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Working Papers / Documents de travail

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WP 2018 - Nr 25

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First version: *September 2015*; Revised: *October 2015*

Abstract

This is an introduction to the special section on financial frictions and debt constraints.

Keywords: Rational bubbles, credit and borrowing constraints, public debt constraints, (in)complete markets, heterogeneous agents, sunspot fluctuations

Debt, portfolio and solvency constraints are among the most studied financial frictions both in general equilibrium theory and dynamic macroeconomics. Still, many issues remain open, and this special section collects five papers representative of frontier research in both areas. Both existence and uniqueness of competitive equilibria and constrained efficiency characterization are tackled in the general equilibrium part of the section in two different Markovian exchange economies with sequentially complete markets inducing imperfect risk-sharing due to lack of commitment. Ramsey models with heterogenous agents and (liberal) borrowing constraints are the object of the third article while the two last are motivated by the recent European sovereign debt crisis and international financial crisis and focus on the role of public debt constraints and financial frictions respectively in the emergence of macroeconomic instability and bubbles.

Solvency constraints in infinite horizon Markovian exchange economies with complete markets

A fundamental line of research concerns the role of debt and solvency constraints under uncertainty. The interaction between uncertainty (think of idiosyncratic shocks to fix the ideas) and solvency constraints suggests a large set of questions ranging from existence and uniqueness of competitive equilibria to efficiency concepts, and a large set of possible environments to tackle these questions. A seminal paper in this literature is Kehoe and Levine [21]. One of the numerous merits of this paper is to fix a benchmark Arrow-Debreu-like theory in a benchmark environment, that's infinite horizon exchange economies with complete and common information, complete contingent claims markets but limited commitment to repay debts. A key ingredient of this theory is the

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so-called **participation constraints** restricting allocations to be self-enforcing relative to autarkic reservation utilities. Default leads not only to seizing individuals' assets but also, and crucially, to their permanent exclusion from future trading. Uncertainty is idiosyncratic, typically modelled through a Markovian process over a finite number of states, agents have the same von Neumann-Morgenstern utility function and same discounting rate, they may only differ in their per period endowment which is random. Since information is complete, individuals cannot enter into a contract in which he would have an incentive to default in some state. Partial insurance is therefore a natural outcome in this framework. Kehoe and Levine provide with the corresponding (constrained and unconstrained) efficiency analysis and welfare theorems.

Alvarez and Jermann [1] have significantly revisited the equilibrium concepts in the Kehoe-Levine type of economies by shifting the focus from the above mentioned participation constraints on individual consumption sets to the **endogenous** solvency constraints implied by the latter, allowing for an illuminating economic analysis in terms of asset prices and a consistent new decentralization procedure. Precisely, Alvarez and Jermann show that Kehoe-Levine's partipation constraints do imply endogenous solvency constraints, which reduce effectively risk sharing as agents with low income can only borrow up to the level they can pay back in the future. More importantly, these solvency constraints lead the authors to define a new equilibrium concept according to which agents will make sure that their wealth is not too small to avoid default and reverting to autarky while enforcing at the same time as much risk sharing as possible (this is the so-called *not too tight debt constraints* put forward in this seminal paper). Interestingly enough, Alvarez and Jermann are able with this new focus to formulate (constrained) efficiency in terms of asset prices, rather than relying on subjective preferences or evaluations of risk. In particular, they find that **high implied interest rates**, that's when the present value of endowments under the Arrow-Debreu price process is finite, is sufficient for constrained efficiency. The connection between high interest rates and constrained efficiency is somehow intuitive in this environment. In the steady state, as the marginal rate of substitution coincides with gross interest rate, reducing current consumption of an individual for equal compensation in the following period is welfare increasing when the interest rate is strictly negative; since this reallocation can be repreated over the infinite horizon, one immediately gets inefficiency of constrained efficiency under low interest rates. Things are much more involved out of the steady state and under uncertainty. In particular, the necessity of high implied interest rates for constrained efficiency is far less obvious. In Alvarez and Jermann, necessity is obtained in the pure tradition of Kehoe and Levine's proof of the second welfare theorem in the same environment but as in the latter additional conditions are needed.[1]

In a subsequent fundamental contribution, Bloise and Reichlin [11] observe

[1] Precisely, Kehoe and Levine [21] prove that as long as induced Arrow-Debreu prices are strictly positive, high implied interest rates hold at equilibrium. This happens under sufficiently productive assets in positive net supply in Kehoe and Levine. Alvarez and Jermann set an alternative condition in terms of (partial) gains from risk-sharing.

that this kind of equivalence between high implied interest rates and constrained efficiency in the Kehoe-Levine environment is not general. Indeed, high implied intereste rates may not be necesssary for constrained efficiency in an economy with non-stationary allocations, stationarity is assumed in Alvarez and Jermann's paper. Inspired by the work of Cass [14] on stochastic overlapping-generations models, Bloise and Reichlin come to an alternative characterization of constrained efficiency in terms of **uniform gains from trade**, that's on the existence of feasible welfare improvements thanks to trade (or risk-sharing), even though a fraction of aggregate endowment is destroyed when departing from autarchy. Precisely, taking the standard general equilibrium approach, they prove that under uniform gains to trade, the support by a linear functional is a necessary and sufficient condition for constrained efficiency for the set of allocations that are uniformly bounded away from zero. Martins da Rocha and Vailakis [25], in this special section, elaborates on Bloise and Reichlin's work to provide with a major result, relaxing, among others, the assumption of uniform gains from trade in the characterization of constrained efficiency. They proceed in two steps. First, they prove that high implied interest rates are necessary and sufficient for constrained efficiency under uniform gains from trade. With respect to Bloise and Reichlin [11], the latter result is established without restricting the set of allocations to be bounded away from zero, and more importantly, the sufficiency proof builds on a new decentralization procedure which does not require unform gains from trade indeed. In a second step, Martins da Rocha and Vailakis construct perturbed economies: these are simple extensions of the traditional environment where a physical and sizable asset is introduced (physical asset means it's in positive net supply as in Kehoe and Levine). It can be readily shown that if the dividend process of the physical asset is large enough with respect to the private aggregate endowment process, the property of uniform gains to trade is automatically satisfied. In their way to establishing their complete characterization, Martins da Rocha and Vailakis show that a constrained efficient allocation can be obtained as the limit of allocations corresponding to the perturbed economies described above, and therefore exhibiting high implied interest rates. The outcome of the first step then allows to conclude. In addition to closely comparing their characterization to Bloise and Reichlin's, Martins da Rocha and Vailakis provide with an illuminating example (on a standard stationary Markovian economy) of the practical interest of their approach and its high operational value.

Another important framework for the analysis of imperfect risk-sharing because of lack of commitment despite sequentially complete markets is explored in this special section. Bloise and Citanna [10] study the existence and uniquess of equilibrium in the Kehoe-Levine environment with a major difference with respect to the literature outlined just above: as a fraction of endowment is pledgable (collateral constraints), which is not systematically the case in the latter literature, no further punishment mechanism is considered. Accordingly, there is no exclusion from trade upon default and the seizure of the collateral by lenders is the only loss an agent faces for his default. A recent exploration into

this class of models is due to Gottardi and Kubler [18]. As interestingly pointed out by the latter authors, the level of the borrowing (collateral) constraint is **endogenously** determined in equilibrium by the agents' limited commitment problem like in the Kehoe and Levine environment and in sharp contrast to the typical exogenous treatment of liquidity contraints in the traditional literature of the permanent income hypothesis. Gottardi and Kubler [18] provide with new results on existence and uniqueness of competitive equilibria in this framework with an accurate account of the specific technical problems encountered with respect to the Kehoe-Levine set-up.[2] Gottardi and Kubler also deliver a partial efficiency analysis. Precisely, Gottardi and Kubler give some sufficient conditions for competitive equilibria to be fully Pareto efficient, that is for the amount of available collateral to be sufficiently large that the collateral constraints are not binding. In this special section, Bloise and Citanna [10] provide with an illuminating exposition on the existence and especially the uniqueness of equilibrium issue in the same environment as Gottardi and Kubler, which not only allows them to completely solve the latter issue, but also to identify some highly useful and broad methodological clues.

A major achievement of Bloise and Citana's paper is the complete proof of uniqueness provided, in contrast to Gottardi and Kubler. Both papers use the gross-substitution hypothesis on preferences, an essential ingredient for the investigation of the existence and uniqueness of competitive equilibria in this environment and in many related dynamic models as examplified by Dana [15]. A key feature of the equilibrium is its recursive structure. While this feature is also shared by the competitive equilibrium in the Kehoe-Levine setting, there is no such a straightforward clue to constrained efficiency in the alternative model. As nicely pointed out by Bloise and Citanna, it's gross substitution which imposes a similar "discipline" at equilibrium in their framework. The technical *tour de force* of Bloise and Citana [10] in this special section is to set an innovative fixed-point strategy based on the monotonicity (induced by gross substitution) of an operator acting on entire wealth distribution functions. Gottardi and Kubler [18] try to establish uniqueness of the competitive equilibrium using a state-by-state minimum operation over the Negishi welfare weights but fail to provide with a complete proof. The strategy elaborated by Bloise and Citana has, in addition, high operational value since it's based on a precise iterative scheme uniformly converging to a unique fixed point.

Borrowing constraints in the Ramsey model with heterogenous agents

The analysis of borrowing constraints in Ramsey-type infinite-horizon economies with heterogenous agents has received a wide attention in the literature over the last 35 years.[3] Following the initial contribution of Becker [2], the standard

[2] Because the equilibrium concept associated is not a standard Arrow-Debreu equilibrium, it is not possible to derive equilibrium allocations as the solution to a planner's problem as in Kehoe and Levine [21] and the authors have to deal with technical problems similar to those encountered in the literature of incomplete markets, as in Kubler and Schmedders [23]. See Gottardi and Kubler [18] for more details.

[3] See Becker [3] for a presentation of the main results.

formulation has been to consider discrete-time models in which the households are not allowed to borrow against their future wage incomes. As a consequence, household savings and physical capital holdings are identical and the capital stock must be non-negative at each time.

In general, the existence of borrowing constraints implies that markets are incomplete and may thus generate inefficiency problems. However, a strong conclusion of this literature has been provided by Becker and Mitra [8] and shows that any equilibrium path satisfying the turnpike property also satisfies the transversality condition of Malinvaud [24] and is therefore intertemporally efficient. Such a property implies a particular degenerate distribution of wealth as it means that the most patient household owns the entire capital stock of the economy whereas remaining households eventually reach the zero capital stock ownership state and maintain that state thereafter. But contrary to the continuous-time version of the same model studied by Mitra and Sorger [29],[4] the turnpike property does not necessarily hold. Becker and Foias [7] then proved that if the production function is such that the capital income is monotone increasing in the capital stock, then the turnpike property is satisfied. Such a restriction, known as the **Capital Income Monotonicity**, being quite demanding, Becker *et al.* [5] has weakened it requiring instead the monotonicity of the maximal income that any household can have. When these restrictions do not hold, period-two efficient equilibrium cycles or period-three inefficient equilibrium cycles may arise but rational bubbles are always ruled out.[5]

In a recent contribution, Borissov and Dubey [12] have relaxed the no borrowing condition by allowing limited borrowing by the households who are then able to borrow against their next period wage income. Now savings include both the capital stock and the household debts, and the borrowing constraint becomes a non-negativity constraint on the sum of each household's capital stock and its outstanding debt. They provide a strong conclusion similar that obtained by Mitra and Sorger [29] in the continuous-time version of the no borrowing model showing that irrespective of production technology employed by the firms, the turnpike property holds. As a result, equilibria are inter-temporally efficient.

In the paper contained in this special section, Becker *et al.* [4] propose to extend the limited borrowing constraint introduced by Borissov and Dubey [12] allowing the households to borrow against their future wage incomes for an exogenous maximum number $N \in \mathbb{N}$ of periods before debt must be repaid. The particular case of Borissov and Dubey is of course obtained for $N = 1$. Under such a **liberal** borrowing constraint, they prove that if the equilibrium path converges to the unique steady state, then the turnpike property holds and that equilibrium is also efficient. They also provide an example in which period-two equilibrium cycles can exist.

Although the conditions for the convergence and for the efficiency of equilibrium paths remain open questions, Becker *et al.* [4] provide a nice investigation of the impact of different borrowing regimes on the consumption inequality in

[4] They show indeed that the turnpike property holds in every Ramsey equilibrium.
[5] See Becker and Mitra [29] and Becker *et al.* [5, 6].

the economy. As usual in infinite-horizon models, the aggregate steady state consumption depends only upon technology and the most patient agent's pure rate of time preference, and is thus independent of N. But under a liberal borrowing constraint, the steady state consumption of the impatient households is a decreasing functions of N, and equivalently the patient household's consumption rises with N and approaches the aggregate consumption as N tends to infinity. As a consequence, the steady state wealth inequality increases as the credit regime is liberalized.

Public debt constraints and macroeconomic stability

The last financial crisis has shed the light on two fundamental aspects of public finance: the control of both the public deficit and the public debt. As the risk of bankruptcy for developed countries has proven to have a positive probability, governments are now strongly encouraged to promote fiscal policies that fulfill some constraints on public deficit and debt. Such rules are at the core of the Maastricht treaty, since the public annual deficit of a country should not exceed 3% of GDP while the ratio of public debt over GDP has to be less than 60%. The sovereign debt crisis has then provided strong incentives to European countries to implement a balanced-budget rule as in Germany or Switzerland which is viewed as a "Golden Rule" of public finance.

Following Schmitt-Grohé and Uribe [35] and Guo and Lansing [20], a huge literature has focused on the first aspect of this problem considering the impact of balanced-budget rules on the dynamic properties of intertemporal equilibria within infinite-horizon Ramsey models.[6] Considering a constant level of public spending financed through labor income taxation, Schmitt-Grohé and Uribe [35] show that a balanced-budget rule generates a non-linear tax rate which is counter-cyclical with respect to the tax base. As a result, it can be a source of aggregate instability as it may generate a strong volatility of agents' expectations. The intuition is simple and clear: any increase in the expected tax rate implies a reduction in future labor supply and therefore of capital returns. Current investment decreases so that households work less. Facing a decreasing labor income, the government then has to increase the tax rate to maintain the budget balanced and expectations are self-fulfilling.[7] Similarly, Guo and Lansing [20] show that a progressive income tax stabilizes the economy by ruling-out expectations-driven fluctuations generated by productive externalities.

As public debt is not considered, the second aspect of public finance is not discussed in this literature. There are of course a number a contributions dealing with the interplay between debt, capital and dynamics, but the role of the government budget constraint is not directly discussed as constant tax rates are

[6] There is also a recent literature considering collateral constraints that are responsible for growth breaks and growth-reversal episodes, during which countries face abrupt changes in their growth rate that may lead to either growth miracles or growth disasters. See e.g. Boucekkine and Pintus [13].

[7] See also Giannitsarou [17] and Nourry et al. [32] for a similar analysis with a balanced-budget rule based on consumption taxes.

considered.[8] In the paper contained in this special section, Nishimura *et al.* [31] consider a Ramsey model in which a constant level of public spending is financed through debt and distortionary taxation on income and debt earnings. To avoid insolvency of public debt, they assume a debt constraint defined as a constant ratio of debt over GDP.[9] This ratio is considered as a policy parameter fixed by the government. As in Schmitt-Grohé and Uribe [35], the tax rate adjusts at each period to fulfill the intertemporal budget constraint of the government. But now, when a positive level of debt is issued, the endogenous tax rate not only depends on the current tax base but also depends on future income and capital level: if capital and, therefore, income raise at the next period, debt emission can be larger. Hence, current public spending is financed by further debt and a lower tax rate is needed to fulfill the government budget constraint. This means that the tax rate decreases with the next period level of income and capital.

In this special section, Nishimura *et al.* [31] show that such an extended non-linear tax rule can be a source of macroeconomic instability related to self-fulfilling expectations on the future income tax rate. Indeed, if agents expect an increase of the future tax rate, they will invest less, implying a lower income in the future. According to the debt constraint, debt emission should be lower, and therefore the income tax rate has to increase today to satisfy the government intertemporal budget constraint. As they assume that labor is exogenous, the main effect of this fiscal policy goes through the impact of debt on the tax rate and is drastically different from the mechanism identified by Schmitt-Grohé and Uribe [35].[10] Hence, fixing the level of debt over GDP, a government faces a trade-off between volatility and welfare evaluated at the steady state. Reducing this ratio, fluctuations due to the volatility of expectations may be ruled out, but at the cost of a decreased stationary welfare.

Financial frictions, rational bubbles and the interest rate

The burst of the housing bubble in the US has clearly been identified as the starting point of the last financial crisis. Usually, a bubble is defined as the difference between the market price of an asset and its fundamental value, that is, the discounted value of future dividends. It is well-known since Tirole [36, 37] that the existence of bubbles is fully compatible with rational expectations. However, it is now a well-accepted fact that bubbles require the existence of trading constraints or informational restrictions that prevent the agents from shorting the assets with an excessive price. Depending on the model considered, the literature has basically identified three main sources of frictions that may generate bubbles: heterogeneous beliefs, asymmetric information and portfolio

[8] See for instance Futagami *et al.* [16], Greiner [19] , Minea and Villieu [27, 28].

[9] A similar constraint has been considered by Minea and Villieu [28] and Nishimura *et al.* [30].

[10] Since they do not consider public debt, the tax rate depends on current income only and the existence of expectations-driven fluctuations goes through adjustments of the labor supply and requires a sufficiently large Frisch elasticity of labor.

constraints.[11] In the paper contained in this special section, Bidian [9] provides a unified framework for the analysis of bubbles in which these three sources of frictions can be considered simultaneously. In particular, he considers a wide class of portfolio constraints that admits as particular cases borrowing constraints, debt constraints, short sale constraints, margin requirements, ... Being able to consider at the same time all these possible sources of bubbles, Bidian [9] can identify the main driving mechanism at the core of the existence of overvalued assets.

The main conclusion of Bidian's [9] is to prove in a very general framework that the existence of rational bubbles requires agents to have a sufficiently low demand for credits that generates low interest rates.[12] In such configuration, the present value of aggregate endowment becomes infinite allowing the existence of bubbles. On the contrary, when interest rates are high, the present value of aggregate endowment is finite and bubbles to occur must become large with respect to this aggregate endowment. But then under rational expectations inter temporally optimizing agents will not choose a financial wealth that becomes too large with respect to their future consumption, thus ruling out bubbles. Bidian [9] therefore extends the initial result of Santos and Woodford [34] showing the universality of low interest rates for the existence of rational bubbles.[13] He also proves that heterogeneous beliefs and asymmetric information are not crucial ingredients in the mechanism that generates bubbles.

References

[1] Alvarez, F. and U. Jermann (2000), Efficiency, equilibrium, and asset pricing with risk of default, *Econometrica* 68, 775-797.

[2] Becker, R., On the long-run steady state in a simple dynamic model of equilibrium with heterogeneous households, *Quarterly Journal of Economics* 95 (1980) 375-382.

[3] Becker, R., Equilibrium dynamics with many agents, in: R.-A. Dana, C. Le Van, T. Mitra, and K. Nishimura (Eds.), Handbook of Optimal Growth 1, Springer-Verlag, 2006, pp. 385-442.

[4] Becker, R., K. Borissov and R. S. Dubey, Ramsey equilibrium with liberal borrowing, *Journal of Mathematical Economics*, this issue (2015).

[5] Becker, R., S. Bosi, C. Le Van and T. Seegmuller, On existence and bubbles of Ramsey equilibrium with borrowing constraints, *Economic Theory* 58 (2015) 329-353.

[6] Becker, R., R. S. Dubey and T. Mitra, On Ramsey equilibrium: capital ownership pattern and inefficiency, *Economic Theory* 55 (2014) 565-600.

[11] See Miao [26] and Xiong [38] for recent reviews.
[12] Low demand of credit is in this framework a consequence of severe financial frictions.
[13] See also Kocherlakota [22].

[7] Becker, R. and C. Foias, A characterization of Ramsey equilibrium, *Journal of Economic Theory* 41 (1987) 173-184.

[8] Becker, R. and T. Mitra, Efficient Ramsey equilibria, *Macroeconomic Dynamics* 16 (2012) 18-32.

[9] Bidian, F., Portfolio constraints, differences in beliefs and bubbles, *Journal of Mathematical Economics*, this issue (2015).

[10] Bloise, G. and A. Citanna, Uniqueness of competitive equilibrium with solvency constraints under gross-substitution, *Journal of Mathematical Economics*, this issue (2015).

[11] Bloise, G. and P. Reichlin, Asset prices, debt constraints and inefficiency, *Journal of Economic Theory* 146 (2011) 1520-1546.

[12] Borissov, K. and R. S. Dubey, A characterization of Ramsey Equilibrium in a model with limited borrowing, *Journal of Mathematical Economics* 56 (2015) 67-78.

[13] Boucekkine, R. and P. Pintus, Is history a blessing or a curse? International borrowing without commitment, leapfrogging and growth reversals, *Journal of Economic Growth* 17 (2012) 27-47.

[14] Cass, D., On capital overaccumulation in the aggregative neoclassical model of economic growth: A complete characterization, *Journal of Economic Theory* 4 (1972) 200-223.

[15] Dana, R.-A., Existence and uniqueness of equilibria when preferences are additively separable, *Econometrica* 61 (1993) 953-957.

[16] Futagami, K., T. Iwaisako and R. Ohdoi, Debt policy rule, productive government spending, and multiple growth paths, *Macroeconomic Dynamics* 12 (2008) 445-462.

[17] Giannitsarou, C., Balanced budget rules and aggregate instability: the role of consumption taxes, *The Economic Journal* 117 (2007) 1423-1435.

[18] Gottardi, P. and F. Kubler, Dynamic competitive economies with complete markets and collateral constraints, *Review of Economic Studies* 82 (2015) 1119-1153.

[19] Greiner, A., An endogenous growth model with public capital and sustainable government debt, *Japanese Economic Review* 58 (2007) 345-361.

[20] Guo, J.T. and K. Lansing, Indeterminacy and stabilization policy, *Journal of Economic Theory* 82 (1998) 481-490.

[21] Kehoe, T. and D. Levine, Debt-constrained asset markets, *Review of Economic Studies* 60 (1993) 865-888.

[22] Kocherlakota, N. R., Bubbles and constraints on debt accumulation, *Journal of Economic Theory* 57 (1992) 245-256.

[23] Kubler, F. and K. Schmedders, Stationary equilibria in asset-pricing models with incomplete markets and collateral, *Econometrica* 71 (2003) 1767-1795.

[24] Malinvaud, E., Capital accumulation and efficient allocation of resources, *Econometrica* 21 (1953) 233-268.

[25] Martins da Rocha, F., and Y. Valakis, Constrained efficiency without commitment, *Journal of Mathematical Economics*, this issue (2015).

[26] Miao, J., Introduction to economic theory of bubbles, *Journal of Mathematical Economics* 53 (2014) 130-136.

[27] Minea, A. and P. Villieu, Persistent deficit, growth and indeterminacy, *Macroeconomic Dynamics* 16 (2012) 267-283.

[28] Minea, A. and P. Villieu, Debt policy rule, productive government spending, and multiple growth paths: A note, *Macroeconomic Dynamics* 17 (2013) 947-954.

[29] Mitra, T. and G. Sorger, On Ramsey's conjecture, *Journal of Economic Theory* 148 (2013) 1953-1976. 2013.

[30] Nishimura, K., C. Nourry, T. Seegmuller and A. Venditti, On the (de)stabilizing effect of public debt in a Ramsey model with heterogeneous agents, *International Journal of Economic Theory* 11 (2015) 7-24.

[31] Nishimura, K., T. Seegmuller and A. Venditti, Fiscal policy, debt constraint and expectations-driven volatility, *Journal of Mathematical Economics*, this issue (2015).

[32] Nourry, C., T. Seegmuller and A. Venditti, Aggregate instability under balanced-budget consumption taxes: A re-examination, *Journal of Economic Theory* 148 (2013) 1977-2006.

[33] Ramsey, F., A mathematical theory of saving, *Economic Journal* 38 (1928) 543-559.

[34] Santos, M. and M. Woodford, Rational asset pricing bubbles, *Econometrica* 65 (1997) 19-57.

[35] Schmitt-Grohé, S. and M. Uribe, Balanced-budget rules, distortionary taxes, and aggregate instability, *Journal of Political Economy* 105 (1997) 976-1000.

[36] Tirole, J., On the possibility of speculation under rational expectations, *Econometrica* 50 (1982) 1163-1181.

[37] Tirole, J., Asset bubbles and overlapping generations, *Econometrica* 53 (1985) 1071-1100.

[38] Xiong, W., Bubbles, crises, and heterogeneous beliefs, *NBER Working Papers* 18905 (2013) National Bureau of Economic Research, Inc.