Advances in growth and macroeconomic dynamics: In memory of Carine Nourry

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ABSTRACT

This paper is an introduction to the special issue of *Mathematical Social Sciences* on *Advances in growth and macroeconomic dynamics* in memory of Carine Nourry.

This special issue of *Mathematical Social Sciences* collects a selection of twelve original papers, covering different topics in growth and macroeconomic theories, and key related normative and positive themes. It gathers some of the major contributors to these research streams like Bob Becker, Jess Benhabib, Jean-Michel Grandmont and Kazuo Nishimura, together with other distinguished scholars, in memory of Professor Carine Nourry, who was a close friend of many of the contributors to this special issue. The body of this volume begins with a tribute to Carine by Grandmont et al. (2021).

The following part of this special issue has been organized in four sections. We describe here below the main original contributions of each paper together with a brief overview of the corresponding research stream. Needless to say, all the papers went through the standard review process.

Macroeconomic stability and fluctuations

The first section deals with macroeconomic stability and fluctuations, a topic extensively studied by Carine Nourry in many of her contributions. As shown by the macroeconomic dynamics literature over the last 40 years, fluctuations in standard optimizing models can be explained by the existence of many sectors, through the occurrence of endogenous cycles (see e.g. Benhabib and Nishimura, 1979, 1985), or by the existence of inefficiencies, through the occurrence of sunspot equilibria and expectation-driven business cycles (see e.g. Benhabib and Farmer, 1994; Dufourt et al., 2015, 2018). The overlapping generations model, considering a life-time of agents that is disconnected from the time-span of the whole economy, fundamentally contains some potential inefficiencies that can lead to the existence of endogenous cycles, as shown initially by Grandmont (1985). The three papers in this section are focusing on these two sources of endogenous fluctuations. The first one is dealing with a general two-sector overlapping generations model, the second one is focusing on human capital externalities in an infinite-horizon model, and the third one is considering a small open economy with debt and borrowing constraint.

In this special issue, Barinci et al. (2021) consider a general two-sector overlapping generations model *à la* Galor (1992), Reichlin (1992) and Nourry and Venditti (2011) with a pure consumption good and an investment good produced by general technologies. Following Reichlin (1986) and Benhabib and Laroque (1988), preferences over a two-period life-cycle are based upon endogenous leisure motive in the first period and consumption in the second period. Two stationary equilibria are shown to exist: a Wealth-to-Capital equilibrium where the total private wealth is equal to the value of the stock of capital, and the Golden Rule equilibrium where such an equality generically does not hold and the stationary consumption is maximized. The first steady state can be characterized by under or over-accumulation of capital compared to the Golden Rule. A local stability analysis of the two steady states is then provided as a function of sectoral equilibrium elasticities of substitution. It is shown that depending on the smoothness properties of factors substitution, both equilibria can be characterized by monotone convergence or endogenous fluctuations through the existence of local indeterminacy and quasi-periodic cycles.

These results generalize and extend the main conclusions of Galor (1992), Reichlin (1992) and Nourry and Venditti (2011) obtained under more restrictive conditions. Indeed, by providing detailed conditions expressed in terms of the sectoral elasticities of capital/labor substitution, Barinci et al. (2021) explicit the mechanisms generating business-cycles fluctuations. Building on a general description of technologies and preferences, this paper provides a significant progress in this highly demanding literature.

Since Uzawa (1965) and more recently Lucas (1988), it is well recognized that human capital is a major driver of economic growth. Investments in human capital are individual and collective choices carrying significant external effects. In general, human capital externalities are considered through their impact on productivity. However, increasing studies in sociology show that human capital also affects welfare. In particular, Ross and Wu (1995) find that better educated agents have a larger demand for health and are more in control of their life as they live in healthier conditions. They can then enjoy more consumption.

In line with this stream of research, Bosi et al. (2021) contribute to this special issue by exploring the implications of introducing different types of human capital externalities into the utility function, the production function and the human capital accumulation of a Lucas-type model without physical capital.[1] They study how these interact with the choice of time to work versus time to accumulate human capital, as well as their effects on growth and on the stability properties of equilibria. It is shown that growth can be no longer balanced and that the equilibrium can be globally indeterminate. This implies that two economies with identical preferences, technologies (of production and human capital accumulation) and initial endowment of human capital, may experience different growth paths. A taxation policy based on constant tax rate is then shown to speed up the accumulation of human capital.

While many papers study the effects of human capital on human capital accumulation (see for instance, de la Croix and Doepke, 2003, Tamura, 2001), very few papers focus on the impact of human capital as a positive externality on human capital accumulation. Among them, Mookherjee et al. (2010) study an overlapping generations economy where, depending on location, parents decide whether or not to educate their children, and Cavalcanti and Giannitsarou (2017) focus on positive network externalities (local peer) on human capital accumulation in an overlapping generations model and reconsider the trade-off between growth and inequality. By computing the explicit trajectories and thus providing a global understanding of the dynamic properties, the paper of Bosi et al. (2021) constitutes a significant extension of this literature to the analysis of various human capital externalities on the accumulation of human capital and the associated impact on growth and macroeconomic instability.

The last financial crisis and more recently the Covid crisis have generated dramatic increases of debt levels in most countries raising the problem of debt financing. The control of the growth rate of public spending has then become a major concern for economists and policy-makers. Yet, the co-existence of various experiences across countries suggests that debt financing is a complex question. While most existing papers are concerned with closed economies (see for instance Chéron et al., 2019; Futagami et al., 2008; Nishimura et al., 2015), it clearly appears now that borrowing on the international market can be more or less limited by collateral constraints, and that the share of public debt hold by residents may play a significant role.

In this special issue, Modesto et al. (2021) provide with a theoretical exploration of the latter interconnected issues. To this end, they consider a small open economy with a credit constraint `a la Fahri and Tirole (2012) and Hirano and Yanagawa (2017), and a preference for domestic public bonds. In such a framework, there is non-substitutability between the different assets, productive capital, public debt and an international asset, and the economy is characterized by an investment multiplier. It is shown that whatever the level of the debt–output ratio, there always exists a high growth BGP which features expectation-driven fluctuations. Moreover, if the debt–output ratio is low enough, global indeterminacy arises as there is also a second BGP with a lower growth rate. But if the share of public debt held by domestic households is high enough, this second BGP is ruled out and global indeterminacy does not occur.

The key findings of this paper provide a significant improvement of the analysis of non substitutable assets in macrodynamic model. Indeed, most previous papers such as Morimoto et al. (2017), which also address the case of a small open economy, assume that the different assets, productive capital and domestic and external debt, are perfect substitutes. As a result, there is no portfolio choice for the households and only the level of total asset holdings plays a role. Such a framework does not allow to properly assess the impact of domestic holding of domestic debt on the stability properties of the economy. While essentially theoretical, by precisely focusing on the non substitutability of assets, the paper of Modesto et al. (2021) is able to capture the case of the Japanese economy which is characterized by a very large debt, a large proportion of domestic public bonds owned by Japanese residents and a weak volatility of GDP.

Existence of equilibria

The second section is concerned with the existence of equilibria. Inefficiencies and multiplicities of equilibria explain the results of many papers of this special issue. They were also at the core of the scientific works of Carine Nourry. Two key ingredients to generate them are of course the presence of market failures and the introduction of sufficiently general models. The existence of equilibria in these contexts is still an open question, especially in multi-period models, which imply intertemporal arbitrages. Both market inefficiencies and generalization of preferences break from some important difficulties and ask for new answers. The two papers in this section are concerned with these issues, the first one dealing with the existence of equilibria with collateral constraints and endogenous production, and the second one in an infinite horizon framework where preferences do not satisfy some too standard properties. Despite the fact that the existence of equilibria is a fundamental issue for economists, these two papers also answer to other questions, that is, the interplay between the real and financial spheres of economies and the selection of equilibria.

The empirical evidence on the pattern of bankruptcy illustrates the interplay between finance and real economic activity. A central question is therefore the financing of firms' investments when financial markets are incomplete. The first contribution by León-Ledesma and Orrillo (2021) studies an extension of the incomplete markets' general equilibrium model in which firms can default and therefore bankruptcy is possible. The production aspects of the model with default and collateral in a novelty of the paper. Their setting is characterized by endogenous production, and collateral constraints involve all the commodities available for consumption and production in the economy. Because the owners of firms have unlimited liability, lenders can seize the value of collateral and future production. This introduces endogenous default. Because of this endogeneity, lenders have a portfolio

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[1] Capital is not considered to simplify the analysis and to focus exclusively on the role of human capital.

of assets issued by producers but cannot anticipate the identity of the firm defaulting. Thus, lenders anticipate a default rate that depends on the average level of production and is therefore counter cyclical. Finally, in order to avoid an equilibrium with no production, an insurance mechanism is introduced.

In this framework, the two key theorems in corporate finance, namely the Fisher's separation theorem and the Modigliani–Miller theorem, are generally not satisfied. Thus, in general, the separation between the financial decisions of firms and their owners is not possible, which implies that the real and financial spheres of the economy are not disconnected. This is important for the design of financial policies. Finally, under usual assumptions on utilities and technologies, the existence of equilibria is shown, and the paper discusses the nature of the inefficiencies due to the occurrence of bankruptcy. Because of an insurance premium, the equilibrium is constrained efficient.

Recursive utility describes classes of intertemporal utility functions that are tractable and extensively used in macro-dynamic models. Optimal growth models in discrete time are clearly the main application of recursive utility functions. When the model considered is sufficiently general, a relevant question is to find a class of utility functions that solves the Koopmans equation for a given aggregator. Some solutions to this problem have been found when the aggregator satisfies some Lipschitz condition. When this is not the case, Marinacci and Montrucchio (2010) proposed aggregators that did not fit into the previous literature. The name of these aggregators are the Thompson aggregators. They proposed new methods to solve the Koopmans equation for such a given operator. The existence of extremal solutions is however a non-constructive result.

In their contribution to this special issue, Becker and Rincón-Zapatero (2021) go a fundamental step ahead: they develop a computationally motivated methodology which offers a selection principle for numerical solutions of recursive macrodynamic models where theory suggests that there are multiple fixed points. They obtain a constructive result. They show that extremal fixed points exist using successive approximations as soon as the conditions of the Tarski–Kantorovich fixed point theorem are met. The proof is based on the verification of an order continuity property. Their result provides qualitative features of the extremal solutions, as semi-continuity and concavity.

Migration and networks

The growth enhancing effect of migrations in both host and sending countries has been a quite active research area in growth and dynamic macroeconomics since the 70 s. A fundamental nexus between human migrations and economic growth is human capital accumulation, in particular via the inherent brain drain (see the early contribution of Rodriguez, 1975). Whether the latter has a net devastating effect on the development of the sending countries, as initially thought, is still an intensively debated issue: induced education in the host country (or the so-called brain gain mechanism as first suggested by (Mountford, 1997) and remittances by skilled migrants (see Faini, 2007) have been among the most frequently suggested channels through which the direct (negative) effect due to the brain drain may end up dominated.

In their contribution to this special issue, Destrée et al. (2021) propose an important theoretical extension incorporating, in addition to the two latter mechanisms, endogenous debt constraints in the sending countries. More precisely, they consider an endogenous growth model based on human capital accumulation where agents face an endogenous debt constraint to finance their education in the home country while they receive remittances from their emigrated children. The debt constraint ingredient is

a key feature of developing economies, and as explained in the seminal work of Banaerjee and Newman (1993), it plays a crucial role in the accumulation of human capital in these economies.

Destrée et al. (2021) assume a non-commitment setting à la de la Croix and Michel (2007) where individuals may choose to default on their debt and be excluded from the asset market. They show that remittances tend to tighten the borrowing constraints for a given level of interest rate, but may enhance growth at the equilibrium. Based on the existence of multiple equilibria, the model is able to replicate both negative and positive impacts of migration and remittances on economic growth. A calibration of the model based on 30 recipient economies shows however that the global effect of migration and remittances on education and growth is positive for a majority of them.

Another increasingly important research question is the role of social networks, not only in driving migrations, but also in connection with labor mobility (see for example Calvó-Armengol, 2004), educational mobility (see a recent study by Stephany, 2019) and the pace of human capital accumulation, and thus *in fine* with the development process. The concept of social network is indeed central in many disciplines: it is deeply rooted in sociological research, in anthropology, geography and political science, and about to become equally central in several streams of the economic literature. In this special issue, we provide with two contributions focusing on the role of social networks. The first one by Domingues Dos Santos and Taugourdeau (2021) studies the role of social networks in international migrations. This article is essentially theoretical but it has been carefully designed to capture some of the salient characteristics of the Portuguese migration to France. To the best of our knowledge, this is one of the few social networks-related papers at the intersection of the migrations and labor market streams. The second by Augeraud-Véron et al. (2021) studies the implications of welfare-enhancing social interactions in the creation of cities and their size via the rigorous concept of urban equilibria. This paper makes progress on one of the most difficult technical problems involved by local interactions, which reveals far trickier to study than the global interactions case in urban economics (see an early treatment of this case in Mossay and Picard, 2011).

The crucial role of social networks has been highlighted to explain behaviors in the labor market and migratory patterns. However, these two concerns are usually disconnected. The interplay between immigrants' informational network, job search activities, migration and concentration in some specific industry has not yet been analytically addressed. The model of Domingues Dos Santos and Taugourdeau (2021) fills this gap. Social networks are taken into account in a matching model to illustrate the persistent situation of Portuguese immigrants in the French labor market. Indeed, they are still concentrated on a sector with low productivity, namely the construction sector.

The paper develops an original matching model that highlights that the employment concentration of the Portuguese community can mainly be explained by their social network. There are two sectors with endogenous allocation of the labor force between sectors and social networks that favor the transmission of job information. Social networks can induce sector concentration even when productivities and entry costs are perfectly symmetric, but they can also trap workers in poorly productive sectors. The transmission of job information within a community improves the matching efficiency, which reduces unemployment and promotes sector concentration. Hence, the model explains the two main specificities of the Portuguese labor force in the French labor market: a low unemployment rate and a high sector concentration. It also highlights the intergenerational persistence of both these features.

As argued above, the urban economics literature typically assumes that interactions are global: all the residents are willing to

interact with every other (Mossay and Picard, 2011) and, all firms make economic transactions with every other (Mossay et al., 2020). Augeraud-Véron et al.'s contribution to this special issue is the first theoretical attempt to cope with local interactions. Due to travel costs, economic agents may not find it optimal to interact with every other, and interactions remain local. In their spatial model, Augeraud-Véron et al. (2021) study how a given mass of identical individuals would locate in a given space assuming that utility in any location depends on consumption of both a composite good and land space, plus the so-called social surplus (that is the gains from local interactions at that location). Landlords rent land (both for residential and farming purposes). An urban equilibrium is reached when individuals have no more incentives to move. The challenge is to characterize and compute the equilibrium population density.

The key finding of the study is that the equilibrium population density function is a solution to a second order advanced-delay differential equation. In other words, changes in population density at any urban location depend on the density at some specific distance (capturing the interaction "window" of individuals) to the left and right hand of this location. The differential equation uncovered is functional, and it is extremely hard to solve. In an intertemporal frame, it corresponds to a differential equation with both time lags and time leads. These equation would arise in optimal growth models with vintage capital as in Boucekkine et al. (2005) but the spatial model developed by Augeraud-Véron et al. (2021) has additional features which make it far more intricate. Besides confirming that the usual properties of urban equilibria also hold under local interaction (albeit with some qualifications), the authors bring out several novel predictions about the role of local versus global interactions in the formation of (monocentric/polycentric) cities. Even more, the authors close their article with an application of their local interaction framework to population dynamics under an epidemic threat as the ongoing Covid-19 epidemic.

Inequalities and income distribution

The last section of this special issue is specifically devoted to the analysis of inequalities, and includes four original contributions. Three take a positive approach: Benhabib and Hager (2021) present a theory of "revenue diversion" by managers and its implications for income distributions, Constant and Davin (2021) study the persistence of human capital inequalities due to pollution, while Boucekkine et al. (2021) build up a theory of elite-biased democracies where in contrast to "pure" democracies, the incumbent autocrat allied with an insider minority remains in power without enforcing the redistribution rate preferred by the majority. The fourth contribution due to de la Croix and Doepke (2021) is normative: the authors propose a new approach to the so-called optimal population size problem (see for example Blackorby et al., 1995) with several contextual implications.

Benhabib and Hager's highly insightful contribution to this special issue brings the casual readers to the origins of the debate on the shape of income/earning distributions (in particular to the relatively unknown pioneering work of (Fréchet, 1939) and then displays a simple and appealing theory of income distributions with "revenue diversion", which they further: (i) connect to the historical debate just above mentioned, and (ii) illustrate with some rough quantitative exercises.

A key aspect of the theory is the allocation of talents across occupations, where "talent" has to be understood in a broad sense (say a combination of technical and social skills). If the distribution of talents were fully observable, then one could infer the earnings distribution for a given mapping of talents into earnings. But the authors note that talents are not fully observable:

there is room for "revenue diversion", that is revenue gains not closely remunerating talents but diverted by a certain class of personal, called "managers" (as opposed to "workers") in the theory produced by Benhabib and Hager (2021). This echoes previous work by Murphy et al. (1991) where "engineers" are opposed to "lawyers". This is also pretty much in line with an ongoing debate on the gigantic business incomes of the managers of the superstar companies of the digital economy (see the recent work by Jones and Kim, 2018, on top income inequality in the US). Benhabib and Hager's allocation of talent theory allows to get that, with or without revenue diversion, the overall distribution of income is hump shaped, and is given by a Pareto distribution above the median (as stated by Fréchet, 1939). Some illustrative quantitative exercises are additionally provided.

Inequalities can be addressed in terms of the effects of pollution. Pollution is a significant reason for health problems (see for instance Raffin and Seegmuller, 2014, 2017; Palivos and Varvarigos, 2017). Children are identified as special victims to these health effects of pollution. The consequences are not only in the short term, but also in the long term. By increasing absenteeism or affecting learning skills, the health effects of pollution have consequences on human capital and income when individuals become adults. The health effects of pollution are thus characterized by inequalities inside each generation. Indeed, children with lower socio-economic status are more vulnerable and exposed to the health consequences of pollution.

Despite their importance, the consequences of inequalities due to pollution have been studied only in a few theoretical papers. Constant and Davin (2021) provide an analysis which contributes to make up for this lack. They develop an overlapping generations model where individuals have heterogeneous human capital. Children suffer from air pollution, but their parents can mitigate this effect by investing in health. These different aspects contribute to the accumulation of human capital. The pollution rate of production and the initial level of inequalities determine the long run behavior of the economy. In particular, if the production is highly polluting, inequalities will persist over time and the economy can even be relegated into an inequality trap. Indeed, pollution affects more poorer children who will accumulate less and less human capital. Constant and Davin (2021) also study environmental and health policies which are able to reduce inequalities. Environmental maintenance financed by polluters can be a good tool when the initial inequality and the pollution emission are not too high. Otherwise, adding a health policy, which consists of health subsidies, could be a relevant option.

Boucekkine et al. (2021) tackle another type of "revenue diversion" within autocratic regimes with insider minorities. They rely on the important work of the political scientists, Albertus and Menaldo (2018), who noted that a significant fraction of democracies are substantially departing from what is usually associated with the very concept of democracy, e.g. inclusiveness, income redistribution from the rich to the poor, strong welfare states. Boucekkine et al. (2021) provide with further empirical evidence of these "impure" democracies: in particular they show that about 40% of formal democracies which have emerged at some point since 1960 still operated under autocratic constitutions in 2006. Typically, these democracies are elite-biased: they are less egalitarian than popular democracies both in terms of income distribution and access to political power.

The main contribution of this paper is theoretical however: the authors extend the basic political transition game-theoretic model of Acemoglu and Robinson (2005) to identify conditions under which elite-biased democracies would arise as an economic–political equilibrium. In particular, the population is split into 2 groups, a minority and a majority, with the additional crucial ingredient that minority enjoys a preferential treatment

or benefit from fiscal particularism under autocracy (insider elite in the terminology of Albertus and Menaldo, 2018). As a result, the preferred tax rate of the majority member is likely to be significantly higher than in a situation, as in the Acemoglu and Robinson's benchmark (see also Boucekkine et al., 2016), where there is only one source of income discrimination. Elite-biased democracies may then arise if one source of discrimination, fiscal particularism, is officially removed, and replaced by a more good-looking coalition, even though the involved redistribution to the majority members is lower than the counterpart under pure democracy.

The optimal population size problem is an old normative problem, which has been the subject of numerous contributions and approaches since the late 60 s (and even much before, see the survey part in Dasgupta (1969). It is however still open, and de la Croix and Doepke (2021) are providing with a novel and intriguing approach in this special issue.

A key issue arising in the standard welfarist approaches is that they ultimately require evaluating the welfare of nonexistent people, because some people exist only in some allocations but not in others. This is a major problem which is has been heavily discussed in economics (see for example, Golosov et al. (2007) and ethics (see Parfit (1984) and his *repugnant* conclusions). To deal with this essential problem, de la Croix and Doepke (2021) advocate for a soul's view approach with introspection as the accompanying method for comparison of populations (of different sizes)

For the authors, the key of the problem is to find an interpretation "where being alive and being unborn are not mutually exclusive, but merely different states which are experienced by one and the same being over time". And this can be even made operational: it is enough to assume that the world is endowed with a fixed supply of souls who get reincarnated from time to time in different human bodies. de la Croix and Doepke (2021) elaborate on this conceptual approach to derive a rich theoretical analysis (including comparison with leading alternatives) and discuss some applications to concrete problems involving long-term environmental risks.

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