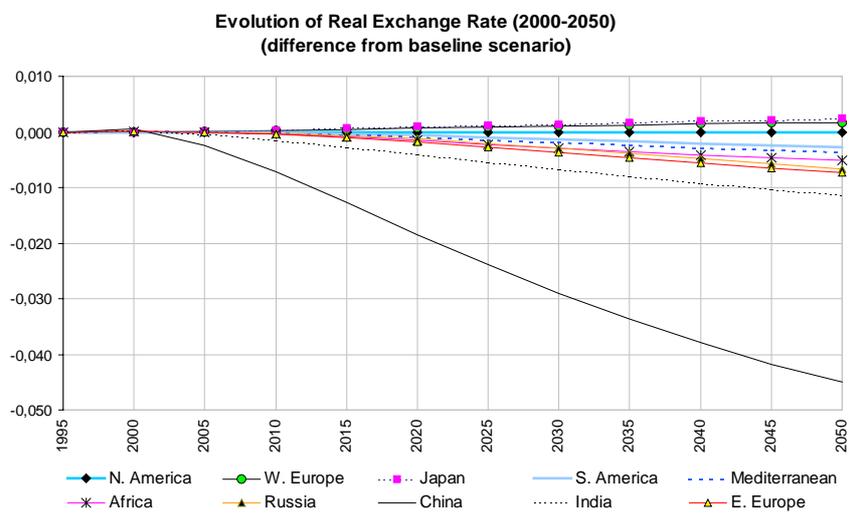
Contrasting with domestic imperfections in credit markets, capital mobility via foreign exchange markets is assumed perfect. Thus interest rate parity holds, leading to changes in the real exchange rates. Since the growth in productivity is higher than in the baseline scenario in China and India relatively to other regions, domestic prices decline in these regions relatively to the rest of the world in both traded and non-traded goods. Therefore, both the terms of trade and the real exchange rate decline. The drift in the real exchange rate arises chiefly in China (Figure 22b). Europe and Japan undergo a further but admittedly modest appreciation relative to North America.

Figure 22a



Source : INGENUE 2.

Figure 22b



Source : INGENUE 2.

6.3 Scenario of improved social welfare in China and India

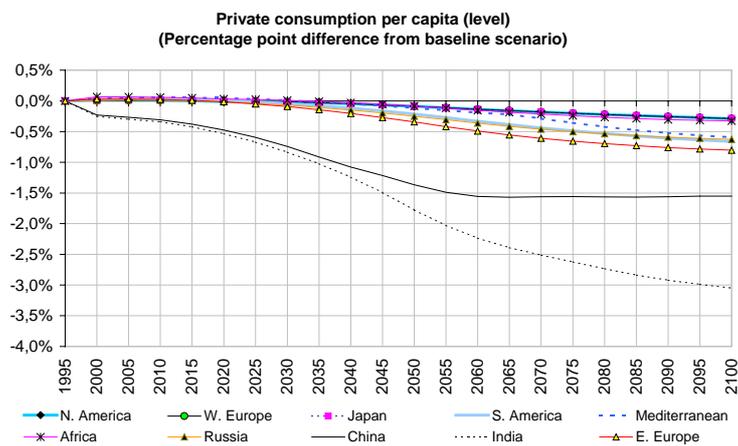
Run relative to baseline for analytical clarity, this scenario exhibits variations qualitatively opposite to the precedent. But the deviations are of a smaller magnitude. This result backs up the view that improving the social welfare must go along with higher productivity growth. It is particularly relevant for China where the social framework of the communist regime was dismantled for the sake of a very strong capital accumulation. Building up a social welfare system is an integral part of an overhauling of growth onto the long-run development of domestic demand.

Indeed, without the extra resources drawn from high growth in productivity, the implementation of public welfare is costly. Reducing the participation of older workers, extending the coverage of publicly-financed retirement shrinks the size of the labor force. Therefore the growth rate declines relative to baseline until 2050 where the reform is completed.

This supply side effect is matched on the demand side by a change in the allocation of household income. Because they have to finance both a higher dependency ratio with higher taxes and a wealth accumulation to provide future income for a longer retirement life, households consume less and save more (as they will earn a pension that is lower than the wage they earned during their working life). While social welfare is expanding until 2050, consumption per capita declines in China and then stabilizes. It goes on declining in India to the end of the century because the participation of people in the 60-70 age group is larger than in China. It takes more time to reach the standard of North America (Figure 23). Lower growth in China and India drags down the rest of the world though admittedly modestly.

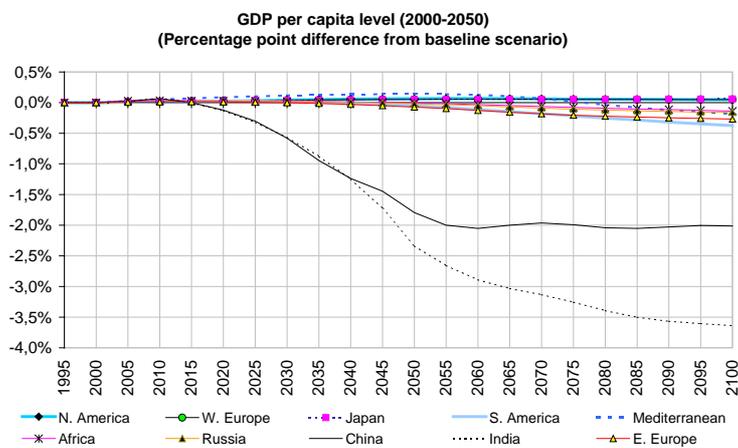
Correlatively, the saving-investment balance is changed worldwide. Because saving is increased and investment lowered, real interest rates decline significantly in China and India in the first half of the century; their subsequent recovery is not enough to return to the benchmark level. Thus, the world interest rate drifts downward a bit (Figure 24). Interests rates slightly decline in all regions with less investment to finance. They do it most in regions which were more indebted in the baseline scenario, namely Africa and Eastern Europe. Conversely interests rates decline less in creditor regions, Japan and Western Europe.

Figure 23a



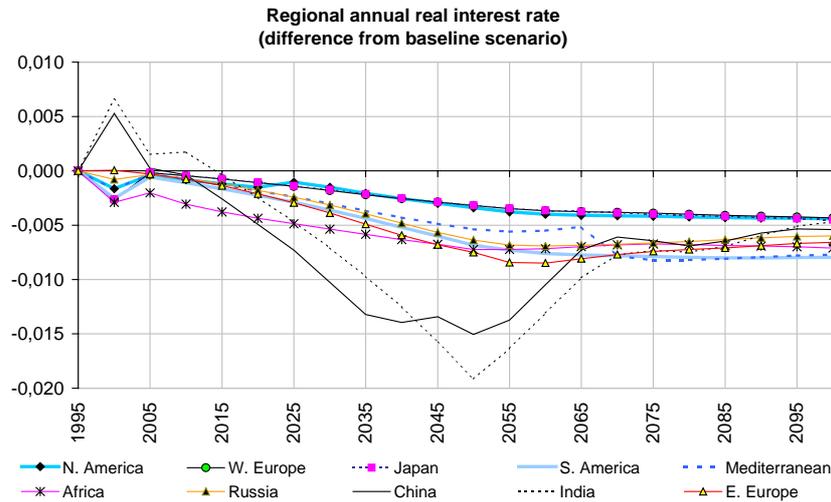
Source : INGENUE 2.

Figure 23b



Source : INGENUE 2.

Figure 24

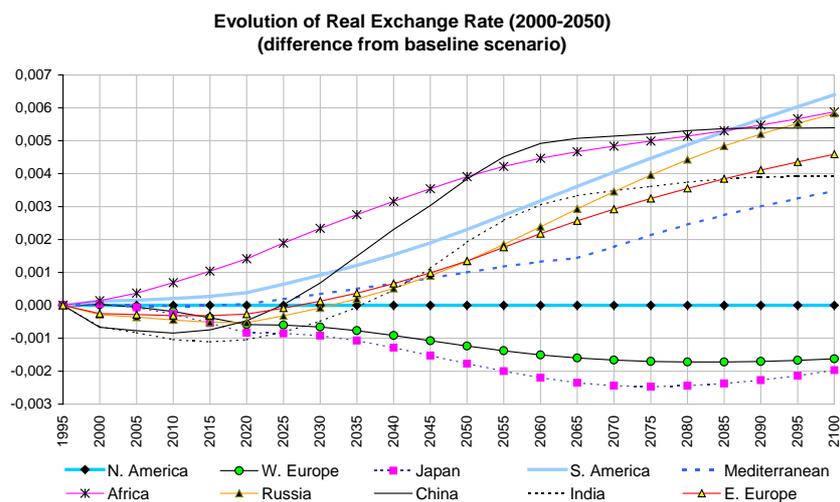


Source : INGENUE 2.

Real exchange rate changes are driven by the changing pattern of interest rate differentials. Exchange rates appreciate in India and China after an initial depreciation. They carry along all the exchange rates of debtor regions while they depreciate a bit in Japan and Western Europe (Figure 25). From the perspective of the supply/demand equilibrium on the final goods market, the initial depreciation of the exchange rate could be explained by the demand shock coming from the negative effect on the life-cycle income of the Chinese and Indian households. This fall in the demand of their final good appears clearly with the instantaneous decrease of consumption per capita (Figure 23a). The appreciation of the exchange rate is then induced by the negative supply shock (coming from the working age population decrease). As can be seen on Figure 23b, this adjustment occurs only after 2015 in the two Asian regions whereas the negative demand shock occurs as soon as 2000.

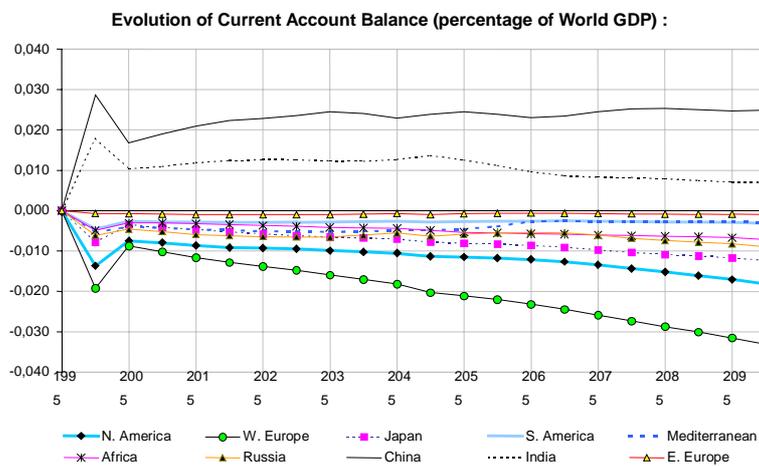
The effects are even more clearcut in international capital flows and foreign investment positions. The current account balance and the ownership ratio improve in China and India which undertake the welfare reform and they deteriorate in all other regions (figures 26a and 26b). It suggests that the way the reform has been defined, i.e. enlarging the coverage of welfare instead of augmenting the replacement ratio of pensions over wages, is an incentive to save more and spend less. Financial positions are improved as a consequence.

Figure 25



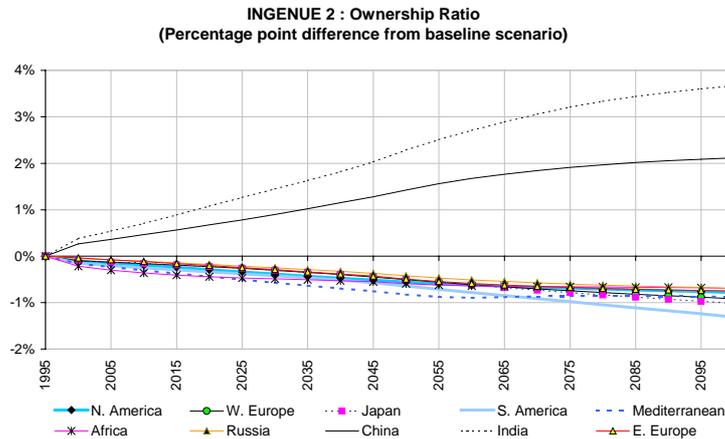
Source : INGENUE 2.

Figure 26a



Source : INGENUE 2.

Figure 26b



Source : INGENUE 2.

Since financial variables move in opposite directions with the supply-side reforms on the one hand and the welfare reforms on the other hand, compounding them in a comprehensive structural policy of modernization makes a more balanced picture of the growth process in Asia and of its impact on the rest of the world. This is the substance of a world growth regime that is a credible alternative to the conservative baseline scenario.

Figures 27a and 27b sum up the effects on growth and on saving of the combined scenario in Asia, focusing on the regions undergoing the structural changes. On these figures, the profiles of the growth cum social reform scenarios are presented jointly with the profiles of the baseline scenario.

In China the speed of technological diffusion raises the growth rate all over the 50 year period relative to the baseline scenario despite the cost of social reform. In India, the slower rate of diffusion and the lower participation rate in the middle-aged groups leaves only a small difference.

The saving rate is the core variable for the impact on capital flows. In the combined scenario, the overall change is the outcome of two countervailing influences. In India they almost cancel out. In China the lower saving linked to the technological diffusion dominates until 2035. Then, the higher saving due to the extension of retirement takes over.

Figure 27a

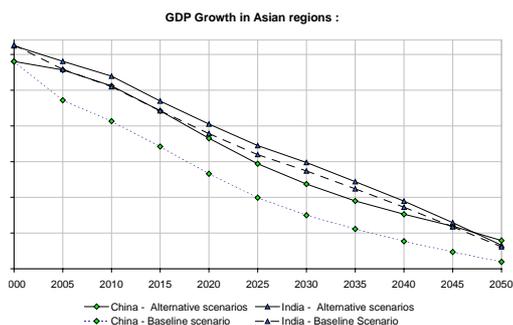
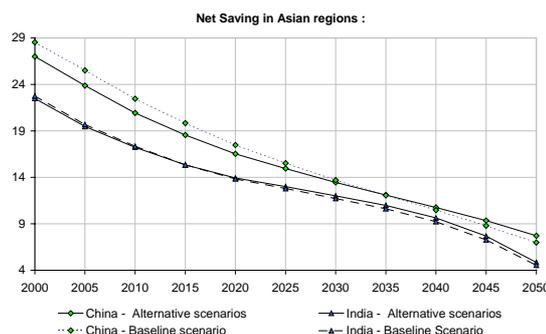


Figure 27b



Source : INGENUE 2.

Figures 28a and 28b depict the evolution of international variables. On real exchange rates, the speedup in productivity growth dominates the countervailing effect of social reforms. This is more visible in China where the growth scenario is based upon a faster catching up than in India. With higher productivity growth, domestic prices decline relatively to the benchmark region (North America). Therefore the real exchange rate depreciates from 2015 onward instead of appreciating. On the contrary, the two parts of the combined scenario have effects on net capital flows which cancel each other, leaving no significant net impact on the ownership ratio.

Figure 28a

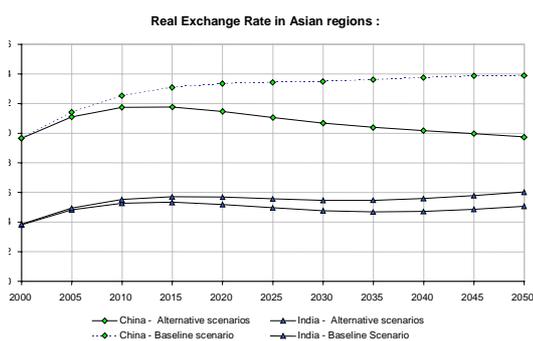
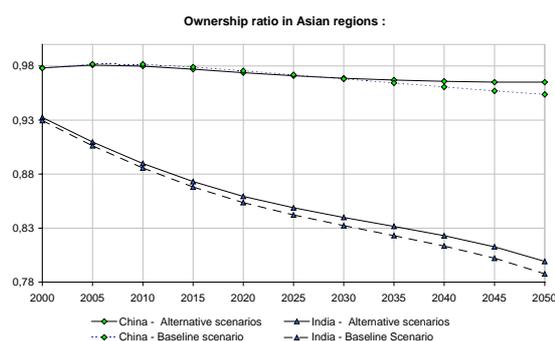


Figure 28b



Source : INGENUE 2.

7. CONCLUSION

Our investigation of the long-run prospect of the world economy has shown how far a sustainable world growth regime is from the present unbalanced stage of globalization. We have developed the conjecture of a world growth regime based upon demographic and technological forces stemming from the large emerging market economies of Asia. The capital flows involved will substantiate an intergenerational saving transfer to the huge number of people who aspire to get access to Western standard of life⁵.

Such a saving investment pattern is one way to resume a convergence process interrupted temporarily by the financial crises of the 1980's and 1990's. Almost all regions, which were victims of the malfunctioning of the international financial system, have rightly reacted in becoming capital exporters to reduce their dollar debts and accumulate large reserves to cushion against financial instability. Still, on top of fuelling real estate bubbles and financing an unhealthy slump in US household saving, this paradoxical pattern of capital flows will undoubtedly hamper the growth potential of emerging market countries if unduly prolonged. But there is no way that the present pattern of capital flows will reverse itself spontaneously without plunging the world in recession. The world economy cannot be set on a virtuous growth track without considerable changes in the three most important economic regions of the world. Here are some policy lessons that can be drawn from the prospective analysis using the INGENUE 2 model.

- **The baseline scenario points to the need of restoring a sustainable saving investment balance in the US**

A steady increase in U.S. saving is required to reduce (progressively) the current account deficit and then, eventually, turn it into surplus in future decades. This structural change would certainly be accompanied by a real depreciation of the dollar across the board. In our benchmark scenario, the trend is most pronounced against the euro and the yen. A real depreciation would improve private saving through several channels. Profit margins would rise in the traded goods sector if there were some pricing-to-market. Domestic demand would slow down with real wages. The changing structure of demand in favor of non-traded goods with the decrease in the relative price of those goods could mitigate the negative impact of the lesser momentum in domestic demand on employment. Yet, a reduction in the budget deficit is the surest way to improve national saving, because Ricardian equivalence appears to be weak in the US.

- **The baseline scenario depicts Western Europe as a slow growth region**

Western Europe has a declining working-age population and cannot hope much on catching-up as a factor of growth because the region is relatively close to the technology frontier. The best source of growth potential would stem from boosting innovation. That

⁵ One must note that the growth regime depicted in this paper depends on capital migration to the faster-growing countries, not on labor migration into aging rich economies as we assumed no migrations between the regions in the baseline scenario of the INGENUE 2 model.

was the Lisbon Agenda, which was not implemented, due to financial constraints, perennial bickering on the federal budget and lack of political leadership. Such an innovation-prone growth requires sustaining a much more ambitious level of R&D and higher education spending, that only the Scandinavian countries have achieved. Better links between public and private firm research is also called for on selected projects that can be financed by multiple sources: origination via a restructured Union budget, borrowing on capital markets by the European Investment Bank with a multiplier effect on institutional investors.

- **The baseline scenario shows that the world growth regime in the XXIst century will have its engine in regions with a huge labor force and a fast catching-up.**

Growth in Asia relies excessively on exports. It must be redeployed toward domestic demand. With Japan getting out of deflation, a move in the right direction can arise if consumer demand recovers. In the developed countries of Asia which underwent the Asian crisis, there is also a lack of consumer demand. Promoting financial reforms to set up well-regulated credit systems for the private sectors could enhance consumer credit. In China and India, the growth scenarios that we have studied rely on multiple structural reforms. Along with the strengthening of the financial sector, structural policies hard to agree upon and time-consuming to implement are paramount. Investing in infrastructure and mass education helps remove the impediments to technological diffusion. Initiating long-standing social policies to vastly extend the coverage of social welfare systems lays out a social sharing of economic risks that will entail a downward trend in private saving and an upward trend in the weight of consumption in GDP.

- **In the baseline scenario, capital flows are smoothly regulated by yield differentials because global financial markets operate under long-run rational expectations. This has obviously not been the case in actual financial systems.**

Because dollar borrowing gave rise to twin crises in currency and banking markets, emerging market countries have consistently reduced their dollar debt and built up comfortable reserves to recover their economic sovereignty. This financial trend is at odds with the pattern of growth underlying the efficient intergenerational worldwide transfer of saving underlain by a growth regime spurred by fast catching-up. But, in order to resume their normal pattern, capital flows are not only dependent on the structural reforms hinted at hereabove. Global financial markets should take a longer-run view and share risk better. Borrowing countries could make their currencies more available to foreign investors as long as they make progress in their domestic financial reforms. Borrowing in domestic currencies or in other currencies of the same region linked by monetary agreements would withdraw much of the instability that plagued the first stage of financial globalization (between 1980 and 1997 when emerging countries have borrowed massively in US currency). Such a move would make the international monetary system more multilateral and would demand some mechanism of global governance.

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APPENDIX: THE REGION IN THE INGENUE 2 WORLD MODEL

In the INGENUE 2 model, the World is divided in 10 regions according mainly to geographical and demographic criteria. These regions are labelled : Western Europe, Eastern Europe, North America, Latin America, Japan, Mediterranean World, Chinese World, Africa, Russian World and Indian World. The content of each region is detailed below.

"Western Europe": 'Channel Islands', 'Denmark', 'Finland', 'Iceland', 'Ireland', 'Norway', 'Sweden', 'United Kingdom', 'Greece', 'Italy', 'Malta', 'Portugal', 'Spain', 'Austria', 'Belgium', 'France', 'Germany' (East and West), 'Luxembourg', 'Netherlands', 'Switzerland'.

"Eastern Europe": 'Estonia', 'Latvia', 'Lithuania', 'Bulgaria', 'Czech Republic', 'Hungary', 'Poland', 'Romania', 'Slovakia', 'Slovenia', 'Albania', 'Bosnia and Herzegovina', 'Croatia', 'TFYR Macedonia', 'Yugoslavia'.

"North America": 'Canada', 'United States of America', 'Australia', 'New Zealand', 'Melanesia', 'Fiji', 'New Caledonia', 'Papua New Guinea', 'Solomon Islands', 'Vanuatu', 'Micronesia', 'Guam', 'Polynesia', 'French Polynesia', 'Samoa'.

"Latin America": 'Argentina', 'Bolivia', 'Brazil', 'Chile', 'Colombia', 'Ecuador', 'French Guiana', 'Guyana', 'Paraguay', 'Peru', 'Suriname', 'Uruguay', 'Venezuela', 'Belize', 'Costa Rica', 'El Salvador', 'Guatemala', 'Honduras', 'Mexico', 'Nicaragua', 'Panama', 'Bahamas', 'Barbados', 'Cuba', 'Dominican Republic', 'Guadeloupe', 'Haiti', 'Jamaica', 'Martinique', 'Netherlands Antilles', 'Puerto Rico', 'Saint Lucia', 'Trinidad and Tobago'.

Japan

"Mediterranean World" : 'Algeria', 'Egypt', 'Libyan Arab Jamahiriya', 'Morocco', , 'Tunisia', 'Western Sahara', 'Armenia', 'Azerbaijan', 'Bahrain', 'Cyprus', 'Georgia', 'Iraq', 'Iran', 'Israel', 'Jordan', 'Kuwait', 'Lebanon', 'Occupied Palestinian Territory', 'Oman', 'Qatar', 'Saudi Arabia', 'Syrian Arab Republic', 'Turkey', 'United Arab Emirates', 'Yemen', 'Turkmenistan', 'Uzbekistan', 'Kyrgyzstan'.

"Chinese World": 'China', 'Democratic People's Republic of Korea', 'Mongolia', 'Republic of Korea', 'Brunei Darussalam', 'Cambodia', 'East Timor', 'Lao People's Democratic Republic', 'Myanmar', 'Philippines', 'Singapore', 'Thailand', 'Viet Nam'.

"Africa": 'Burundi', 'Comoros', 'Djibouti', 'Eritrea', 'Ethiopia', 'Kenya', 'Madagascar', 'Malawi', 'Mauritius', 'Mozambique', 'R\{e}union', 'Rwanda', 'Somalia', 'Uganda', 'Tanzania', 'Zambia', 'Zimbabwe', 'Angola', 'Cameroon', 'Central African Republic', 'Chad', 'Congo', 'Democratic Republic of the Congo', 'Equatorial Guinea', 'Gabon', 'Botswana', 'Lesotho', 'Namibia', 'South Africa', 'Swaziland', 'Benin', 'Burkina Faso', 'Cape Verde', 'Côte d'Ivoire', 'Gambia', 'Ghana', 'Guinea', 'Guinea-Bissau', 'Liberia', 'Mali', 'Mauritania', 'Niger', 'Nigeria', 'Senegal', 'Sierra Leone', 'Togo', 'Sudan'.

"Russian World": 'Belarus', 'Russian Federation', 'Ukraine', 'Kazakhstan', 'Republic of Moldova',

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