

The Larger Europe: Technological

Ingenue Team*

We investigate the long-run growth of Europe in the world economy. The research covers the first half of the XXIst century. The basic trends that will shape the growth regime in the global economy are the demographic transition and the diffusion of technological progress. We use the framework of INGENUE, an OLG model that divides the world in ten broad regions. Hypotheses are elaborated on the basic trends and discussed in an historical perspective. Structural changes are then introduced into INGENUE to make prospective scenarios.

A baseline scenario is built to outline the main macroeconomic features of the broad regions. This scenario being used as a benchmark is deliberately conservative as far as structural and institutional changes are concerned. It depicts Western Europe as an ageing low-growth region, accumulating net foreign assets and enjoying an appreciating real exchange rate. These are the characteristics of a permanent creditor in a world growth regime supported by capital mobility.

The frontiers of Europe are investigated in the last part of the paper by means of two alternative scenarios. First it is assumed that EU enlargement accelerates the technological catch-up of Eastern Europe and boosts growth. Second labour mobility is simulated. Because the cost of financing public retirement is higher in Western Europe, a policy of immigration is implemented to eschew the decline of the labour force. Both the beneficial effects on Western Europe and the adverse effects on the regions of emigration are displayed.

L'ÉLARGISSEMENT DE L'UNION EUROPÉENNE. CONVERGENCE ET MOBILITÉ DU TRAVAIL

Nous explorons la croissance tendancielle de l'Europe au sein de l'économie mondiale. La recherche couvre la première moitié du XXI^e siècle. Les principaux facteurs du régime de croissance vont être la transition démographique et la diffusion du progrès technique. Nous utilisons le modèle INGENUE qui découpe le monde en dix grandes régions. Des hypothèses sont formulées sur ces facteurs et discutées dans une perspective historique. Les changements structurels impliqués par ces hypothèses sont introduits dans INGENUE pour faire des scénarios prospectifs.

Un scénario de référence est construit qui décrit les principales caractéristiques macroéconomiques des grandes régions. Parce qu'il veut être la base à partir de laquelle sont étudiées des variantes, ce scénario est conservateur dans les changements structurels et institutionnels qu'il incorpore. Il décrit l'Europe occidentale comme une région vieillissante à croissance faible, qui accumule des actifs

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nets sur l'étranger et qui bénéficie d'une appréciation réelle de l'euro. Ce sont les caractéristiques d'un créancier permanent qui tire parti de la mobilité du capital.

Deux scénarios illustrent les frontières de l'Europe. D'abord, on suppose que l'élargissement vers l'Est accélère le rattrapage technologique de l'Europe de l'Est et donne une impulsion à la croissance. Ensuite, on simule une politique d'immigration en Europe de l'Ouest pour compenser le déclin de la population active et modérer l'augmentation du coût du financement public des retraites. Le modèle met en évidence et quantifie les effets bénéfiques en Europe de l'Ouest et les effets contraires dans les zones d'émigration.

Classification JEL: C68, D91, F21, F22, H55.

INTRODUCTION

In the early years of the XXIst century the world we are living in is in flux. Globalisation is deepening. It is no longer restricted to international exchanges in trade and finance. Technology transfers gain momentum. The countries able to assimilate its arcane can jump several stages in the international division of labour in some sectors and areas while still being in utter backwardness in others. Heterogeneity makes their development highly unbalanced but it fosters potential opportunities for both foreign and advanced domestic firms. Management systems, accounting and information standards are also part of the process of globalisation. Multinational firms are no longer exclusively Western and Japanese spreading world-wide. They are challenged by multinationals originating in other parts of the world, making competition fierce in truly world-wide markets.

Therefore the conjecture of a growth regime significantly different from the past stages of capitalist development can be contemplated. After World War II only in Western Europe the catching-up process to the leading country was able to be interactive amongst the converging countries, making an integrated region. Growth in Japan and in the so-called Asian dragons was both domestic and export-led, without reciprocal dynamic relationships. Exports were essentially driven to the US market. Domestic production was import substitute from the US and Western Europe. In the first half of the XXIst century, for reasons underlined below, multiple poles of integrated development will rise. This makes world growth a regime that requires a model linking together vastly populated regions of the globe, catching up at their own speed.

To study what the world growth regime will stand for in the next decades and what the scope of Europe is likely to be, section I depicts the demographic and technological forces that will foster convergence in the present half century. Section II introduces the conjecture of the world growth regime, discussing the crucial hypotheses and outlining the *INGENUE 2* model. Section III describes the macroeconomic features of the baseline scenario and the place of Europe in a changing world. Section IV defines alternative prospects in the relationships of Western Europe with its neighbourhood. One is faster convergence in Eastern Europe due to economic integration; the other is a flow of labour migrations from the East and the South (the Mediterranean contour and Sub-Saharan Africa). Finally the paper concludes on the benefits for Europe from being a pole of attraction.

THE NEW GREAT TRANSFORMATION: DEMOGRAPHIC TRANSITION AND TECHNOLOGICAL CONVERGENCE IN THE XXIST CENTURY

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. Mobility of labour, capital and ideas has intermeshed. The stages of capitalist development are connected with different directions of this mobility.

Demographic expansion, migration and economic development

In the late XIXth century there was an impetus to globalisation prodded by a joint expansion of European capital and labour in under-populated overseas territories. The momentum was impressive indeed. For the average of the years 1880-1913 the net flow of capital exports for the total of 13 European countries reached 3.5% of their aggregate GDP. In comparison the same measure of overall capital mobility was 2% in the 1930's and 1.5% in the thirty mighty years after World War II. It rose again after the first oil shock to 2.7% in the last decade of the XXth century (Taylor [1996]).

The most striking feature of the world growth regime in the late XIXth century however was the complementarity between capital export from Europe and the emigration of its population. In the UK 3% of the initial population emigrated in the 1880's, 5.2% in the 1890's plagued by a severe recession, 2% in the growth years of the first decade of the XXth century. In Spain the figures were respectively 1.5, 6, 5.2% and in Sweden 2.9, 7.2 and 3.5%. These figures were very high for countries with a long tradition of capitalist development. But in the lands of immigration they were properly astonishing. Indeed in the 1890's the population swelled 9% with immigration in addition to the natural expansion in the US, 17% in Australia and 25% in Argentina.

It was a transplant of the European labour force that was young, productive and attracted by higher wages or entrepreneurial income as settlers. Because of capital imports, the expatriated labour force benefited from fast technological progress in railways and sea transportation, converted into low costs of the primary commodities entering into European manufacturing industries. Therefore the labour migration of the time entailed an international division of labour whereby the real cost of wage goods diminished in Europe, while emigration helped sustaining an increase in real wages after the turn of the XXth century. Meanwhile capital exports from Europe and capital accumulation in Europe occurred in alternate phases of the financial cycle, preserving a stable long-run interest rate.

World War I and the ensuing monetary disorders, culminating in the world depression that fragmented international trade broke this world growth regime. It was not until the 1960's that another pattern of world growth emerged. It was very different from the former. Huge institutional changes after World War II

had rooted a self-sustaining growth process in Western countries. It was based upon a virtuous circle encompassing the baby boom, fast productivity gains, matching real wage increases, progressive social transfers and mass consumption. In the 1960's trade opening under sequential GATT rounds enhanced a convergence club in OECD countries. This process entailed primarily domestic migrations from rural to urban areas. It was supplemented by immigration from the so-called Third World after completion of decolonisation. This immigration was stirred on the supply side by the demographic explosion in the Third World, by the dislocation of traditional agricultural structures and the deterioration in the terms of trade that spread mass poverty in the mega-cities. On the demand side it was attracted by a chronic shortage of low-skilled labour in the fast-growing industries of consumer durables. This migration pattern went on to the early 1980's and in some respect still goes on chiefly in North America and to a lesser extent in Europe.

New Prospect between demography and economy in the XX1st century

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 XX1st century. It is a sequential and lengthy process of ageing. The developed countries, the Eastern European countries, Russia and ten years later China, will be ageing from the top of the age structure. Most of the developing world is ageing from the bottom of the pyramid.

When the world is broken in ten regions, according to the nomenclature adopted in *INGENUE 2*, a sharp contrast will arise in the rate of growth of the labour force. It will decline throughout the half century in Russia (very fast), Eastern Europe, Western Europe and Japan. It will decline more moderately in North America (after 2010) and China (after 2020). It will decelerate but grow until 2050 in South America, India and the Mediterranean countries (outside Europe). The most atypical region is Africa where the labour force will hardly decelerate at all (Figure 1). 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. In the upcoming decades the opposite will occur. Emerging market countries have the potential for a new growth regime based upon a widespread, albeit not generalised, catching-up.

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.

As the leading OECD countries concentrate the largest part of world capital, the growth regime will depend on international capital rather than labour mobility. An intergenerational transfer of resources *via* capital export from the rich ageing countries to the labour force growing countries will make the world regions strongly interdependent. We already advocated this approach in former papers based upon *INGENUE 1*, the first version of the model. Indeed the idea of a mutually advantageous exchange, whereby wealthy households in rich countries export their saving to growth-hungry countries, is the core insight in the *INGENUE* project. Figure 2 illustrates why this intergenerational exchange will arise.

Figure 1. Working age population annual growth rate 1960-2050

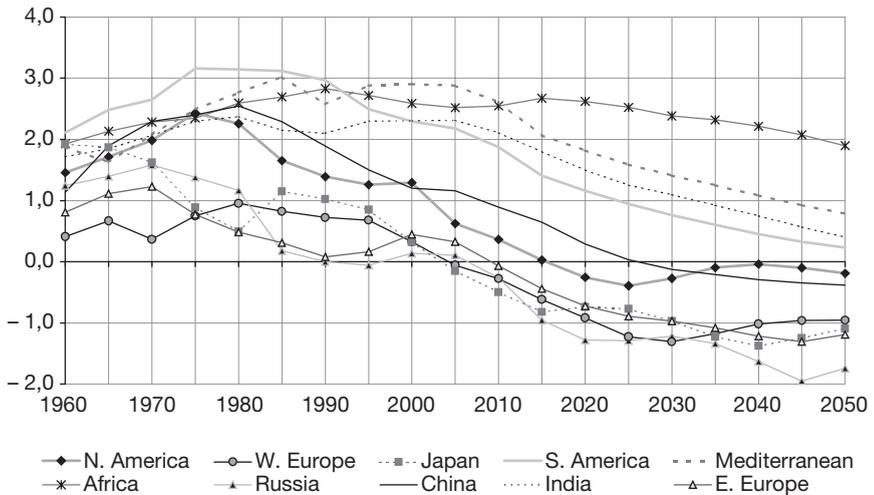
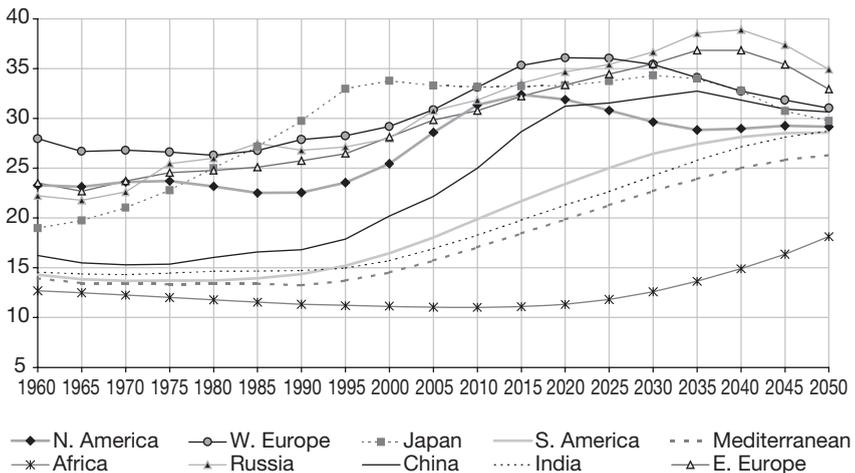


Figure 2. High Savers Ratio (age group 45-69 yrs in percentage of total population) 1960-2050



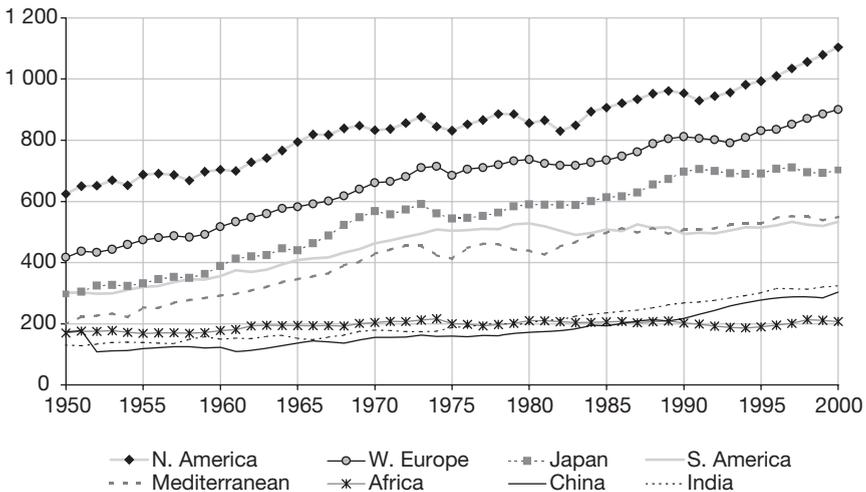
One can see that the proportion of high savers in total population follows a wave pattern that propagates from one region of the world to the next through the decades. The ratio culminates first in Japan as soon as 1995 and remains at high level until 2030. Then North America will have its maximum in 2010 and Western Europe in 2015, Eastern Europe, Russia and China in 2030. All are regions where the labour force will decline and thus hamper growth in the future. On the contrary the regions found on figure 1 as the potentially fast-growing regions will see a progressive ageing leading to an increase of the high savers ratio which will not culminate before 2050. It follows that saving will 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.

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 labour and of technological progress defined as TFP. Therefore the latter is computed with the use of the production function. The stock of capital and the national account data were drawn from Heston-Summers data base [2002]. They were aggregated in \$1996 for the regions of the INGENUE breakdown. Ad hoc adjustments were made for missing data. The elasticity parameter for the impact of capital in the production function was held the same at 1/3 in all regions. Then total factor productivity was computed for every year of the period 1951-2001. The results are exhibited on figure 3.

Figure 3. Total Factor Productivity: 1950-2000 (1996 \$)



In the second half of the XXth century North America has always been the world leader. Western Europe and Japan were catching up until 1990. From a TFP equal to about 66% of US level in 1950, Europe reached 90% in 1990. From 50% Japan reached 75%. Then the trend changed abruptly. Producing and diffusing the use of IT in the larger service sector the US has been able to speed up its TFP growth. In the meantime Europe was not able to follow suit and Japan stalled completely. Therefore the gap has widened for the first time since World War II. One can also observe the impact of the oil crises on countries which subsequently suffered repeated debt constraints. In Latin America TFP has been stagnant since 1975 after

a solid growth in the 20 years before. This profile contrasts markedly with the Asian performance. TFP took off in 1980 in China when reforms were launched. It has persistently accelerated since. It did also in the mid-1980's in India where it has shown a hefty profile in the 1990's and beyond. Finally no take off has arisen in Africa after decolonisation. Combined with the high increase in population growth depicted on figure 1, it means that GDP per capita actually declined, plunging the overwhelming majority of the population in abject poverty.

THE CONJECTURE OF 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 the change in demographic structures and the process of differential convergence in TFP must be depicted in models dedicated to explore the long run.

A provocative mechanism was proposed by Lucas [2000] to explain both the divergence in real income per capita between countries for a considerable period of time, then a convergence that might occur in the present century. This mechanism is worth considering.

The takeoff of individual countries starts at random. After the initial shock they follow a growth regime *à la* Solow. The trend of their total factor productivity is the faster, the larger the distance of their income per capita to that of the leader. This dynamic 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.

Still the speedup of technological revolutions is another stylised fact that shape trends of productivity gains. 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]).

This assumption rests on the diffusion of technological progress. The knowledge invented somewhere is a non-rival good. It can be used anywhere with the caveat that relevant institutions and policies have been established. In embodying both the faster growth in a late takeoff and a higher probability of takeoffs as long as the world becomes more technologically knowledgeable, Lucas shows that a clever calibration can deliver interesting simulations. During a long a period of two centuries after the first industrial revolution, income inequalities between countries widen; then they will shrink in the XXist century.

Crucial hypotheses on world growth

How can we accommodate this suggestion in the INGENUE framework? Figure 3 gave the path of TFP for the second half of the XXth century. It exhibits partial catching up of the different world regions to North America. This

catching-up was interrupted in the 1990's by the IT revolution which erupted earlier in the US. We assume that North America will remain the technological leader until 2050, 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 1.5% per year. With a 2/3 share of labour income in GDP, it means a 2.25% steady growth in labour productivity.

For the rest of the world there will be 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 at 1.5% per year: $A_{1,t} = (1 + g)A_{1,t-1}$ with $g = 1.5\%$. The diffusion of technological progress to a zone i is given by the following equation:

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

The first bracket captures the speed-up in the rate of technological progress, due to the shortening 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_i is the brake factor to the convergence in level that is specific to each region. There is a caveat however. To make account for the attractiveness of Europe upon its neighbour regions, we assume that these regions will converge to the European target. As a result:

Western Europe, Japan, China, India and South America will converge to North America.

Eastern Europe, Russia, Mediterranean world, Africa will converge to Western Europe.

Table 1. Exogenous Catching up (μ values): Baseline Scenario

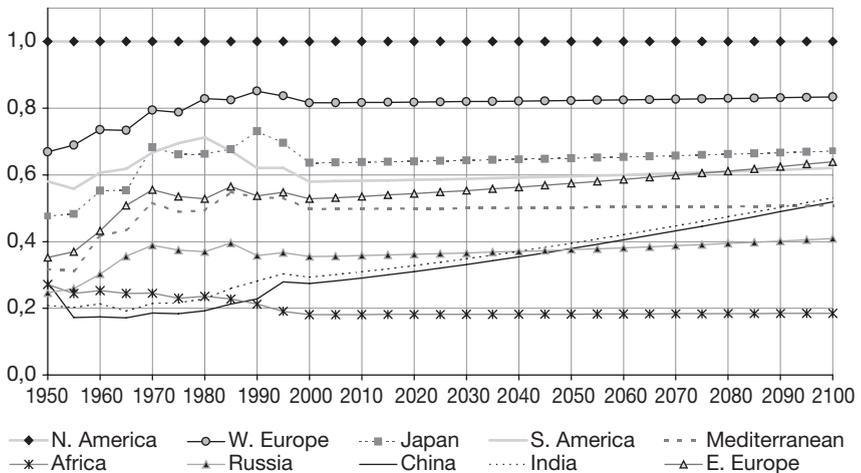
W.Europe	E.Europe	Russia	Africa	Med.	Japan	China	India	S.America
0.99975	0.999	0.99975	1.000	1.000	0.99975	0.999	0.999	0.99975

Figure 4 gathers the profiles of TFP in the world regions of the INGENUE 2 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, will gain momentum. The rise of these continental countries to the status of prominent powers will attract whole regions (Chinese and Indian worlds) into commercial and financial integration. Eastern Europe will also be 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. 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 will entail no catching-up, is a marked improvement on the last quarter of a century which has seen no progress at all and thus a relative setback on the rest of the world.

The profiles in TFP (figure 4) are combined with the ones in the labour force. The latter are given by the profiles of the working age population (figure 1) adjusted for age-specific rates of participation in the labour market. Adjusting finally the age profile of the labour force with a time and region-invariant age-efficiency profile, one gets the main exogenous factors of growth embodied in the INGENUE 2 model.

Figure 4. Total Factor Productivity: 1950-2100 (percentage of "North America" level)



BOX. Non-technical overview of the INGENUE 2 model¹

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

Overlapping generations: 21 generations overlap. Unit time 5 years, hence the maximum life span is 105 years. 17 cohorts of adults and 4 cohorts of young (under 20). Cost per child proportional to the consumption of their parents. Exogenous labour supply adjusted for an age-specific participation ratio in each region.

Macroeconomic framework:

Household behaviour: life cycle hypothesis + voluntary bequest left to children at age T subject to survival until that age. 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) corrected by the survival probability of generation age $a - 1$. 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 labour income (after social security taxes) modulated by an age-efficiency profile for people in full labour activity; a mix of labour income and pension benefits for people partially retired (reduced labour activity); full pension benefits for people entirely retired. The lifetime utility program is maximised under the intertemporal budget constraint, taking prices, social contributions and benefits as given. (Modigliani [1986]).

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 *et 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 behaviour. In each type of sector, firms act on competitive markets. They maximise 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 maximise 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/labour ratio resulting from the first-order condition. Other type producers face a more simple maximisation problem. Domestic goods producers and the world producer maximise 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 sector of each region, the social security policy parameters in each region. The competitive world equilibrium stems from five set of equations: intertemporal utility maximisation of households, intertemporal profit maximisation of firms in intermediate goods sectors, period profit maximization of firms in final goods sectors, period profit maximisation 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.

1. The INGENUE 2 model is presented in a technical document : "A long-term intertemporal world model for the XX1st century", Ingenue Team, *CEPII Working Paper*, 2006, Forthcoming.

MAIN MACROECONOMIC CHARACTERISTICS OF BASELINE SCENARIO: EUROPE IN A CHANGING WORLD

The baseline scenario is the outcome of a long and weary process of calibration. To put the model on an acceptable track on the projection phase starting in 2000, an adjustment must be made. It is why the model computation shall begin at an initial date as far in the past as the data permit it. The initialisation is the five-year period beginning in 1950 where initial stocks of capital, household assets and an age distribution of savings are estimated.

An opening of the world economy is supposed from 1955 onwards. The further degree of opening follows the historical data on country shares in world trade and country ratios of openness and then aggregated to the INGENUE regions. Historical data for total factor productivity are injected up to 2000. The law of motion explained in section II is used thereafter. Huge past changes in the world economy are introduced as shocks. The collapse of the USSR in 1990 has given birth to a fast-track opening of Eastern Europe accompanied by an unexpected and massive write-off of the capital stock. China and India have opened much faster than before. Furthermore the IT revolution starting in North America led to a speed up in total factor productivity growth. This higher growth is assumed to be temporary and will be phased out in the present decade, TFP growth returning to its long-run average.

The baseline scenario is not easy to depict since it is a dynamic rational expectations general equilibrium, whereby newcomers appear in each period of time. Any order of description is somewhat arbitrary because it could give the false impression of a recursive causal system of determination between blocks of relations. It is just a narrative device in vernacular language.

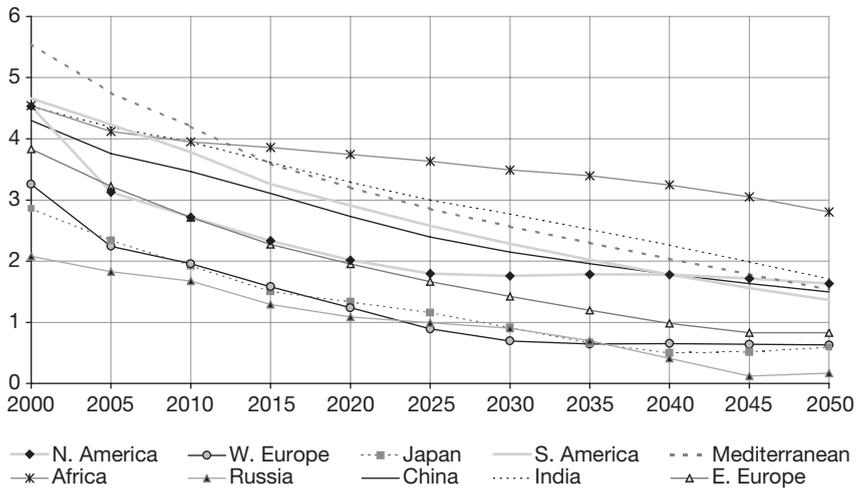
Regional growth

Assumptions regarding technological convergence are conservative in the baseline scenario. Besides the parameters that define public pension systems perpetuate existing policies in the beginning of the XX1st century. Therefore the pattern of the GDP regional growth rates largely follows that of the regional growth rates of the labour force. Two characteristics stand out (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 the growth rates is almost as large in 2050 as in 2000, because ageing is

a lengthy process with countervailing impacts on the labour force of less-developed countries. Nevertheless convergence in total factor productivity has an impact since the dispersion in the growth rates of the labour force is substantially higher in 2050 than in 2000, while the dispersion in the GDP growth rates is slightly lower. The Chinese region, which encompasses already developed countries, is the one where the catching up is the fastest. It is why its growth rate matches other regions with much higher growth in their labour force.

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 labour force and productivity do so. But the working age population stops declining in 2025, recovers and remains stationary 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 to 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. GDP Growth rate



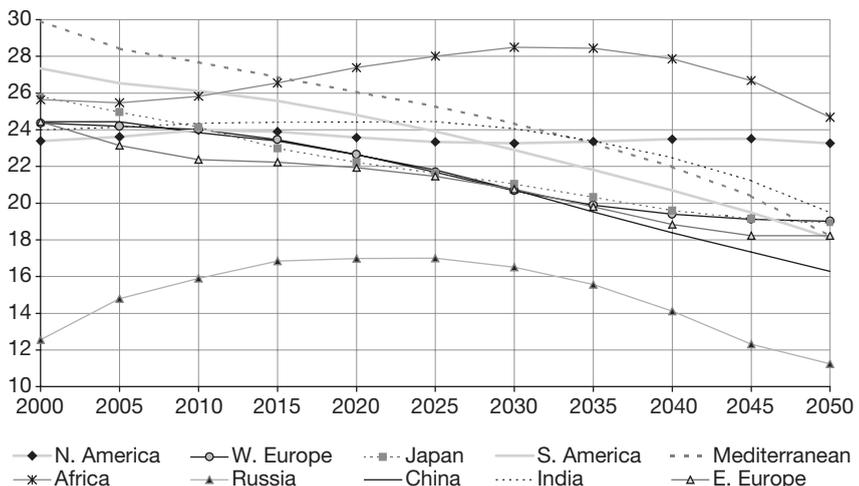
Investment and saving

Because the model works at full employment with an exogenous labour force, the stock of capital in each period is a rising function of employment adjusted for labour efficiency and of capital intensity (capital/effective labour). 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. Prices enter the picture and they bring the whole system of intertwined relationships.

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 the more the larger foreign debt is. It shows up in a higher rate of economic depreciation of the capital stock. In creditor regions (ownership ratio above one) the rate of depreciation is a constant, thus independent on financial condition.

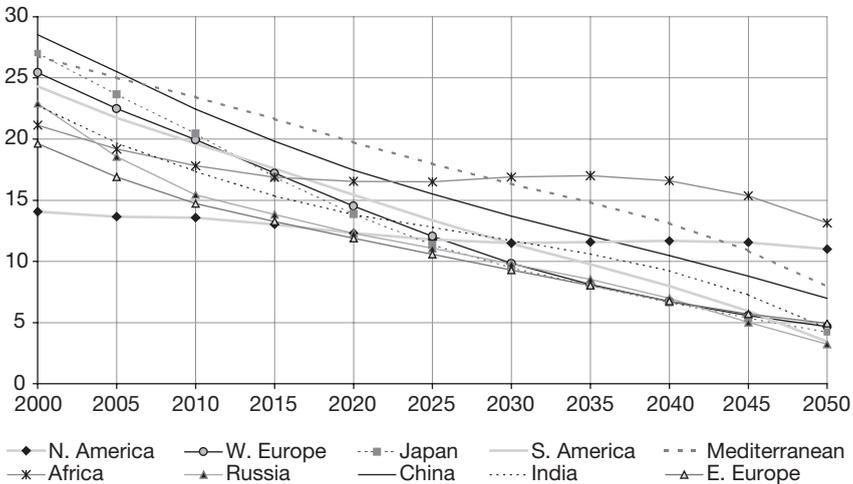
Gross investment rises with net capital accumulation and with replacement, which is modulated by the change in the rate of depreciation in debtor regions. Therefore in regions with a fast growth of the labour force and high foreign indebtedness, raising markedly the rate of economic depreciation, the rate of gross investment to GDP will increase until 2030. Such conditions point out Africa whose capital starts from a low base. 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 labour force that it impinges negatively upon capital accumulation. Yet the rise in capital intensity counteracts the effect of the labour 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. There is an exogenous shock on investment in the early 2000's. This is the recovery from the collapse of the 1990's, which led to the scrapping of more than half of the capital stock; hence the humped-shape curve of Russian rate of investment, which remains by far the lowest of all regions (Figure 6).

Figure 6. Evolution of the gross investment to GDP ratio



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 the PAYG pension systems. Demographic determinants are prevalent. Regions with the fastest-increasing dependency ratios are the ones with the fastest-decreasing net saving rate, 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 savers 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. Like for investment, Africa and North America have more steady saving ratios throughout the half century.

Figure 7. Evolution of the Net Saving (in percentage of GNP)



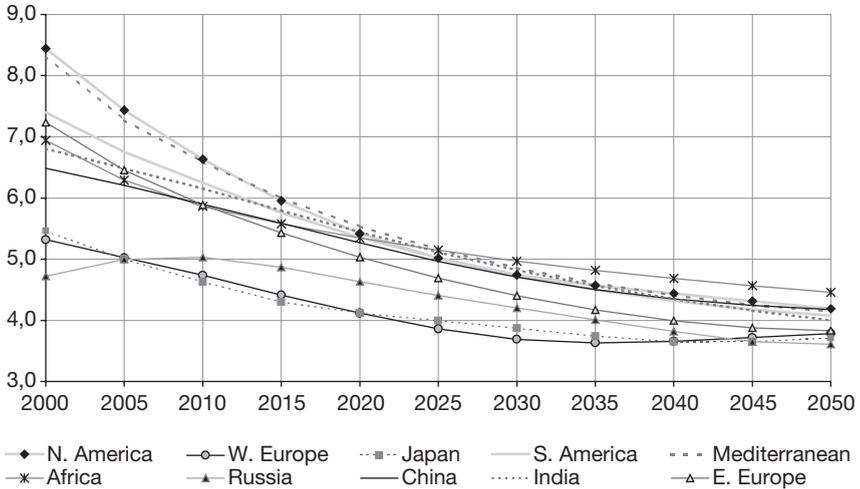
Prices

In INGENUE 2 a lot of prices regulate markets. It has already been observed that the gross rate of return on capital influences capital intensity in each region. Relative prices of domestic intermediate to final goods and world intermediate to domestic final goods are factors of competitiveness which determine the share of domestically-produced intermediate goods and world-imported intermediate goods contributing to the production of final goods in each region. The domestic price of final goods is itself a non-linear combination of domestic and world prices of intermediate goods. The relative price of the domestic intermediate goods price to the world price, *i.e.* the terms of trade, determines regional exports. The world price of intermediate goods is a non-linear average of the intermediate prices of the different regions. Finally the real exchange rate of a region relative to North America is the relative price of final goods in this region

to the price of final goods in North America. Because the North American intermediate price is taken as numeraire and the internal relative price in this region is roughly constant, one can say that real exchange rates are defined in constant dollars.

The world real interest rate is declining over the fifty-year period. This is due to global ageing. Figures 1 and 2 show that the working age population is decelerating or declining absolutely while the age group of high savers is growing in one region after another. As a result 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 interest rates (Figure 8). The hierarchy of regional real interest rates is linked to the rate of change of the real exchange rates. The real interest rates regulate investment and saving flows, as explained here above. 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. Regional annual real interest rate



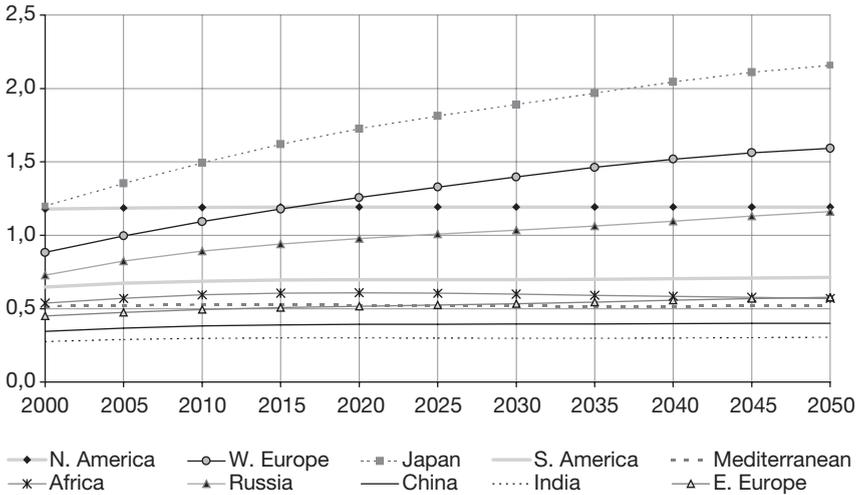
Exchange rates and world finance

The world financial equilibrium allocates capital flows, which finance current account imbalances modulated by real exchange rate changes. Nevertheless the equilibrium in financial markets is a stock equilibrium. 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. In INGENUE the magnitude of financial positions is measured by the ownership ratio. This 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. Despite the general interdependence of prices one can roughly say that the

world interest rate is the price which equilibrates the world financial market as a whole, matching total aggregate wealth and world capital stock.

Real exchange rates appreciate relatively to North America in the two regions that have consistently a 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. The paths of the exchange rates are mostly parallel to the one of North America.

Figure 9. Evolution of Real Exchange Rate



The ownership ratios are mainly determined by cumulative current account balances. The most striking feature is the divergent profile of North America. It is due to an assumed change in household behaviour. The deficit in the early years of the century is, as every one knows, due to the low saving rate of households in the US. It has been assumed that this behaviour will not be sustainable in the long run. American households will converge to the saving behaviour 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 the ownership ratio.

The main teaching 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 it as long as their growth rate is diminishing and their households save more because they get older and richer.

Ownership ratios do not show the same converging pattern, because regions accumulate either net foreign assets or debts because the sign of the current account balance does not change along the fifty year period. It was observed on

figure 10, which depicts current account balances as a percentage of world GDP, that the polarisation between creditor and debtor regions will persist with the notable exception of North America. Therefore the profiles of the ownership ratio do not exhibit any convergence. 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 those 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 10. Evolution of Current Account Balance (percentage of World GDP)

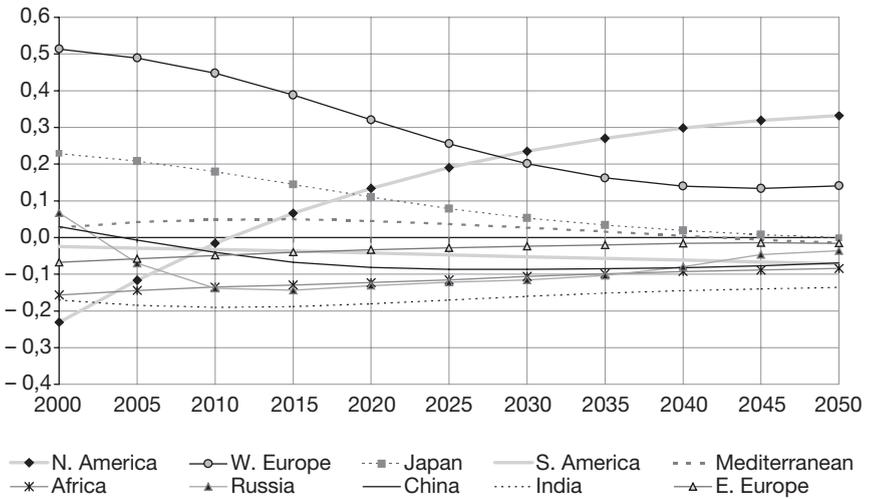
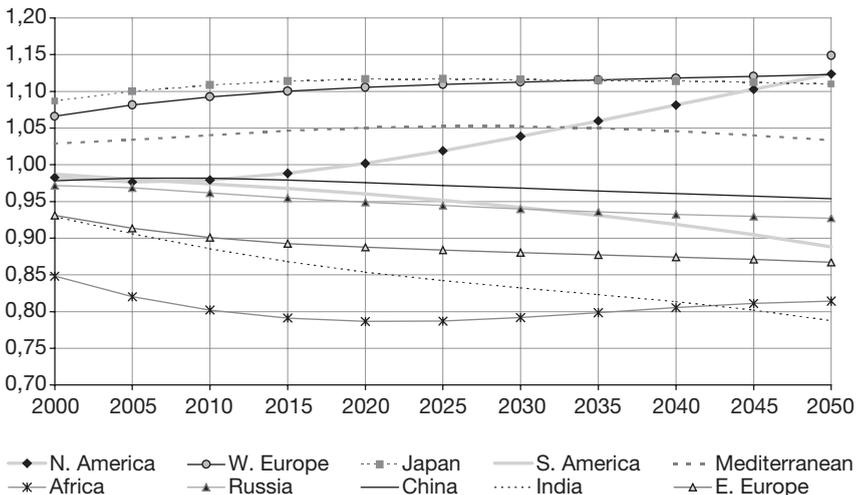


Figure 11. Ownership Ratio



Foreign trade

In INGENUE tradable goods are intermediary. Regions export on a world market where a fictive world producer “produces” a world intermediate 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.

Figure 12. *Terms of Trade*

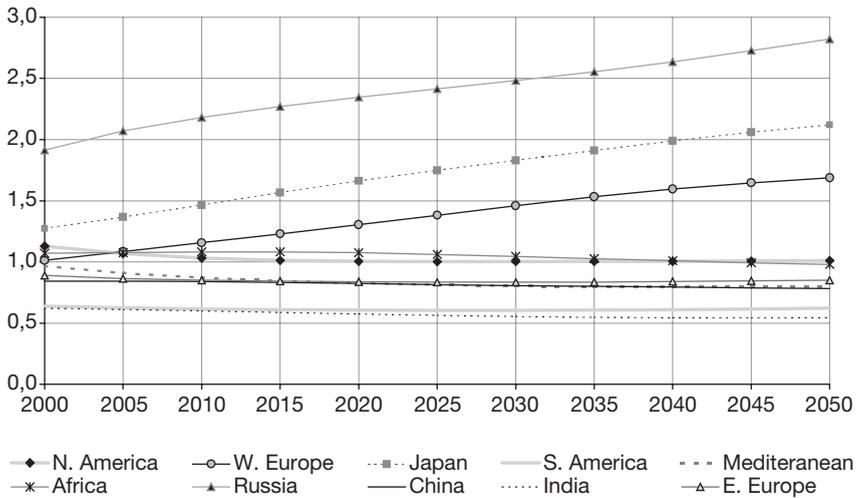
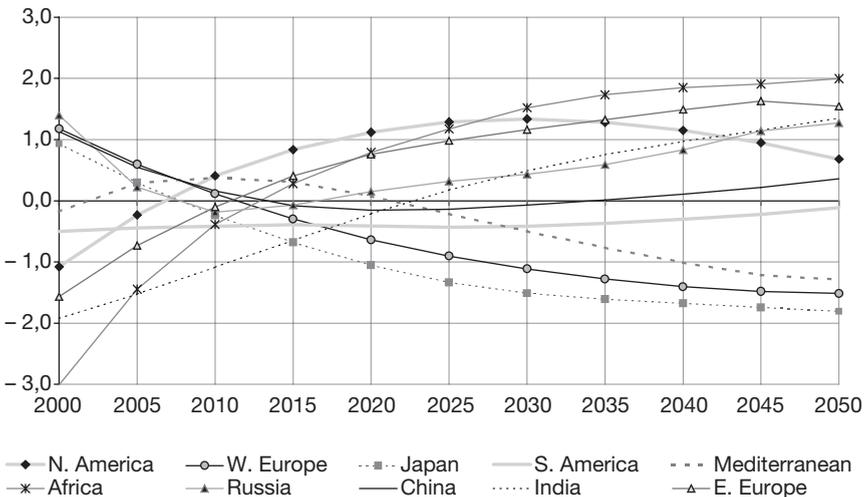


Figure 13. *Evolution of Trade Balance (percentage of regional GDP)*



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, much weaker than in others (Figure 5), pushes prices upwards. In Japan and Western Europe those rising prices generate the widening trade deficit to match the demand of intermediate goods by the final goods sector. (Figure 13). In Russia the population declines more than anywhere else and the consumption per capita is lower. Furthermore Russian 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.

ALTERNATIVE PROSPECTS IN THE RELATIONSHIPS BETWEEN WESTERN EUROPE AND ITS NEIGHBOURHOOD

The baseline scenario has shown the salient feature of Western Europe in the first half of the XXIst century. It is an ageing region, most advanced in the demographic transition. It benefits from globalisation as a perennial creditor region. European growth will get lower and lower. But the accumulated wealth of its household will give them the opportunity to draw a permanent income from the rest of the world on its ownership of foreign asset. But it is well-known that the public pension scheme in Western Europe is expensive. Different scenarios have already been studied with *INGENUE 1*, involving policy reforms within Western Europe. They were conceived to diminish the cost of financing retirement benefits, either in limiting the social contribution rate or in boosting growth via the postponement of the retirement age. Another view is improving the benefits that Western Europe draws from its relationships with the rest of the world.

Since the frontiers of a larger Europe are not well-defined, it might be relevant to assess the consequences of tighter links between Western Europe and regions wrongly or rightly perceived to be in its backyard. One such structural change is already in motion. It is the tentative economic integration of always more remote territories. Another fashionable view is the opening to larger flows of migrants from nearby territories.

Studying these alternative scenarios within the *INGENUE* framework is not that easy however. In its present version *INGENUE 2* is not fitted to simulate the consequences of privileged trade links with some outer regions rather than others. Technically such a scenario would entail modifications in some of the equations, not only changes in exogenous parameters. Given the complexity of the dynamic resolution in this forward-looking general equilibrium model, the exercise, while feasible, would have been too time-consuming to be implemented right away. On the contrary, privileged demographic links, *i.e.* immigration to Western Europe coming preferentially from neighbour regions; involve exogenous changes in the upstream demographic model and are immediately feasible.

Considering those technical constraints two types of alternative scenarios are analysed below. The first is a *faster technological convergence in Eastern*

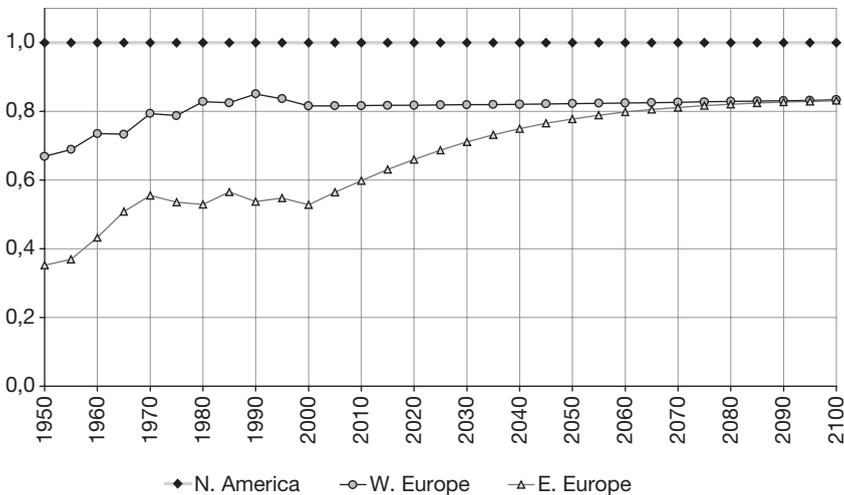
Europe. It might be justified by an economic dynamism launched by the prospect of the participation to a larger economic community. But the positive consequences of enhancing growth in Eastern Europe are diffused worldwide instead of being preferentially directed towards Western Europe. Since Eastern Europe is such a small economic region, its impact on Western Europe is weak. Most interesting is the impact on Eastern Europe itself, due to the multiple linkages with the world economy that are modelled in INGENUE 2.

The second scenario explores *labour force immigration into Western Europe originated preferentially, but not fully, in Eastern Europe and in the Mediterranean*. The advocates of such policies have no ideas on the order of magnitude of the economic effects and do not care about the dire effects of the population haemorrhage on the countries exporting their labour force. Therefore this first exercise with the INGENUE 2 model delivers results which are a matter of concern.

Faster convergence in Eastern Europe

In sharp contrast with the baseline scenario, a catching up of Eastern Europe total factor productivity to the level of Western Europe is assumed over the course of the XXIst century (Figure 14). If it can be sustained the speed-up in TFP growth will also mark a deep change from the laggard stance of productivity in the last three decades of the XXth century. Therefore this hypothetical gain in productive efficiency is by no means a prevision. It is rather a representation of the wishful thinking of the EC Commission, where it is fashionable to expect that the enlargement of the European market can make wonders.

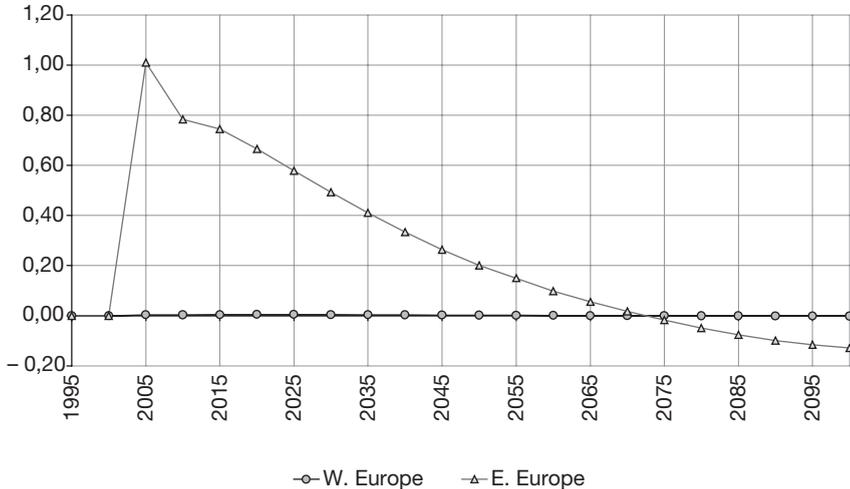
Figure 14. Total Factor Productivity: 1960-2100 (percentage of "North America" level)



Assuming that the trend in TFP will move upward as soon as the countries involved enter the EC and that the future evolution to a complete catching-up is

expected, GDP growth rate will jump 1% above the growth rate in the baseline scenario. It will then slow down steadily, but stay above baseline growth well after 2050 (Figure 15).

Figure 15. GDP Growth rate (difference from baseline scenario)

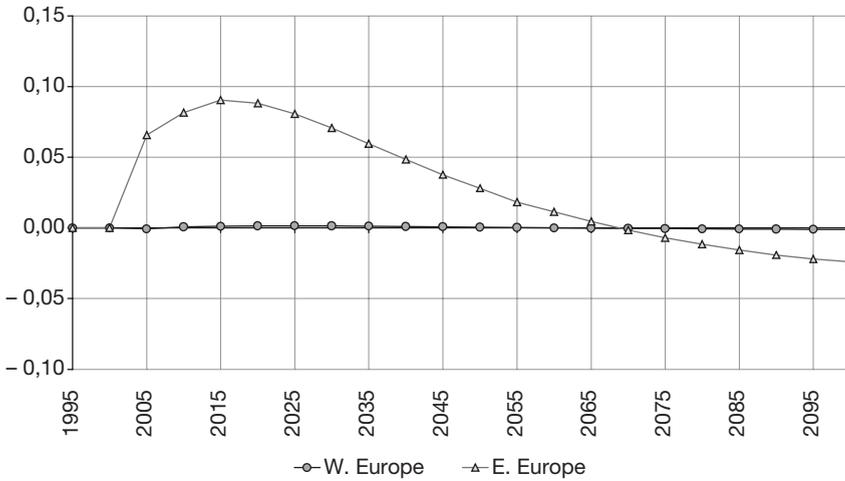


The dynamic can be easily understood. On the supply side a permanent higher TFP increases labour productivity; hence production since the labour force is fully employed. On the demand side it entails an expectation of higher future income. The latter induces households to diminish saving and raise consumption. As a consequence the average private consumption per capita jumps immediately higher in consistency with the forward-looking view of households. Then it rises systematically above its baseline level.

A higher growth profile requires capital accumulation. With a lag of one period, investment growth follows GDP growth: it jacks up 1.7% ahead of the baseline rate of growth. The gap shrinks steadily thereafter but remains positive until 2050. The slowdown in investment growth is regulated by the cost of capital. Because domestic saving does not match investment needs, net saving actually being under baseline until 2025, an inflow of foreign capital fills in the gap in the investment saving balance. It is attracted by a higher interest rate in Eastern Europe. It follows a hump-shaped profile with a maximum in 2015 (Figure 16).

The foreign accounts of Eastern Europe are regulated by the real exchange rate and by the terms of trade. Both prices diminish relative to baseline. The real exchange rate depreciates as long as the regional real interest rate is higher than the world interest rate. The depreciation is fostered by the hypothetical convergence in TFP which lowers domestic prices. The same impact, admittedly amplified, arises on the terms of trade. The improved competitiveness will boost exports and mitigate imports. Therefore the trade balance and the current account balance show the same profile.

Figure 16. *Regional annual real interest rate*
(Percentage point difference from baseline scenario)



In the first two decades the rise in both consumption and investment calls for higher imports of intermediate goods financed by capital inflows. The trade balance turns negative relative to the baseline scenario, because exports are discouraged and imports stimulated by the strong domestic demand. After about two decades the investment saving balance swings to an inverted pattern. As explained above the investment growth rate slows down steadfastly while the working age population diminishes. People take advantage of their higher real income to save more. Both the trade and the current account balances turn to surplus (Figure 17). As a result the ownership ratio relative to baseline scenario exhibits a U curve with a minimum around 2020 (figure 18).

Figure 17. *Evolution of Trade Balance (percentage of regional GDP)*
(difference from baseline scenario)

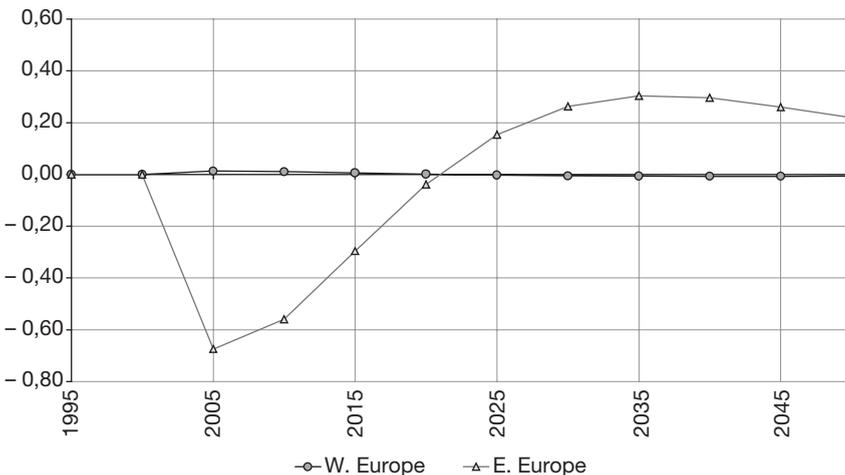
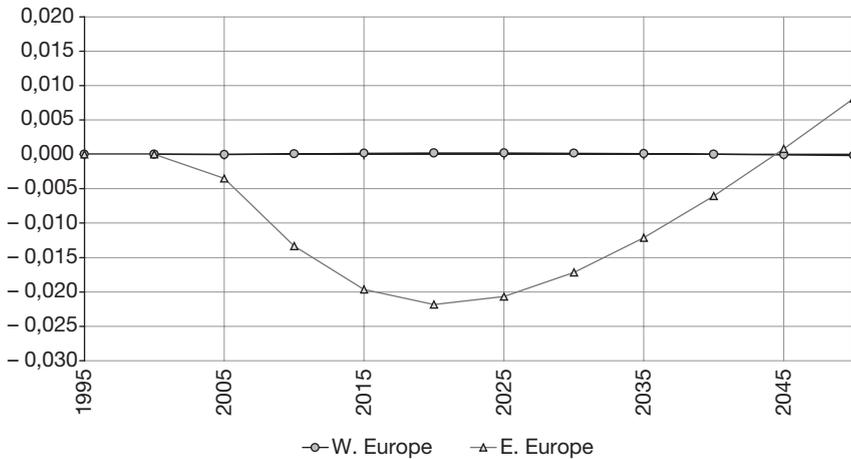


Figure 18. *Ownership Ratio* (Percentage point difference from baseline scenario)



Labour migration from the East and the South

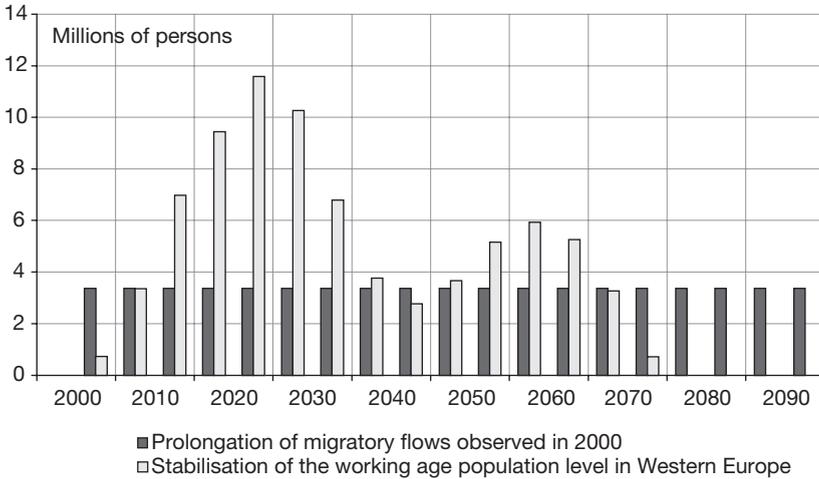
The second alternative scenario has another aim. It is to shed some insight in the debate about immigration into Western Europe. (Héran [2002]). In the baseline scenario Western Europe has the highest social security contribution rate in the world. It is due to the relatively high replacement ratio people enjoy at constant policy and to the highest dependency ratio. The contribution rate is expected to increase steadily from 17% in 2000 to 32% in 2050. Meanwhile the dependency ratio will rise from 43% of the working age population to 98%.

Amongst the policies to alleviate the financial burden on the public retirement system, immigration rides high in the mind of UN and Euro technocrats. Some political leaders seem also ready to embrace the idea that an influx of migrants is the best way to save the European welfare system. Let us notice that this policy stance is quite at odds with the mutually beneficial intergenerational exchange upheld in the INGENUE project. We do think that the first best way is to enhance a world growth regime via intense technology transfers at low cost and sustained capital exports. In the present stage of capitalist development the opportunity raised by the growing labour force in the most populated regions of the world should be met. According to this perspective it is questionable to draw flows of labour out of their countries.

However the INGENUE model is fit to describe the consequences of migrations on both the regions receiving and losing the migrants. The scenario is conceived as follows. It defines the flows of migrants so that the projected decline of the working age population in Western Europe is cancelled out. It will adjust to the last stage of the wave shock generated by the baby boom while the numerous cohorts have toppled over the retirement age. Therefore the immigration flow implied by the assumption of constant labour force in Western Europe will rise sharply from 2005 (supposing the policy starts at this date) to the years 2025-2030. It will reach roughly 12 millions migrants for the 5-year period; It will abate thereafter because the demographic transition expects the fertility rate to

recover so that constant reproduction of the generations is achieved. The flow of immigration will disappear altogether around 2080 (Figure 19).

Figure 19. Migrations flows into Western Europe



The migrants are supposed to be young adults who adjust to the productivity of the host region as soon as enter the labour force. When the flow of migrants prolonged those observed in the 1996-2000 data, the migratory flows during the first decade 2005-2014 represent 1,1% of the initial population (in 2000) in Eastern Europe, 0,5% in the Mediterranean world and 0,2% in Africa. This is much less than the emigration from Europe in the last decade of the XIXth century. When the flow is normatively designed to smooth out the effect of the baby boom on the decline of the labour force, a larger proportion is supposed to come from the Mediterranean and Africa which are the most populated in the vicinity of Western Europe. 11% of total migrants will come from Eastern Europe, 32% from the Mediterranean, 25% from Africa, 32% from the rest of the world.

Domestic consequences of migrations

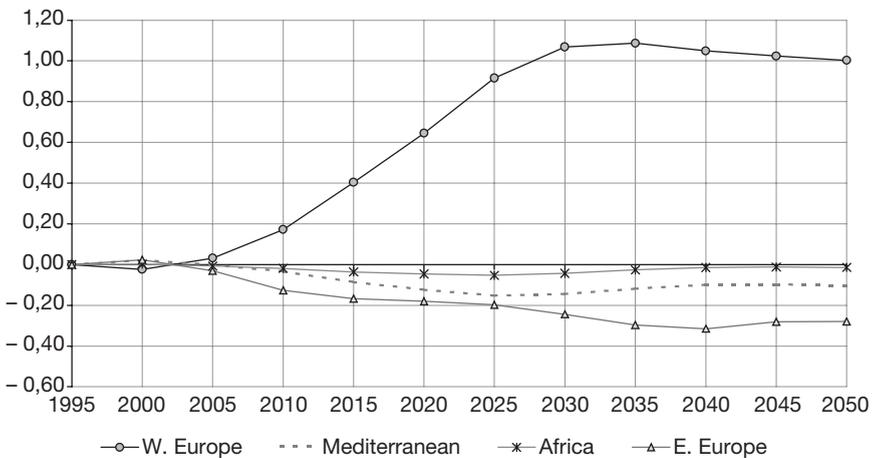
As defined to smooth out the working age population in Western Europe, the scenario has a large impact since it lowers the dependency ratio in 2050 from about 1 in the baseline scenario to 0.65. It follows that the financing of the PAYG system is dramatically improved. The social security contribution rate falls continuously in percentage of baseline. This means that in 2050 the contribution rate is only 24% in the high migration variant against 32% in the baseline, because migrants contribute massively to its financing. It is a huge improvement. Indeed the deterioration of the contribution ratio would be only 7%, since it amounts to 17% in 2000.

The impact on the growth rate is substantial. The inflow of young workers expecting higher wages boosts consumption, which spurs a speed up in the growth rate until 2030 where it is 1% higher than in the baseline scenario. Then

the stock of earlier migrants enters the high saving stage of their life cycle. The increase in saving moderates consumption and the growth rate flattens but at 1% above baseline until 2050 (figure 20).

The mirror effect of the improving economic situation in Western Europe due to immigration is a limited deterioration in the two main regions of emigration: Eastern Europe and the Mediterranean. The magnitude of the deterioration depends on the loss of potential workers relative to the total of the labour force in the region. It is why in Eastern Europe, a region much advanced in ageing and already suffering from a declining population, the adverse consequences of emigration are more critical.

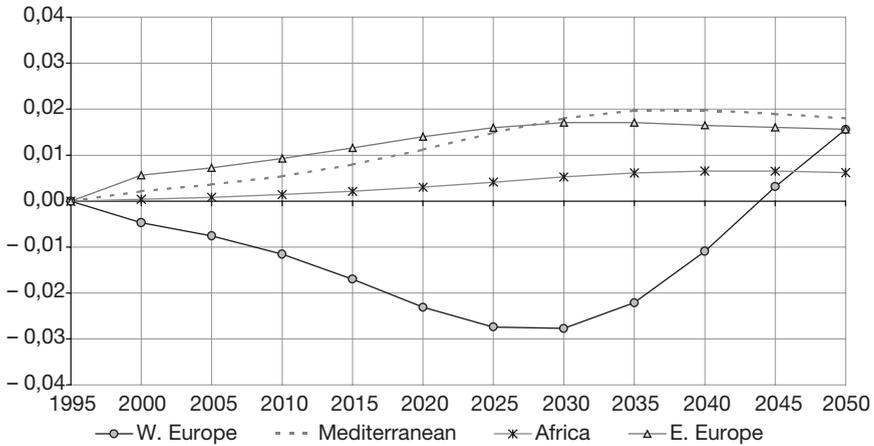
Figure 20. GDP Growth rate (difference from baseline scenario)



Nevertheless the level of consumption per capita is less than in the baseline scenario in Western Europe until the very end of the half-century. The reason lies in the production sector. The inflow of workers reduces capital intensity relative to baseline. The marginal productivity of capital is raised and the interest rate as well. Conversely labour productivity is diminished with a lower capital intensity. The real wage rate, being a decreasing function of the return on capital on the factor price frontier, is itself on a slower path than in baseline. It ensues that relatively to the baseline scenario consumption is less augmented than total population; hence consumption per capita is lower. Around 2030, when saving gains momentum the interest rate recedes a bit because saving grows faster than investment. Furthermore figure 19 shows that the flow of new migrants will be receding fast after 2030. Therefore the growth of consumption per capita relative to baseline turns positive from 2025 onwards. The level moves upward again but does not overtake baseline before 2045 (figure 21).

The opposite occurs in emigrating regions. But the impact is diffused over several regions and mitigated by the size of the labour force. The modest fall in the interest rate and the subsequent increase in productivity persists for almost the entire span of the fifty year period. Only Eastern Europe and the Mediterranean exhibit a non-negligible elevation of consumption *per capita*.

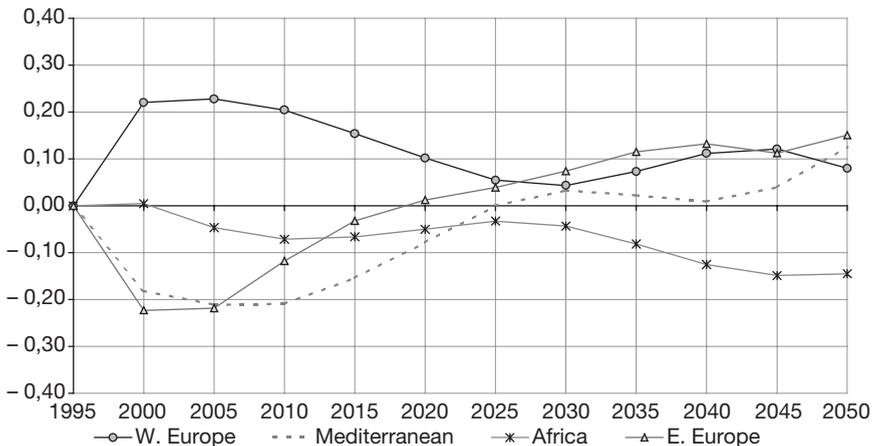
Figure 21. Consumption per capita (level) (Percentage point difference from baseline scenario)



Migrations and the foreign accounts

Because of the rise in interest rate, the saving investment balance stays more in surplus than in the baseline scenario. The current account balance, which was already in surplus in baseline (figure 10), is therefore more so. The real exchange rate is depreciated relative to baseline since the real interest rate is higher. Yet it still appreciates slightly during the half-century. It follows from the improvement of the current account balance that Western Europe reinforces its creditor position in the world economy. The ownership ratio rises systematically above baseline. The regions of emigration with slightly appreciating exchange rates relative to baseline stay more in deficit and more in debt. The change in the trade account balance is more pronounced. It reflects the scissors effect in the saving investment balance due to the inverted U-shape of migration flows. Therefore the trade balance is negative then positive relative to baseline in Eastern Europe and the Mediterranean (Figure 22).

Figure 22. Evolution of Trade Balance (percentage of regional GDP) (difference from baseline scenario)



CONCLUSION

In the next half-century Europe is likely to be a low-growth region, because of its adverse demographic profile and its slow progression in total factor productivity. Nevertheless it will benefit from the advance of globalisation. Being one of the two regions (with Japan) where real interest rates are persistently the lowest, Western Europe will be a permanent creditor, accumulating net foreign assets for the whole half-century. Its real exchange rate will also appreciate consistently. Therefore European households will gain from globalisation in both income drawn from the yield of their foreign assets and in purchasing power relative to other regions. It is why consumption per capita measured at PPP will take over North America after 2015 and rise thereafter in sympathy with real exchange rate appreciation.

The baseline scenario is conservative however. It does not embody a significant acceleration in the catching-up process, except to some extent in China and India. The world-wide consequences of a much faster increase in TFP would change the pattern of world growth dramatically. This world growth scenario will be left to further study. In the present paper it was illustrated by an hypothetical catching-up in the small region of Eastern Europe. As soon as it occurs, the structural change in production entails a jump in the growth rate in the forward-looking framework of INGENUE. Growth must be supported by capital accumulation financed by capital inflows attracted by the rise in interest rate. The reversal of capital flows will come later when people get richer and save more while the growth rate declines steadily.

The former scenario illustrates the virtue of capital mobility and technological diffusion with the proviso that investments to assimilate technological progress are efficient in the importing country. This scenario must be contrasted with international labour mobility. Migration flows boost growth in the importing region but weaken it in the exporting ones. They also pull apart the financing of the public pension system as much as migrants are young productive adults. Therefore even if the migrants themselves might be better off, migration is a mechanism to redistribute wealth in favour of the richer regions at odds with a world growth regime.

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