

Aging - Knowledge Accumulation – Capital Accumulation

Technical and social innovations in aging societies

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Abstract

This paper investigates how innovations are influencing the development of societies that are characterized by the demographic trend of an aging population. The study of such a setting seems to become particularly important for the European Union, which currently faces a rather dramatic acceleration in the aging process of its population. While such a trend clearly has severe consequences on re-regulation, e.g. education-pension systems and immigration rules, its interplay with innovations has not yet been sufficiently studied. The paper therefore will try to provide an overview of a new combination of different strands of economic research:

- Demo-economic modelling using an overlapping generations model,
- Epistemological research on the meaning of knowledge accumulation,
- Empirically oriented research on the embeddedness of technical innovations in capital accumulation,
- Research on the political economy of social innovations, e.g. institution building.

In other words, a new combination (in Schumpeter's sense) is proposed to be tested as possible scientific innovation.

Introduction – The Need for a Synthesis

Since the end of World War 2 economic theory building was characterized by an accelerating development of specialization, division into sub-disciplines and formalisations tailored to the needs of the respective field of inquiry. Additionally some more advanced formal

representations started to live a life quite independent of the economic processes they originally were meant to refer to – today they often are more or less well-respected members of mathematics proper¹. This evolution of economic theory evidently mirrored the advancing division of labour that took place in work in general, and in many cases the successes of economic scholars working in their narrowly defined domains have been very impressive indeed. Nevertheless actual economic processes possess stringent time constraints, e.g. points of sale, where every specialised economic activity of a supplier suddenly has to pass the test of being useful for somebody representing demand. Contrary to that economic theory building – at least to some extent – was able to circumvent such tests by producing its own marketability commission within the scientific community of economists. The tests used on these placebos for real markets rely on norms (mostly concerning technical versatility) which with respect to actual economic processes often look somewhat arbitrary: accepted mainstream theory defines what is accepted as additional mainstream theory. The carrier medium for this process is a growing diversity of highly specialised technical economic journals.

As already observed by Keynes in the interwar period – and probably a major source of Keynes' success – the resulting inability of mainstream economic theory to answer practical questions of economic policy provides a vacuum that immediately is used by a wide variety of voodoo economics². Economic theory becomes economic fashion of the day and decision makers, politicians and journalists are eagerly shopping in this bazaar for latest fads and trends.

A remedy for this situation is not easily found. A particular difficulty emerges due to the rapidly increasing interdependence of most economic processes, interdependence in time (e.g. expectation building) as well as in space (e.g. ICT influence), across sectors as well as across households. The concept of globalisation only covers a part of this phenomenon. If economic theory really wants to get back to relevant economic policy issues concerning the subject it was originally intended to theorise, then economists have to reach out for a possible synthesis combining the most relevant pieces of specialised approaches³. The adjective 'relevant' signifies an important qualification for economic model-building in this vein: It is possible and necessary to *choose* what is relevant for the synthesis necessary for an economic problem. Somewhat like an artist the economic model-builder will have to use intuition and experience to achieve a temporarily satisfactory model.

So let us set the scene for a modest example of this methodological approach. Three burning economic problems are the starting point:

¹ Compare Roy Weintraub's study for a detailed description of this process [E. R. Weintraub, 2002].

² 'Practical men, who believe themselves to be quite exempt from any intellectual influences, are usually the slaves of some defunct economist. Madmen in authority, who hear voices in the air, are distilling their frenzy from some academic scribbler of a few years back.' [J. M. Keynes, 1936, p.383]

³ There is little doubt that GET as put forward by Arrow and Hahn in the late sixties despite its formal elegance cannot be considered as such a synthesis. It remains a formal exercise.

- In an aging society pay-as-you-go pension systems can deteriorate.
- Knowledge accumulation in societies with advanced ICT and some aspirations for old-style property rights needs a new type of governance.
- The accumulation of physical capital in OECD countries seems to be able to sustain high profit rates only by shifting employment towards low wage countries.

Perhaps somewhat surprising one major link between these questions is innovation.

As is well-known, for many economists the growth of productivity seems to be an appropriate cure for the difficulties arising from financing inter-generational transfer payments, payments that start to be an ever heavier burden for the economically active generation. The population aged between 15 and 65 is opposed to an increasing population of retired persons; life expectancy is forecasted to increase even further (compare figures 1a, 1b and 1c).

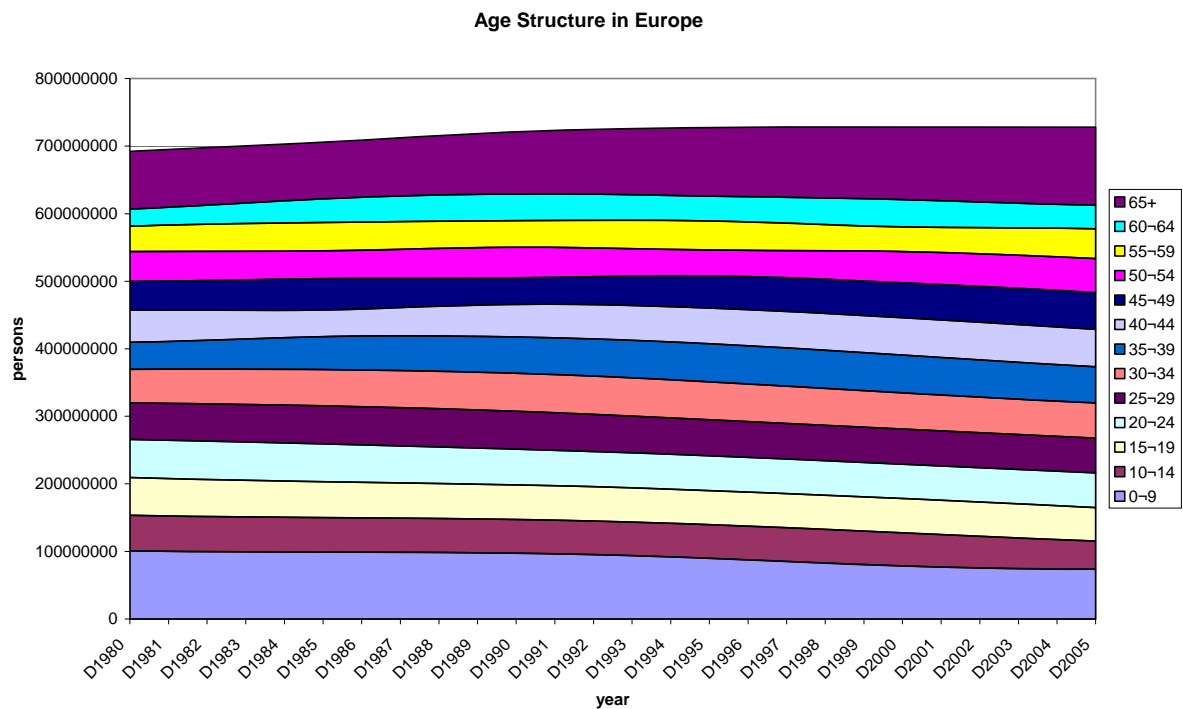


Figure 1a: Population by age group

Of course, growing net output surely will ease any transitional bottleneck in finance, but how and to which extent still is not well understood. The importance of technical (including organisational change at the firm level) innovation for total factor productivity growth is evident.

On the other hand, labour productivity growth always implies some sort of employment problem, and in the sequel some sort of effective demand problem on the macro-level. In particular the knowledge embodied in the human capital of elderly employees, a knowledge

that is sometimes necessary to handle advanced physical capital goods, certainly might lead to employment problems of young, unskilled workers. And this is certainly one of the most pressing economic problems of Europe today. The details of *process innovation* thus determine to which degree this phenomenon will occur.

For *product innovation* the entrepreneur’s vision of the demand side plays a decisive role. It is expected demand that induces the entrepreneur to come up with new products and services. In aging societies types of products that are appropriate for the elderly will gain importance; but only to the extent that these social strata really represent *effective* demand. Employment and purchasing power problems stemming from process innovation, i.e. cost reductions, might fire back on product innovation prospects - see the last paragraph.

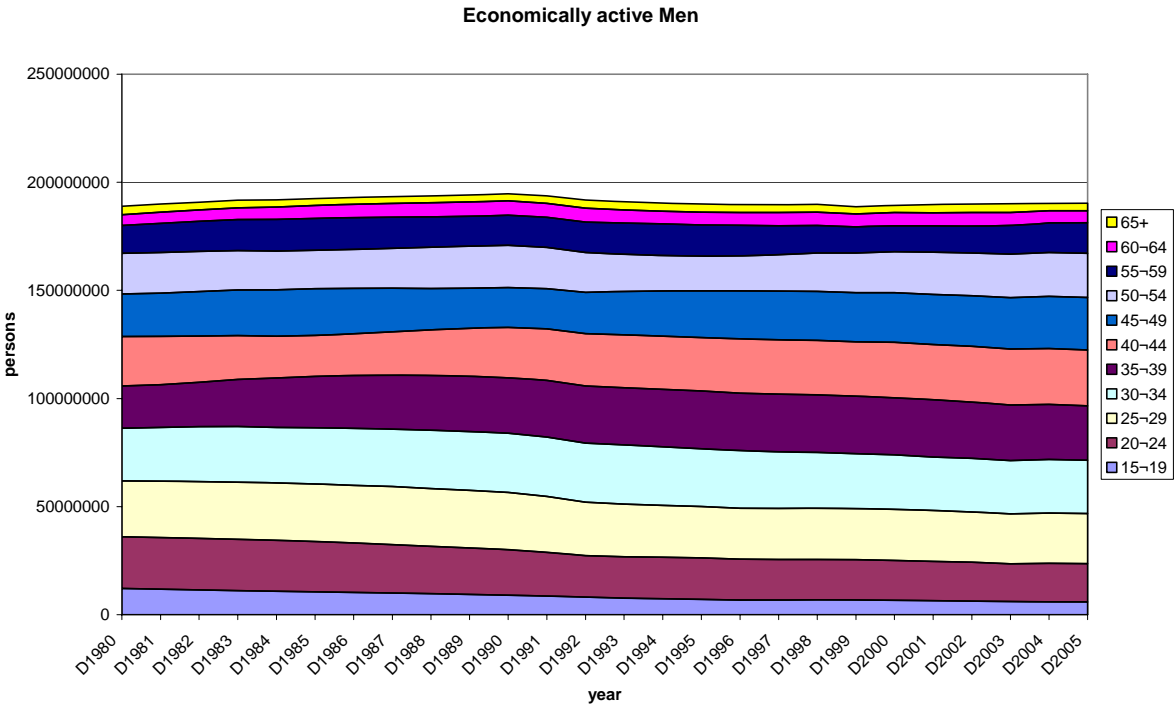


Figure 1b: European economically active men by age group

The latter development clearly is embedded in a rather complicated network of social institutions. These institutions are permanently collecting and re-distributing social funds across generations, across fields of economic activity, and across geographical boundaries. Some of these institutional rules recently have been re-designed to advance the possibilities of women. Indeed, the *exploding participation rate of women* in labour markets has been one of the most significant developments in Europe in the after-war period, and it certainly contributed essentially to Europe’s economic renaissance.

Of course, an adequate framework aspiring to picture the working of this network of social institutions goes far beyond the scope of this paper. What can be done is to identify those social institutions that are most endangered by our scenarios, and to locate those areas of the political economy where social innovation, i.e. the conscious design and emergence of social institutions is most probable to occur.

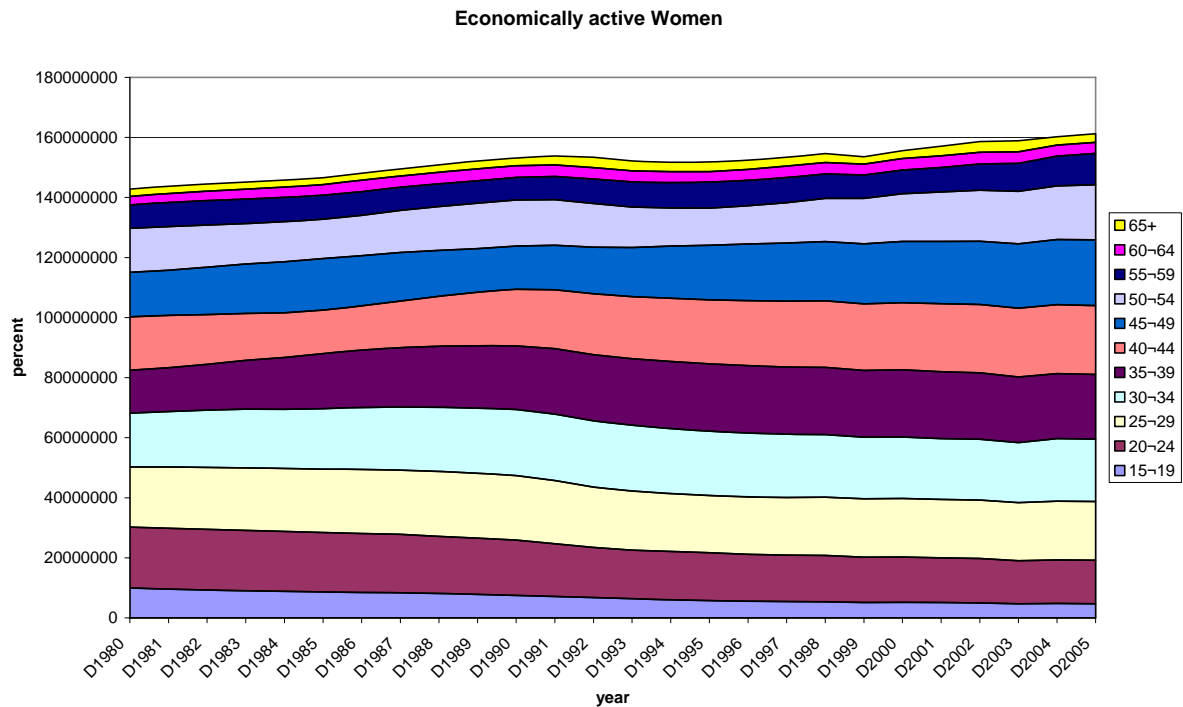


Figure 1c: European economically active women by age group

In the next chapter these still rather loosely connected conjectures are reformulated in a sketch of a prototype model that consists of several building blocks encompassing some of the different perspectives mentioned above. A basic OLG model determining changes in social transfers between generations consists of three overlapping generations (young / education, middle / work, old / pension); it is combined with an aggregate endogenous growth model. The latter is open enough to allow for the inclusion of some ideas on innovation, technical innovation as well as social innovation. The third component of the prototype will be a labour market allowing for disequilibrium unemployment dynamics. As far as possible in the following specification female and male dynamics will be distinguished.

2 – A prototype model

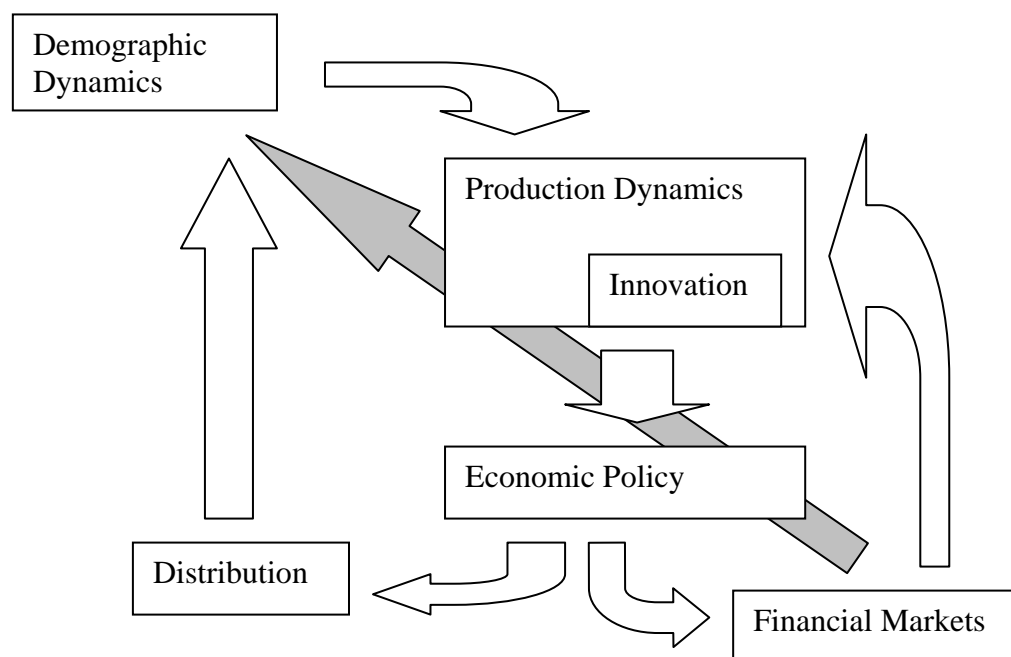
The class of models this prototype belongs to can easily be presented by the following scheme. The blocks represent typical sets of dynamic equations that together describe a certain area of relevant relationships between endogenous and exogenous variables. At this stage the granularity of the prototype still is left open, not to speak of functional forms of the relationships. Moreover the topics of these blocks are ‘big’ topics, which in any more elaborate application certainly would be split up into several sub-topics.

The most important single issue omitted in this version is the fact that it is aiming to picture just one large continental unit of a political economy, e.g. Europe, without explicitly describing its relationships with the other continental units in the world⁴. The reason is that our model-building strategy proceeds from first taking a look at each continental unit separately to learn more about their respective essential features, and only then to develop an overarching structure that connects them. At the moment the presentation of such a global prototype has to remain the topic of a future research paper.

Note that the gender issues are not set apart in a separate building block. They are so deeply interwoven in almost every block presented that it makes much more sense to deal with them again and again as they appear in the detailed specifications.

The various blocks and a possible specification will be discussed below.

Scheme 1: Model Structure



Demographic Dynamics

Three generations are distinguished: generation E consists of n^E young individuals in education, generation A consists of n^A individuals in the economically active range of lifetime, and generation R consists of n^R individuals already retired from economic activity. With each year a part of the n^E young individuals becomes a member of generation A and a

⁴ Another hot area not touched so far concerns immigration. There is a quick fix by just adding an exogenous variable describing the number of immigrants. But the really important challenge would be to deal with the issue on the level of emergent micro-politics.

part of A retires and increases n^R . Furthermore the birth rate g^B increases n^E while the death rate g^D decreases n^R .

Labour supply thus in principle is determined by n^A though some important modifications have to be taken into account. *First*, the economically active population has to be distinguished with respect to gender. Participation rates of women in labour markets have increased dramatically in the last half century, with the effect that household incomes could be kept at a higher level than otherwise – due to deteriorating income distribution – would have been possible. Nevertheless women's wages in most countries still are considerably lower than their male counterparts and consequently exert downward pressure on the average wage rate. On the other hand reproductive work within households - that used to be done as unpaid labour by women in the past – now either has been economized by the use of a more advanced capital stock of household machinery, or has been outsourced to external food suppliers, kindergartens and the like. This shake up in family structures in turn evidently has changed incentive structures of households in a way that implies a decrease of birth rates. To endogenise the birth rate is one of the crucial tenets of demo-economic models. *Second*, qualification structures of labour supply became enormously important, particularly in the last two decades of enforced global division of labour. Investment in the quality of the labour force of generation A in principle takes place while this cohort still is part of generation E; training on the job often still is a negligible phenomenon since it typically appears as cost with minor expected profit for the employer. Therefore a given number of persons in the range of age of economic activity, n^A , has an additional attribute, namely a quality index Q that specifies properties important for the matching with the labour demand of a globalizing production sphere. Note that Q changes slowly with every year's new exits and entries to and from the pool of generation A.

In this stylized world the major role of generation E clearly is to prepare for a high quality index Q that in the sequel becomes manifest if this generation is left and generation A is entered. Note that investment in human capital of generation E only becomes visible with a delay and typically is financed by public authorities, i.e. the state. The yearly amount of government expenditure to provide education infrastructure therefore is the driving variable behind the dynamics of the quality index Q of the labour supply. The higher the yearly amount and the longer it is experienced, the higher the contribution to Q in the future will be. Finally generation R can be described as receiving payments from public authorities in a pay-as-you-go system. In other words, both generations, E and R, receive government expenditures that have to be financed by government income. Financial markets, i.e. the conditions for public finance, hence play an important role for the payments to receiving generations. Typically the number of individuals in generation R, n^R , is annually increasing due the exogenously given growth rate of life expectancy g^L . Note that contrary to g^L the entry points into generation A (point EE, end of education) and into generation R (point E^A ,

end of economic activity) are policy parameters that can be changed by public authorities⁵. Nevertheless it is assumed that changes of E^E and E^A are subject to a game theoretically described slow dynamics reflecting the preferences of the three generations. Additional influence on this game comes from public authorities trying to avoid budget deficits.

Production Dynamics

Production dynamics considered in this model refer to observed aggregate regularities. The underlying implicit assumption is that firms are typically involved in a permanent evolutionary race for new profit opportunities that pushes industries periodically away from market equilibrium. To model the details of this type of microeconomic firm behaviour goes beyond the scope of this paper, what is aimed at here is to capture some of the observed regularities such behaviour produces. If one accepts to model microeconomics more detailed in an extended version of this research paper, then these regularities typically should re-appear as emergent properties of the micro-model.

Two types of firms are assumed to characterize production structures in OECD countries:

- i. Large transnational corporations pushing innovations with high profits earned by exploiting the opportunities of a deepening global division of labour (including institutional diversity, diversity of national laws, exchange rates, etc.);
- ii. Small and medium sized firms (SME), which are responsible for most of the employment, and which have to be more or less subsidized and protected by national authorities.

Traditionally the most discussed decision variables of firms have been output and price, the latter usually assumed away by the assumption of perfect competition. In the alternative school of economic thought that goes back to Schumpeter and Marx the role of price and output setting has played a rather minor role; main emphasis has to be laid on innovation, the emergence of new combinations in production (product and process innovation) and social relations (social innovations). This alternative tradition of economic thought thus interpreted the success of capitalism in the last 300 years (including merchant capitalism, see [Hanappi, 1989]) as an emergent property of the activity of economic and social entrepreneurs forcing the system out of market equilibrium.

In our view the economic development of industrialized economies in the after-war period supports the innovation-oriented, Marx-Schumpeter interpretation of the success of capitalism. Aggregate growth rates of output - after a jump due to the immediate needs for reconstruction necessary after the war - did fall continuously in the long-run and - apart from short-run deviations - now run in a constant distance to population growth rates (compare figures 2a, 2b and 2c). This seems to be the case for all three parts of the so-called triad: Europe, North America and Japan.

⁵ Of course, an even more elaborated approach could introduce a sub-model describing the influence of public finance (for medical research, environmental protection, etc.) on the development of life expectancy.

The surprising common property of these diagrams is that estimating a logarithmic trend line for the growth rates of real GDP leads to line that everywhere seems to approach a parallel development to population growth with a difference of about two percentage points!

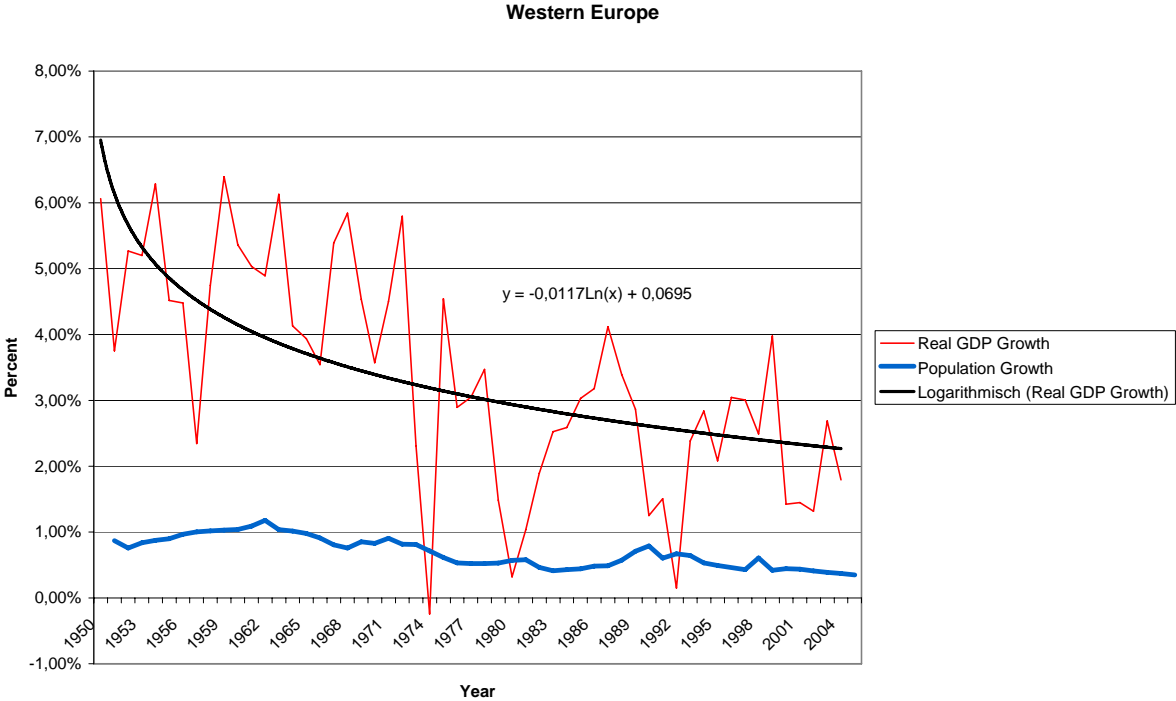


Figure 2a: GDP and Population growth in Western Europe since 1950

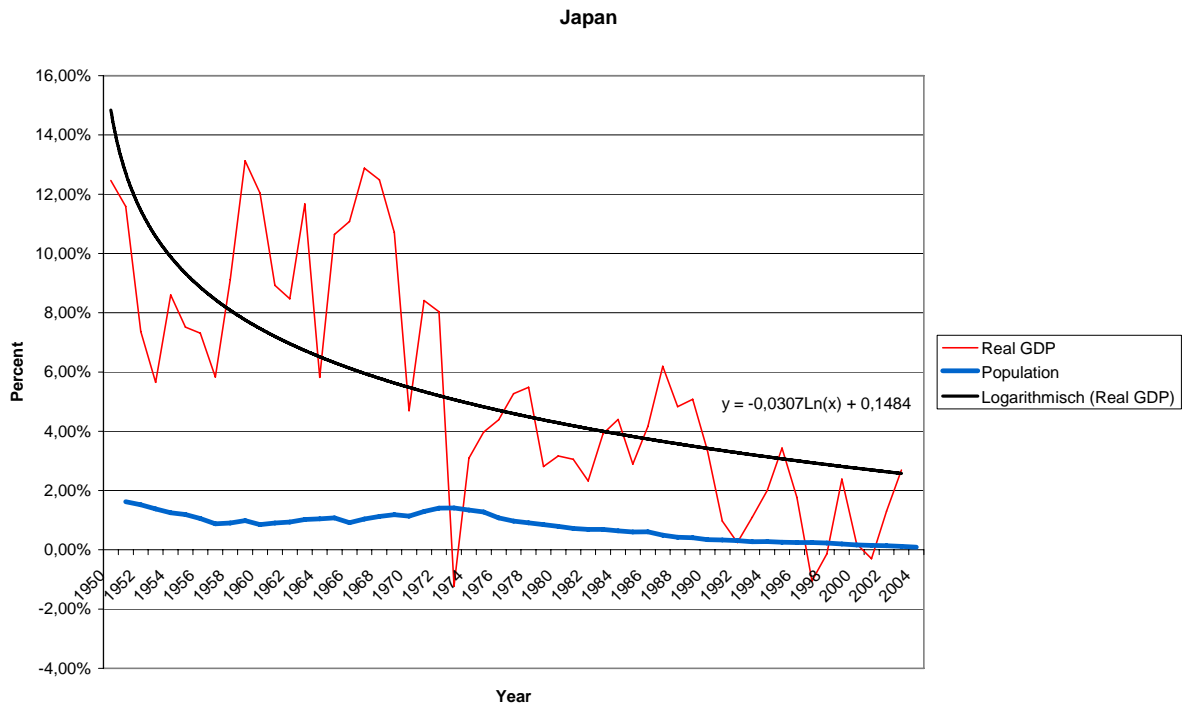


Figure 2b: GDP and Population growth in Japan since 1950

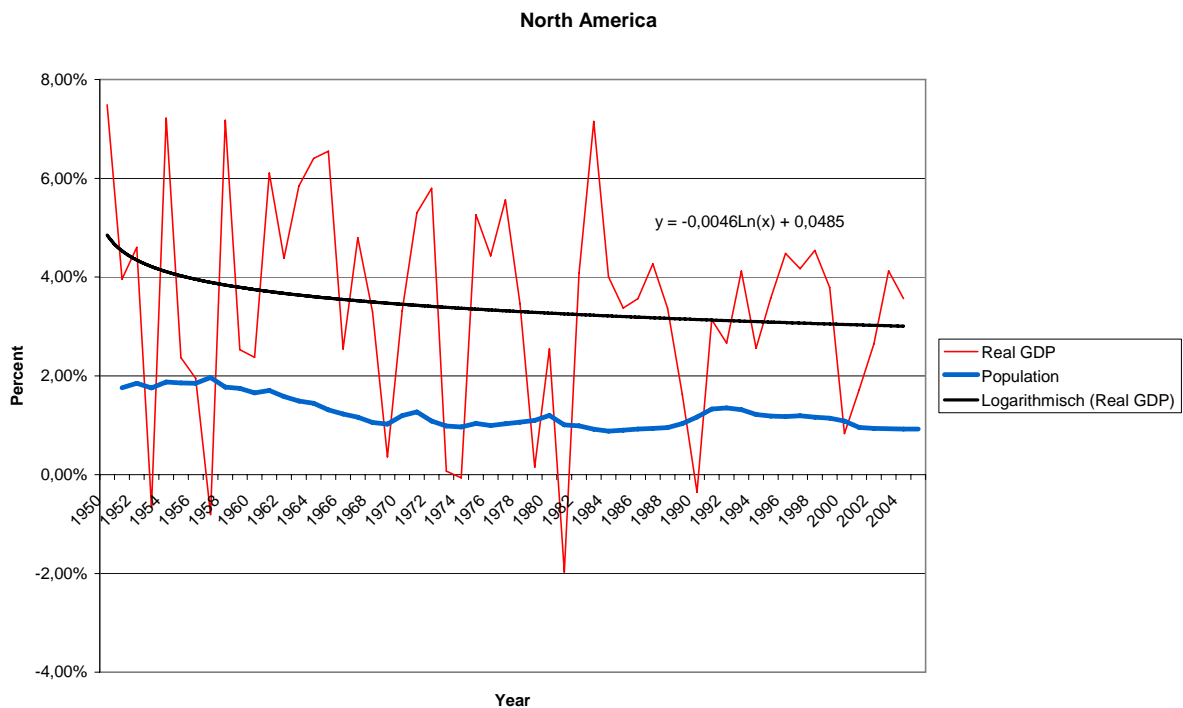


Figure 2c: GDP and Population growth in the USA since 1950

The economies that have been destroyed during the war clearly come down steeper from higher initial growth rates than the USA, which is plausible. And for these two the actual

GDP growth rates show two different regimes, one before and one after the switch from fixed to variable exchange rates in 1971, the breakdown of the Bretton Woods system.

It is tempting to interpret this stylized fact in terms of Solow's basic growth model [R. Solow, 1956], where with the assumption of full employment, constant savings rate and constant depreciation rate it could immediately be concluded that such an empirically observed dynamics must imply a rising capital output ratio. Thus capital must have increased faster than output. But, of course, Solow's argument is doomed by his strong and unrealistic assumptions.

Note that nevertheless even without such strong assumptions these developments of the smoothed long-run series tells us something: If in the long-run output grows about 2 percentage points faster than population – be it for any long-run unemployment rate one wishes to assume – then something else, in general a combination of capital growth and innovation is responsible for this constant overshooting.

In the simplest case it seems therefore save to assume that long-run development of output follows the (decreasing) population growth rate plus an innovation constant.

Economic Policy

On the other hand such a long-run consideration, interpreting it as supply-side determination, can only be an attractor that pulls mid-term deviations back on track if they diverge too strong – as the diagrams vividly show. As can be seen the mid-run demand cycles, which just as Keynes rightly suggested are the short-term policy intervention cause, might be quite strong. There are numerous reasons for these pulsations, political business cycles, mid-sized innovation cycles, transmissions from trade and the like. One is reminded of Schumpeter's famous 3-cycle scheme, where the long-run Kondratieff cycle now is exemplified by the after war period⁶, the mid-run Juglar cycle is the demand and policy induced ordinary business cycle, and the short-run Kitchin inventory cycles more or less have been ironed out due to on-demand production.

Distribution

Demand pulls leading away from the long-run trajectory thus are typically initiated by interventions changing the income distribution. A typical model that depicts a certain type of pulsation initiated by a typical economic class struggle between capital and labour is Richard Goodwin's growth cycle [R. Goodwin, 1965]. In this case oscillations in income distribution induce investment booms and vice versa. Note that these mid-term limit cycles fluctuate

⁶ David Gordon would have added the political notion of a Social System of Accumulation, SSA, as a complement to Kondratieff's more technically oriented basic innovation argument (see [D. Gordon, 1978]).

around a long-run growth path - in this case Harrod's unstable knife edge growth – a long-run path that again is determined by labour productivity growth and population growth⁷. Needless to say that Goodwin type models fit perfect into the building block 'Distribution'.

One of the innovations of the prototype model, following in that respect many other demographic approaches, is that distribution feeds back into demography. There are many arguments why this is the case. As mentioned in the last chapter, household incomes of workers might only be sustainable if both adults have fulltime jobs, thus implying a change of incentives for having children. Or a short-run political goal of reducing government expenditure might seduce politicians to reduce transfers to pay-as-you-go pensions, with severe consequences for the contributions of the active population and similar effects on population growth as in the previous example.

Financial Markets

A major set of relations not covered by the distributional models mentioned so far concerns financial markets.

Many of the deviations from the long-run path do not develop as fiercely as their in-built mechanisms would imply, due to the fact that financial markets, in particular credit systems, help to dampen the effects. On the other hand there are some financial mechanisms, which rather follow rules that can contribute to instability, notably at stock exchanges and in creditor networks.

Since any economic system today is a monetary system developments on financial markets immediately influence the whole economy – in particular households and production systems. The standard assumption is that they do so via the interest rate, but there are many other channels too. More recently, in the age of globalisation, a most important set of financial markets started to play a key role: the foreign exchange markets. As already mentioned these markets allow transnational firms to exploit whole nations in the developing world – with important implications for small firms without international links.

In Europe the most severe consequence of this argument concerns employment. Although at first sight time series in Europe and Japan seem to suggest that in the long-run employment and population tend to grow with the same (declining) speed, this is not too good if there already exists a stock of unemployed (compare figures 3a and 3b). Unemployment of the young and low-skill workers is here to stay⁸.

⁷ It is imprecise to attest Goodwin's model the property that it derives growth from cyclical movements; it only describes growth rate oscillations around a growth trajectory already in-built by assumptions.

⁸ As diagram 3c shows this is not true for the USA. Indeed the hegemonic country in the world economy seems to have preserved the ability to reduce unemployment – at the price of really low wages for blue collar work as some would argue.

Again it is necessary to look below the surface of aggregated series to discover what is going on. And again agent based simulation can help to derive the just mentioned observations as emergent properties. Indeed this is the place where the deficiency of not having embedded the prototype in a global model hurts most. Micro-behaviour, institution building, taxation of transnational firms and the like are very difficult to model if the option for a transnational corporation to leave the country cannot be properly included.

Despite this drawback several interesting simulation runs have been carried out with the prototype model just described. The last chapter will mention some of our findings.

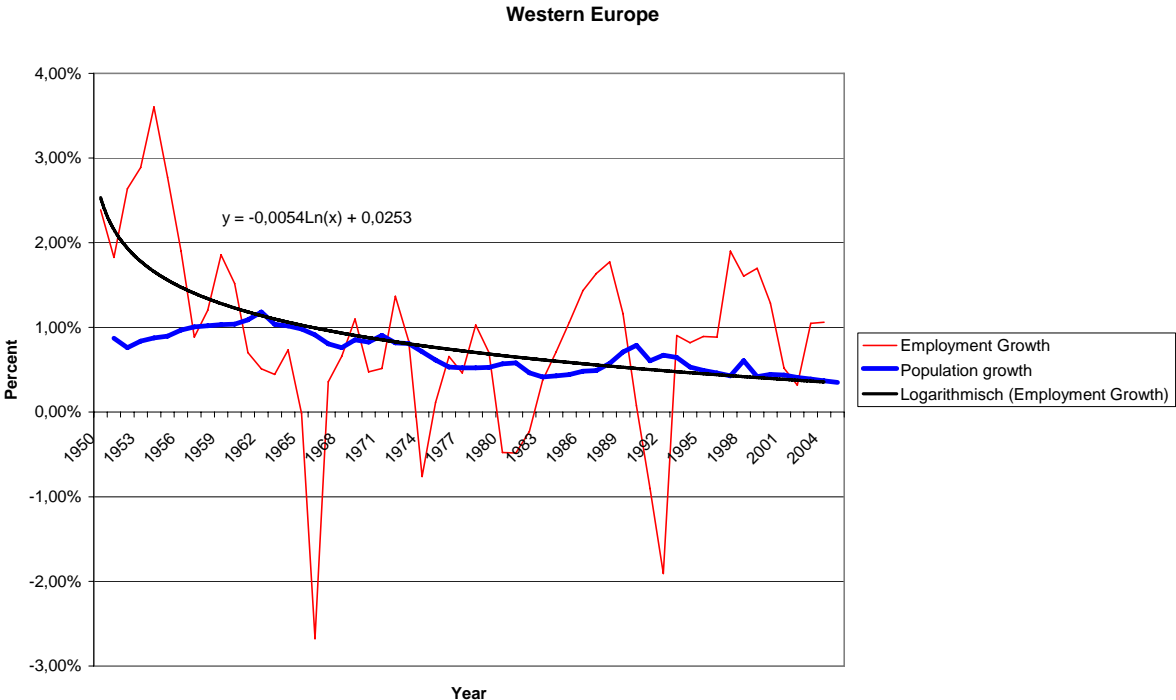


Figure 3a: Employment and population growth in Europe

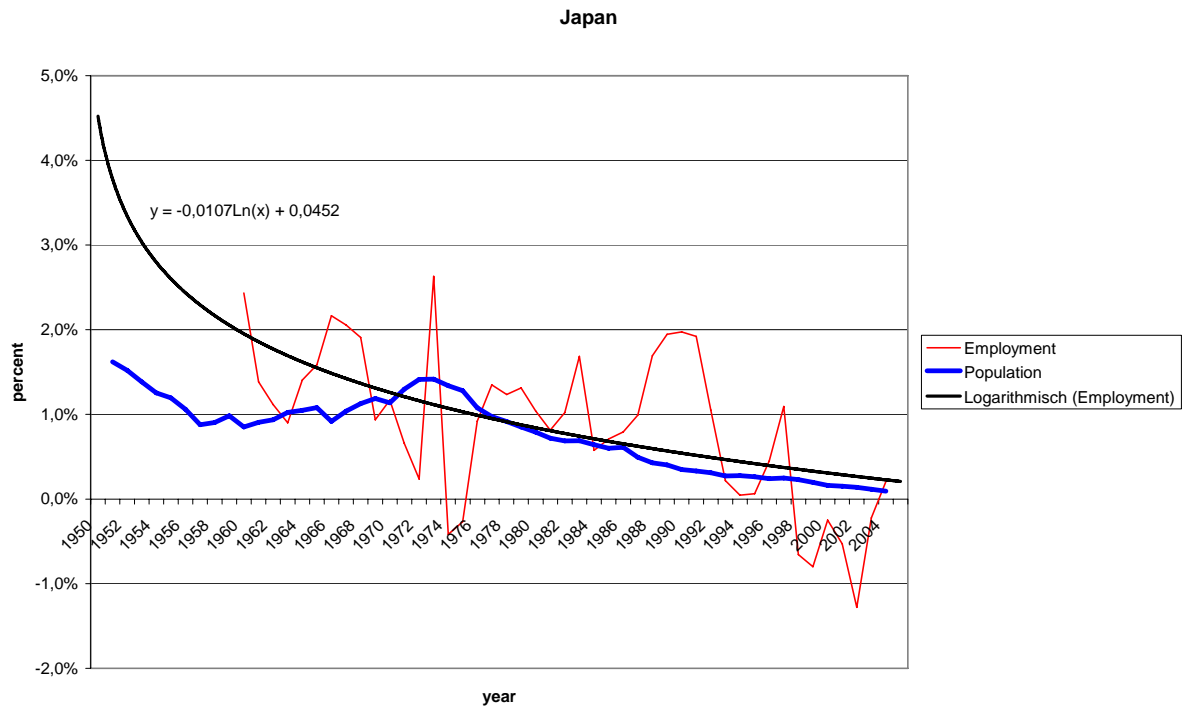


Figure 3b: Employment and population growth in Japan

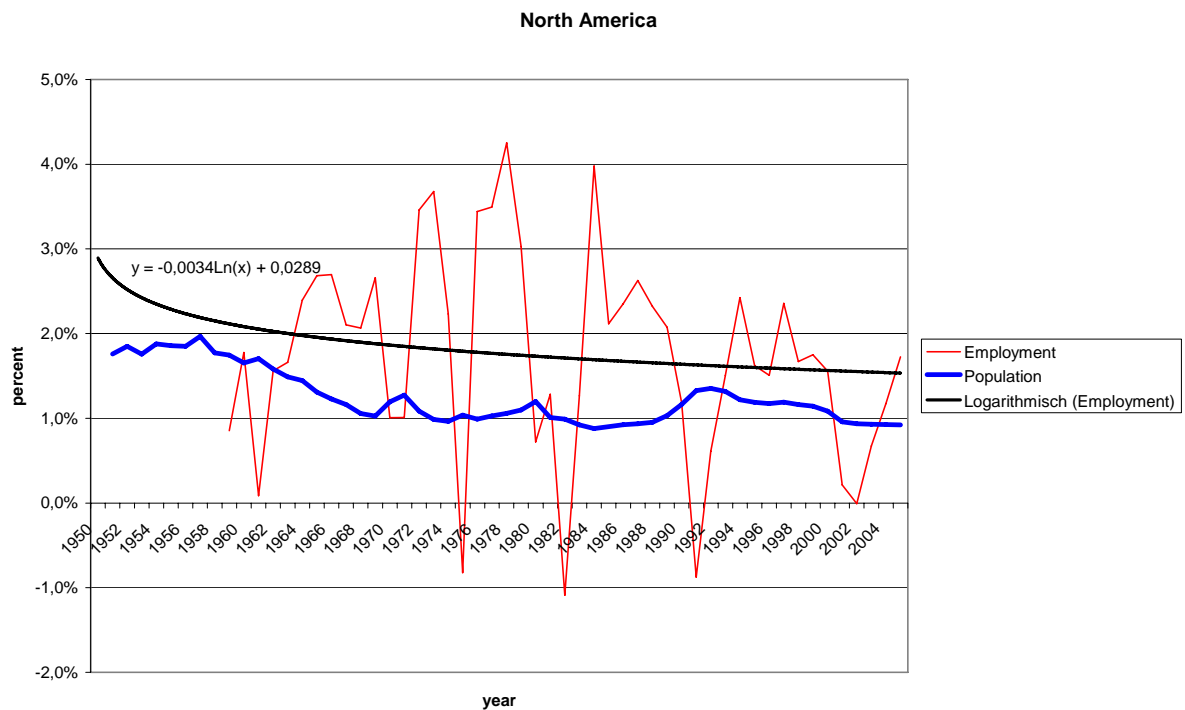


Figure 3c: Employment and population growth in North America

3 - Conclusion

What economic and political conclusions can be drawn from such a prototype model?

One interesting question concerned the feasibility of transfers in a pay-as-you-go system if life expectancy increases along its past trajectory. The simple answer to this question seems to be 'yes', with the moderate productivity growth that have been observed in the past future pensions can be financed in the conceivable future. Much of the current excitement around this question seems to be motivated by short-run budget goals of finance ministries. Even a brief glance at figure 1a would confirm that developments are not as dramatic as sometimes propagated.

If one looks periodically for a Nash equilibrium in a game between young, middle and old generation to check if the incentives for a change of the intergenerational transfer systems has occurred, then the stability of the current solution is surprisingly high⁹. Only strong deviations from the principle one person/one vote would enable faster changes. Again innovation contributes to stability.

More dramatically are changes in the family structures induced by changes in the firm structures in Europe. Contrary to some comments from politicians with vested interests the role of economic policy, in particular of trade policy combined with incomes policy is dramatically increasing. Providing infrastructure, including education infrastructure will become an overriding task, the finance of which will spur new developments in financial markets. A possible welfare enhancing strategy could consist of a slight increase in retirement age combined with a more pronounced increase in education time before entry into economic activity. While the former is already on its way, the latter is surely not on the current agenda of commonsense politics. Unemployment of European low-skill young workers competing with unbeatable competitors in most other places in the world will therefore stay with us for some time. The question how to finance such a *European education initiative* could be brought to the table in the meantime. It surely would need innovative finance, something very different from the current fashion. But at the end of the day this might be one of the few routes out of current dilemmas.

On the micro-level the role of women in society is one of the most rapidly changing characteristics. With it comes a profound re-definition of what constitutes a household, as well as a re-definition of reproductive work in general. The old discussions about the boundary between public and private sphere are suddenly on the agenda again. Disputes on wage-price systems in Europe, with special emphasis on gender bias, are just the surface of a much more profound question brought into play by women: the role of exploitation in social life, meaning and need of a so-called career, and the like.

⁹ Note that the assumption of a certain amount of altruism of the older generation is necessary to render the solutions observed in the past rational.

The paper and the runs of the simulations of the prototype certainly have discovered more open questions than they were able to answer; but nevertheless we insist that this is exactly the way in which economic progress works.

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