On the Macroeconomics of Uncertainty and Incomplete Markets*

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1 Macroeconomics, uncertainty and incomplete markets

1.1 As a full-time academic, I have led a rather even life. Yet, I have engaged in two more venturesome explorations. On my 65th birthday, my wife and I took off in our 42-ft sloop and sailed around the world. Also, I have explored some macroeconomic issues. That second venture proved more hazardous, more demanding and rather less rewarding than the first.

My interest in macroeconomics arose in the late seventies, as the recession lingered on. Over the following decade, I travelled across the spectrum of theoretical, econometric and policy studies.[1] The European policy debate convinced me that the main stumbling block on the road to effective policies came from the shortcomings of macroeconomic theory, in particular, the relative neglect of the demand side. I thus decided to concentrate on theoretical research, an orientation visible in this address, which articulates semi-formally the main themes which have haunted me lately. But I wish to stress at the outset the practical and policy-based motivation behind sometimes abstract theorising.

There is a distinctly European flavour to my concerns. Let me bring out some salient facts. Figure 1 displays the evolution of unemployment and

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[1] Cf. Drèze (1991).

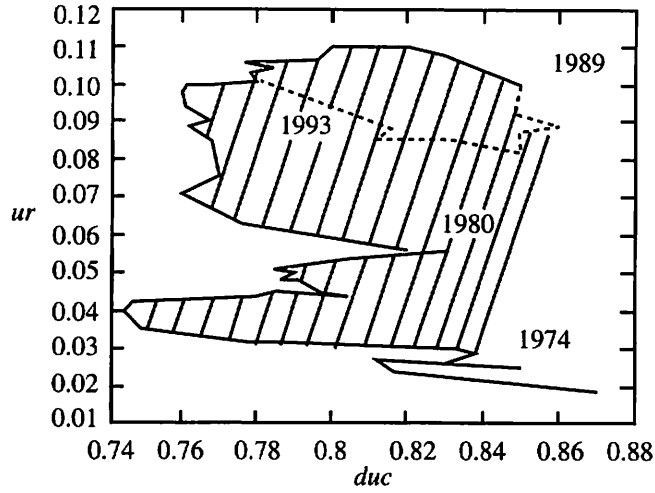

Figure 1 : *Underutiliasation of Productive Factors in the EEC*

	76 – 80	81 – 85	89 – 90	91 – 95
EC12	3.0	1.5	2.9	1.3
US	3.0	2.7	2.5	2.3
Japan	4.4	3.8	4.5	1.4
Belgium	3.0	0.8	3.0	1.4
France	3.1	1.5	3.2	1.1
Italy	4.8	1.6	3.0	2.5
Netherlands	2.6	1.0	3.1	1.8
Spain	2.6	1.0	3.1	1.8
UK	1.8	2.5	3.4	1.2
West Germany	3.3	1.2	3.4	1.9

Table 1 : *GNP Growth Real Average Rates*

capacity utilisation in EC12 over the period 1973-1993. The striped area corresponds to the waste of non-storable resources (labour and capacity) over the period 1974-1989. The idleness of both labour and capital suggests that more output was at hand, if only the idle resources could be mobilised.

Another indication of the waste of resources is provided by output, whose growth rate displays substantial volatility. Table 1 splits the period 1976-95 into sub-periods of 5 years each. For Europe, though not for the US,

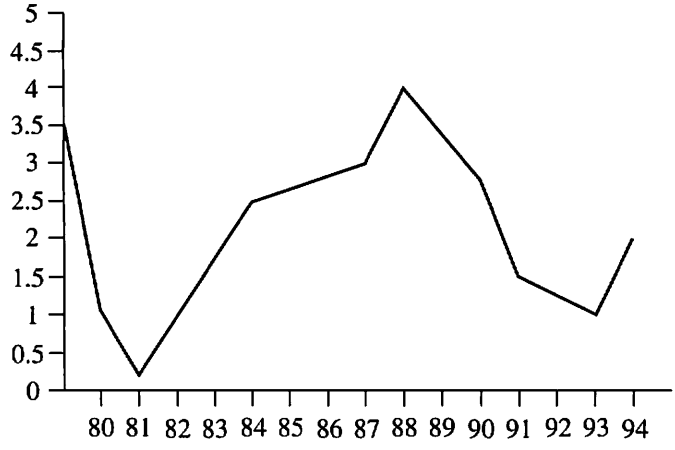

Figure 2a : *Growth Rate of Real GDP, EC12, 1971-1994*

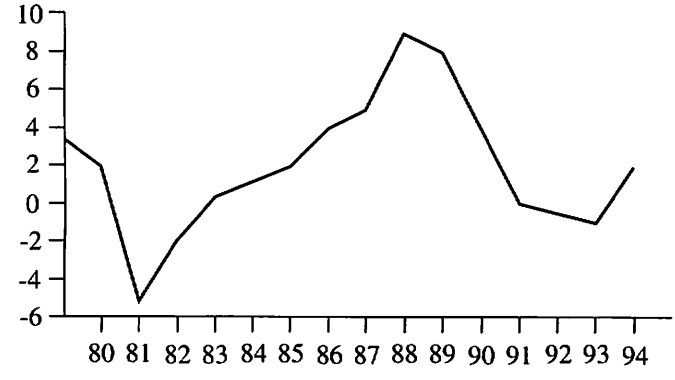

Figure 2b : *Growth Rate of Real Investment, EC12, 1971-1994*

the table reveals differentials of 1.5% among successive averages, i.e. of 7.5% among overall growth for successive sub-periods. Yet 3% annual growth was within reach throughout. Volatility, with persistence of under-activity over several years, is part of the picture to be understood. So is the Europe-US contrast.

Figure 2 brings out the role of investment in that volatility. It displays the growth rates of output and investment in EC12, 1980-94. It confirms the simultaneity of the output and investment cycles[2] and the volatility of investment (the scale of the bottom panel is four times the scale of the upper panel).

[2] Standard correlation .9 in Real Business Cycles calibrations.

1.2 Uncertainty and incomplete markets belong intimately in a realistic treatment of most economic problems. Macroeconomics is no exception.

Uncertainty means that the economic environment tomorrow is not known today. At best, there exists a *set* of alternative, mutually exclusive states of the environment, one and only one of which will materialise. This reflects our uncertainties about fundamentals – like tastes, resources and technology – but also about developments beyond the purely economic sphere : Will Mercosur lead to a monetary union ? Will agreement on pollution charges come about ? Will confidence in the monetary institutions of South East Asia be restored ?

Complete markets is an idealisation under which it is imagined that agents can trade all commodities (goods and services) contingently on future states of the environment. That is, hedging opportunities are unlimited. Instead markets are incomplete when consumers save more, as they did in 1990, but firms do not know whether they intend to retire sooner, to pay more taxes or to consume more. Markets are incomplete when firms do not know how future consumption will be allocated between tourism in Latin America, housing or gadgets. Markets are incomplete when workers do not know on what terms they might find alternative employment, should their firm be downsized. Markets are incomplete when currently inactive or unborn agents are concerned, as with forest management. And so on.

I shall outline two implications of market incompleteness : volatility of demand, especially investment; then wage and price rigidities. These are microeconomic issues, so land is in sight and navigation is easy. Afterwards, I shall turn to macroeconomic considerations. The structure of my presentation is outlined in chart 1.

2 Incomplete markets breed demand volatility

At a point in time, economic agents observe some, but not all, aspects of the economic environment. Their information is asymmetric. Based on what they observe, they hold expectations about future states and associated economic developments. Economists are seldom unanimous, to say the least, so expectations are bound to be multivalued. Information is asymmetric, so expectations are heterogeneous. All this is fully consistent with rationality.

Current observations and expectations determine the market behaviour of agents. Because the information of individual agents is not fully observable, revisions of expectations may be triggered by new information not previously recognised as significant – as when publication of the monthly trade statistics caused a minor panic on Wall Street in November 1987. Such phenomena generate volatility of expectations, hence of market behaviour,

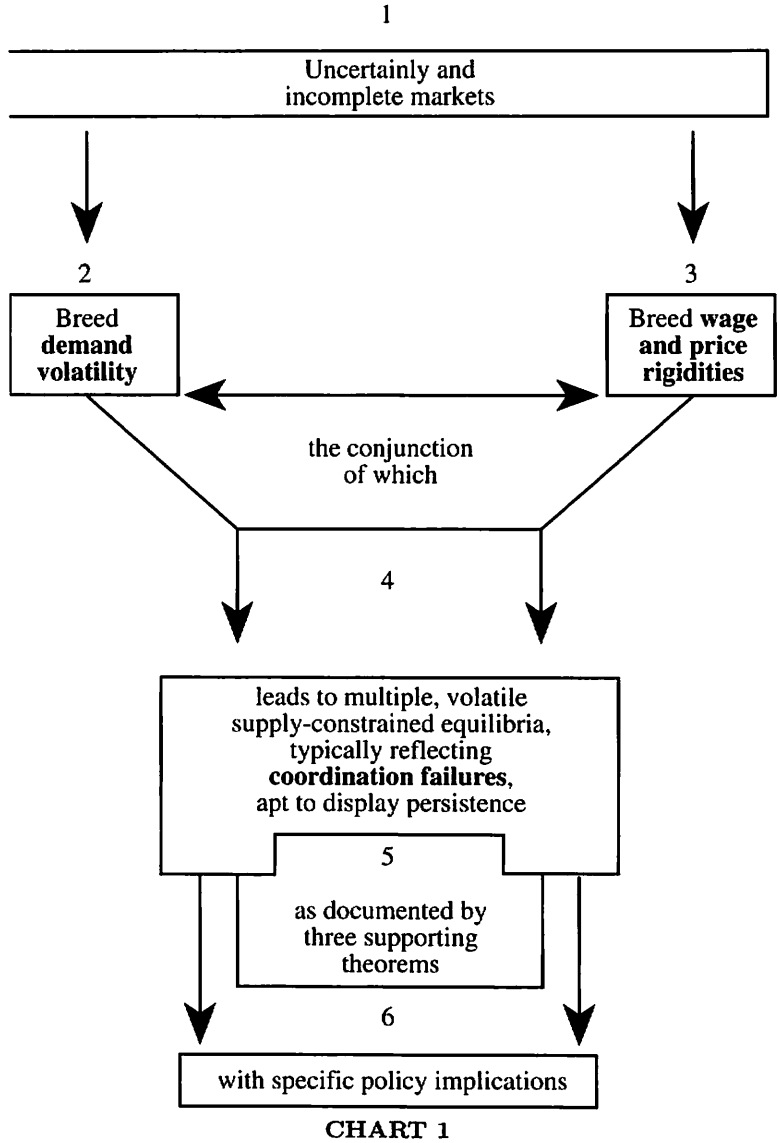

CHART 1

relative to observed data – relative to "fundamentals" some would say[3] .

Let me spell out two specific illustrations of how future uncertainties breed volatility. Uncertainty about future incomes (more variance at unchanged mean) reduces consumption and increases savings, under the generally accepted condition of (endogenously) diminishing absolute risk

[3] I avoid the words "sunspots" and "animal spirits", because the information at stake is genuine, even if its significance is not fully recognised.

aversion; cf. Drèze and Modigliani (1972). A parallel result concerning investment appears in the book of Dixit and Pendyck (1994) on *Investment under Uncertainty*, which extends and integrates several earlier contributions, like Bernanke (1983) or Mac Donald and Siegel (1986). An irreversible investment should be undertaken, not whenever the net present value of the associated profit stream is positive (as often taught), but when that value is higher than the value of an option to carry out the same investment at a later date – possibly with more information. But the option value increases with the uncertainty about future cost or demand conditions. So, greater uncertainty encourages postponement and reduces current investment demand.

Thus, the equilibrium of savings and investment will be upset by a *change in the uncertainty* perceived by economic agents. A fundamental macroeconomic relation is thus recurrently perturbed.

The insistence by Dixit and Pendyck that investments better be timed optimally also implies that a small displacement in time will usually have a second-order effect on utility or profits, at equilibrium. An event entailing a small incentive for households or firms to postpone investment could thus lead to a significant reduction of aggregate investment demand, with macroeconomic consequences of the first order. This is a sort of "menu costs" argument in reverse. It contributes to our understanding of the volatility of investment (as illustrated in figure 2b).

A clear example of increased uncertainty is provided by the Gulf War of 1990. When the conflict erupted, tax payers realised that in some way they would foot a bill, of unknown severity. So, consumption expenditures, especially for durables, were curtailed. Investment, by households as well as business firms, could better be postponed pending more information about how long and costly the war might be. In the US, gross capital formation fell by 9% in 1990-91, while real private consumption deviated from its 3% trend growth and declined some. Unemployment rose by 2 percentage points, at unchanged real wages, with inflation staying on trend.

The foregoing rests on uncertainty, without explicit reference to incomplete markets. The idealisation of complete markets would attenuate both the volatility of market behaviour and its consequences. First, complete markets would bring out the circumstances leading to revisions of behaviour, eliminating surprises and improving common information. Second, contingent markets cleared *ex ante* would permit immediate equilibrium when an event occurs. Otherwise, the adjustment evolves in real time, with temporary disequilibrium along the process. (Of course, the reasoning assumes universal *ex ante* clearing, an idealisation that would be infinitely costly to implement !)

3 Incomplete markets breed wage and price rigidities

3.1 Because weather forecasts span only a few days, risk-averse sailors embarking on long passages base their schedules on statistical regularities, which impose rigidities. When the absence of markets prevents agents from hedging price variations, it may be second-best efficient to limit price variations in the first place[4]. The second-best efficiency defines an optimal trade-off between *ex post* allocative efficiency, which requires price flexibility, and *ex ante* risk-sharing efficiency, which is enhanced by bounded price flexibility, under incomplete markets. The gains in *ex ante* risk-sharing efficiency originate in the fact that, under incomplete markets, the degree of risk aversion varies across agents, often in a systematic way; for instance, it is higher for workers or consumers than for firms. Reconciling the two goals is sometimes possible in the framework of long-term contracts.

A transparent example is provided by mortgage loans, for which standard contracts stipulate a fixed nominal interest rate, not adjusted to future variations of nominal rates. In this way, the borrower is insured against these variations. In principle (i.e. the savings-and-loans disaster in the US notwithstanding), lenders are in a better position to bear the risk of interest rate variations, because they have better access to hedging on financial markets and because their equity is held by investors with diversified portfolios[5].

I may mention in passing that a similar argument applies to country loans. Emerging countries are more sensitive to risk than such lenders as rich countries, multilateral institutions or large banks. The practice in the seventies of issuing loans at variable rates was an inefficient risk-sharing arrangement, which left the borrowers exposed when interest rates skyrocketed in the late seventies and early eighties. There remains scope for corrective action today; see Drèze (1999c).

3.2 How does this reasoning explain wage rigidities in the face of unemployment ? We know from the literature on implicit labour contracts[6] that employment in a firm facing cost or demand uncertainties is efficient provided the marginal value product of labour matches in all states its opportunity cost, which is equal to market wages under full employment, to reservation wages otherwise. The spread between the two can be substantial, like 40

[4] This was also the motivation behind my early work on equilibria with price rigidities, Drèze (1975).

[5] More recently, a variety of contracts, differing as to initial rates and scope for future revisions, have been offered. Borrowers are free to choose their preferred combination of expected rates and variability of future rates, on the basis of their own constraints and risk aversion. This enhances overall market efficiency. Note that it all happens in the framework of long-term contracts.

[6] See Azariadis (1975), Baily (1974), Gordon (1974), the informal introduction in Drèze (1979) or the survey by Rosen (1985); individual labour contracts are introduced in Drèze (1989a) and general equilibrium with incomplete markets and labour contracts is treated in Drèze (1989).

to 50%[7]. Instead, wages should fluctuate less than marginal value products, to provide income insurance to risk-averse workers. If the firm were risk neutral, wages should be constant across macroeconomic fluctuations. This is the same idea as fixed nominal rates in mortgage contracts. But many workers are not covered by long-term contracts. Some are employed under temporary contracts. Some will enter the market tomorrow (as in the case of today's students) or re-enter it (as in the case of workers temporarily withdrawn from work or threatened with dismissal). These workers-to-be bear the uncertainties surrounding future labour-market conditions[8].

In states unfavourable to labour, market clearing tomorrow might call for wages falling to reservation levels and "voluntary" unemployment. In other states, competitive wages might result in low profitability or inflationary pressures. Containing wage flexibility through downward rigidity in low-wage states and incremental labour or income taxes in states more favourable to labour, enhances risk-sharing efficiency for prospective job seekers.

The argument for second-best wage rigidities cum unemployment benefits is spelled out in Drèze and Gollier (1993)[9]. It provides an explanation of downward real-wage rigidities complementary to other theories, like efficiency wages, union bargaining or insider power, but more sharply focussed on macroeconomics fluctuations[10].

In practice, downward wage rigidity at the low end of the scale is implemented through unemployment benefits and minimum wages, which are themselves downward rigid, either in nominal terms (in the US) or in real terms (in Europe). These legalise a form of social consensus, often seen as redistributive, but also interpretable as a form of *ex ante* insurance[11]. Higher in the scale, downward wage rigidity for new recruits inherits whatever rigidity prevails for workers under contract, because wage discrimination by hiring date (two-tier contracts) is notoriously unpopular and seldom practised[12]. The implicit-contracts argument thus operates indirectly also for new recruits[13].

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7 Granting that the disutility of being unemployed typically exceeds the disutility of working, unemployment benefits provide an approximate measure of reservation wages.

8 We hardly ever see future or contingent labour contracts (whereby for instance a first-year law student signs up with a Brussels law firm four years ahead contingently on graduating and not marrying a foreigner...).

9 See also Bean (1984).

10 Efficiency wage theories argue that wages may not adjust to changes in labour supply, but leave them free to adjust to other circumstances. Insiders are assumed insensitive to unemployment. Instead, unions are assumed concerned with the unemployed as well; see Oswald (1985) or Pencavel (1985).

11 See Drèze (1999a).

12 This is in violation of second-best efficiency; see Drèze and Gollier (1993, section 4). On the rationale for absence of wage discrimination, see Bewley (1998), Drèze (1986, section 2.3.3) or the "hiring scenario" of the insiders-outsiders theory, e.g. Lindbeck and Snower (1988) or Lindbeck (1993, p.41).

13 The incremental labour or income taxes recommended by the second-best analysis in states particularly favourable to labour are seldom implemented. This feature need not detain us, as my interest focuses on downward rigidities.

3.3 Regarding downward price rigidity in the face of unused capacity, there is an argument to which I assign significance, even though my analytical work on this topic is still in progress. The standard explanation of this phenomenon is imperfect competition, see, e.g. Bénsassy (1995). (More on this below.) An alternative, or complementary explanation relates to incomplete markets. Excess capacity means capacity, hence prior investment, hence fixed costs and more often than not, debt service. Fixed costs and debt service must be covered under all states of the environment, if the firm is to survive. And firm survival matters, due to the costs of bankruptcies and reorganisations. Under complete markets, it would suffice to cover fixed costs on average : profits could be transferred *ex ante* from good states to bad states through financial transactions. It would then be possible to price at marginal cost in all states : the profits earned when operating at full capacity could be used to cover fixed charges in all states (through contingent transfers). This is the stochastic analogue of peak-load pricing : prices equal to marginal costs at all times, fixed costs covered entirely from the mark-up at peak times.

Under incomplete markets, it is *not* possible to transfer profits freely across alternative states, so fixed charges must be covered *in each state* from the receipts in *that* state. Hence prices in each state must exceed marginal cost by a mark-up sufficient to cover fixed charges[14]. Broadly speaking, this means average cost pricing, hence downward price rigidity below capacity[15].

Adding imperfect competition, I record that firms setting prices so as to equate marginal costs and marginal revenues are often uncertain about the price elasticity of the demand for their products. Greenwald and Stiglitz (1989) argue that price adjustments may be riskier than output adjustments. Under any kind of menu costs leading to finite price adjustments, uncertainty about the demand elasticity leads risk-averse firms to behave as if they faced a kinked demand curve; see Drèze (1979a). This feature is interpretable as an incomplete markets phenomenon[16]. It provides an additional rationale for demand kinks, distinct from the traditional argument in terms of reactions by competitors (Sweezy, 1939) and from the search-theoretic argument developed by Stiglitz (1984). The kink leads directly to price rigidity.

An important side implication of average-cost pricing – whether due to constant returns or to fixed costs – concerns the reaction of output and employment to demand shocks. Under diminishing returns and market clearing output prices, demand shocks affect the price level at unchanged output and employment under rigid real wages, but affect output and employment under rigid nominal wages; see Grandmont (1989). Under average-cost pri-

[14] For instance, Hall (1987) reports mark-ups of 50% in more than half the industries he studies, and Bils (1987) concludes that mark-ups are "very countercyclical".

[15] Technically, incomplete markets turn an *ex ante* convex technology into an *ex post* non-convex one – with well-known associated difficulties. The rationale for average-cost pricing under fixed costs in competitive environments is presented in Dehez and Drèze (1988).

[16] Firms cannot quote prices contingent on demand *elasticity*, which is not observable.

cing with non-increasing average cost, demand shocks affect output and employment in both cases. The mix of firms operating under diminishing returns on the one hand, constant or increasing returns on the other hand, is thus relevant to the operating characteristics of real economies. There are always some quantity effects when the latter firms matter, as they do in reality.

4 From volatility and rigidities to coordination failures

4.1 With experienced sailors, serious mishaps result only from the conjunction of several problems – like a dragging anchor compounded by a wind shift near a lee shore. I wish to bring together wage-price rigidities and aggregate-demand volatility, expecting some mishaps from the conjunction. My task will be more conveniently carried out after a digression, which provisionally ignores the price rigidities.

With incomplete markets, an economy goes through a sequence of temporary equilibria, in the terminology of Hicks (1936) and Grandmont (1974, 1977, 1982, 1988). At a point in time, economic agents make some idiosyncratic observations, hold expectations about future states of the economy and define accordingly their supply or demand schedules for trading on spot markets. Spot markets concern contemporaneous goods and services, and assets; they are complemented by a few markets for futures and options on the same.

The supplies and demands of individual agents are brought into agreement through some adjustment process. Hopefully, an equilibrium exists and is obtained as rest point of a stable adjustment process.

When new information arrives, individual expectations are revised. Spot markets are reopened. The adjustment process starts over, and a new temporary equilibrium is reached. The path followed by the economy through time is a sequence of temporary equilibria; see Grandmont (1982, 1988) for a survey of properties.

There is one idealised case where the sequence is always well defined and Pareto efficient. It is a special case of what Radner (1972) calls "equilibrium of plans, prices and price expectations in a sequence of markets". Two very strong assumptions are needed, sequentially complete markets and perfect foresight. The first assumption (not used by Radner) states that, although markets are incomplete, they permit agents at any date to transfer wealth across all the events at the following date; that is, markets are "one-period ahead complete", and will be so again in the future. The second assumption (used by Radner) asserts that, at any point in time, price expectations for all markets to be opened in the future are single valued,

common to all agents, and such that the transactions planned by the agents will clear these markets[17].

Under these very strong assumptions, the sequence of temporary equilibria implements an equilibrium with complete markets. Hence, Arrow-Debreu existence theorems carry over, as do stability theorems for Walrasian tâtonnement. But the coordination of plans and price expectations in the absence of markets is a dark mystery, even darkened by the possibility of multiple equilibria[18]. Yet , for all I can tell, this is also the model underlying "new classical macroeconomics".

Relaxing somewhat my two precious assumptions can open the door to multiple sequences of equilibria. As stressed by Keynes, all agents hold expectations about each-other's expectations, now and later. There results an interdependence conducive to multiple, equally consistent equilibria : formal examples are easy to construct. Today, other sources of multiplicity are being discovered left and right. Some are surveyed in a classic paper by Cooper and John (1988), stressing strategic complementaries and spill-overs. A standard source is monopolistic competition; see Dixon and Rankin (1995). Woodford (1991) derives multiplicity from kinked demand curves. A parallel literature studies multiple paths, chaos and endogenous cycles in aggregated dynamic models; see Benhabib and Farmer (1997).

It is common practice in that literature to associate multiplicity with "self-fulfilling expectations" : when there exist multiple equilibria, it is enough that all agents expect one of them to come about, and their expectations will be realised. Again, the coordination of expectations without markets is a dark mystery.

When equilibria are multiple but some are in a sense better than others, the possibility of a coordination failure arises. An inferior equilibrium may obtain, that could only give way to a superior one through a coordinated modification of the plans, or expectations, of some or all agents. A clear-cut concept of "better" is Pareto ranking, which requires special assumptions; macroeconomists are usually satisfied with ranking of such aggregates as output or employment[19].

So, by coordination failure I refer to equilibria for which there exist superior feasible alternatives. A stronger concept refers to existence of a superior alternative implementable through a well-defined feasible policy.

4.2 Sailors often follow roundabout courses, like going from Panama to San-Francisco by way of Hawaii. My digression places me in a position to sail downwind through the core argument of this address. I will extend

[17] Because Radner (1972) does not assume sequentially complete markets, he only obtains existence of a "pseudo equilibrium" which need not be Pareto efficient; see also Radner (1982, section 5.4).

[18] See Hahn (1999), Chichilnisky (1999a) or Drèze (1999b, section 6 and appendix).

[19] The presumption is that such aggregates could be translated into Pareto ranking through suitable transfers; but suitable transfers are not always identified, seldom implementable and never fully implemented.

step by step the reasoning of my digression to price rigidities and supply constraints[20].

I start again from asymmetrically informed agents addressing to the market supply and demand schedules reflecting their expectations. The equilibrium concept and adjustment process are no longer Walrasian tâtonnement, as some prices are, say downward rigid. When a price is downward rigid, quantity constraints come in to ration excess supply – workers are unemployed or capacities unused. Following van der Laan (1982, 1984), I define a "supply-constrained equilibrium" by :

- a vector of prices for all commodities, consistent with *a priori* given bounds on some prices
- a set of vectors of quantity constraints, one for each agent[21], limiting the supply of commodities with downward-rigid prices
- a set of optimising choices by all agents, compatible with these signals, such that all markets clear[22].

Hopefully again, such an equilibrium exists and can be obtained as rest point of a stable adjustment process. My first and third theorems below address these two issues.

As new information arrives, the process restarts, taking the economy through a sequence of supply-constrained equilibria, that is of temporary equilibria with supply rationing.

Individual agents rationally anticipate such a sequence, so their expectations concern quantity constraints on par with prices. The expectations are idiosyncratic, if only because the constraints are idiosyncratic.

In the idealised model, existence and stability followed from Walrasian theory. I extend these results to price rigidities and idiosyncratic expectations of quantity constraints in three theorems. Now, incomplete markets introduce conceptual and technical complications, like defining decision criteria for business firms or using degree theory to prove existence. To avoid these, I retain provisionally the repugnant assumptions of sequentially complete markets and perfect price foresight. But I use these assumptions to establish the existence of multiple equilibria and coordination failures *even in that idealised case*; thus not at all to conclude that an equilibrium is an optimum. It is my conjecture, backed by one elementary example, that a formal treatment of incomplete markets and imperfect foresight will reinforce my conclusions[23]. What I offer today is barely sufficient to bring out some specific implications of uncertainty and incomplete markets for macroeconomics – barely sufficient, like when you sneak into the lagoon of a Polynesian atoll with half-a-foot clearance under your keel.

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20 The seminal paper on this topic is Grandmont and Laroque (1976).

21 You may be unemployed whereas your neighbour is not.

22 Technically, van der Laan also imposes that at least one (unspecified) commodity be free from quantity constraints; the property holds trivially when at least one commodity is free from price rigidity.

23 See footnote 30.

The next step in my digression was to consider multiple sequences of temporary equilibria, and coordination failures. Supply-constrained equilibria are natural candidates for coordination failures, due to the aggregate demand externality. Relaxation of the constraints on some commodity leads through income effects to relax the constraints on other commodities. As a firm hires more workers, the demand for output increases somewhere, leading to more hirings, and conversely. A multiplier operates. My second theorem asserts existence of a continuum of supply-constrained equilibria, sometimes Pareto ranked, hence of coordination failures.

These equilibria are associated with alternative levels of supply constraints inherited from the past or expected to prevail in the future. The selection of a specific equilibrium depends in particular upon the unobserved state of information of the agents. Regarding tomorrow's equilibrium, multiplicity and volatility are two sides of the same coin. When resources are underutilised, there typically exist other equilibria at less restrictive levels of current and future constraints but still compatible with the fundamentals of the economy (physical assets and technology, demand and supply behaviour) and with the price rigidities. In such a case, there is a coordination failure, and the issue of devising a corrective policy arises. The policy might aim at lifting today's constraints or at raising expectations about to morrow's constraints. Multiplicity says that feasible alternatives exist – neither more nor less.

This is my own interpretation of the flourishing literature on multiple equilibria, sunspots, animal spirits, self-fulfilling expectations, endogenous business cycles and the like, to which I am adding a chapter on incomplete markets and price rigidities.

The link from volatility to underutilisation of resources and persistence has a static and a dynamic aspect. First, availability of inputs sets an upper limit to output, but there is no lower limit, so that volatility manifests itself as underutilisation (or else as inflationary pressure). Once the underutilisation is there, it will persist as a coordination failure until conditions change. Second, underutilisation is apt to *generate* persistence, for three identifiable reasons: lower activity today reinforces the expectation of low activity tomorrow; low investment today contracts supply possibilities tomorrow; low activity today influences adversely financial positions tomorrow[24].

The picture is thus complete, and may be summarised as follows:

Given that some prices are downward rigid, we observe supply-constrained equilibria, where the extent of rationing is linked to history (path dependency) and to idiosyncratic unobserved expectations about future quantity constraints. These equilibria and associated expectations are multiple and volatile. They typically reflect coordination failures, and they are subject to persistence.

[24] This in particular hardens tomorrow's price rigidities, as suggested under 3.2 above.

This is not the alpha and omega of macroeconomics. It is a tentative presentation of an intriguing and probably useful emerging chapter. My analytical results require extension and generalisation. The feedback's, whereby potential coordination failures exacerbate volatility and rigidities, deserves explicit analysis. My treatment undoubtedly neglects many macroeconomic implications of uncertainty and incomplete markets that others will bring out. Also, it badly needs extension to expectation formation and learning.

5 Three theorems

5.1 On ocean passages, no landmarks are in sight, and sailors rely on celestial or satellite navigation. They share faith in abstract calculations with mathematical economists.

My core argument is backed by three theorems. Two bear on existence, the third bears on dynamic adjustment. They are proved for real economies extending over time under uncertainty and defined by the same primitives as in Arrow-Debreu. The real nature of the model is an obvious limitation, given my interest in nominal as well as real rigidities. I have satisfied myself that all three theorems extend naturally to suitably defined monetary economies[25], as confirmed by research in progress with Jean-Jacques Herings. Otherwise, the framework is general and flexible.

My distinctive modelling assumption is an *a priori* given partition of commodities into two groups. Commodities in group I have flexible prices, their supplies or demands are never subject to quantity rationing. Commodities in group II have fixed prices in the existence theorems, downward rigid prices in the stability theorem[26].

Think about group II as including labour services, in particular unskilled labour, and goods which are produced from facilities entailing fixed costs. Think about the latter prices as equal to marginal cost plus a mark-up. The mark-up is precisely the price of the input "capacity". Thus, the price rigidities concern non-storable inputs, for which recurrent underutilisation is empirically documented. The exogenous partition and bounds on prices are not a fully general specification, but one that has proved usefully tractable.

The equilibrium concept is always the supply-constrained equilibrium, as defined above.

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[25] Suitably defined: there is lack of unanimous agreement about modeling money in general equilibrium; I favour the approach developed in Drèze and Polemarchakis (1998, 1999).

[26] I am satisfied that existence holds under downward rigidities, as confirmed by research in progress with Jean-Jacques Herings.

5.2 Now for the first theorem. Take as given the partition into group I and group II commodities, with group I non-empty; and take as given the prices of group II commodities, positive but arbitrary. Consider then an exogenous set of supply-constraints for the group II commodities, i.e. one vector for each agent. Again these vectors are strictly positive, but otherwise arbitrary.

Theorem 1 : Under standard assumptions, there exists a supply-constrained equilibrium, with the group II prices as given, and with supply constraints for group II commodities at least as severe as stipulated by the exogenous vectors[27].

Think about these exogenous vectors as representing constraints inherited from the past or expected in the future. There always exists a supply-constrained equilibrium where these constraints, whatever they may be, are validated, possibly with room to spare. The result holds if the rigid prices are compatible with a competitive equilibrium and again if they are not. In either case, markets for flex-price commodities clear through prices. Nothing is said by the theorem about how the flexible prices adjust to the supply rationing - but they do[28].

The generality of the result may surprise. Let me guide your intuition. The challenge, in the fix-price case, is to eliminate excess demand for those commodities whose prices might be too low relative to other fixed prices. Income effects see to that. Real incomes can be depressed both by constraining the supply of other group II commodities or by adjusting the prices of group I commodities. After all, that is also the logic of fighting demand-pull inflation through tight fiscal policies or high interest rates. Tightening the income constraints generates the supply constrained equilibria, with a multiplier process at work[29].

Supply-constrained equilibria are thus pervasive. That does not make them arbitrary. Demand is never constrained, so that all the standard equilibrium conditions associated with the demand side are satisfied. Broadly speaking, the supply constraints affect the levels of incomes and income expectations of households, the levels of demand and demand expectations of firms. In an aggregated macro-model, which ignores micro-level substitutions or complementarities, there is a one-dimensional continuum of equilibria, indexed by the perceived aggregate wealth of the households, a macroeconomic determinant of aggregate demand and activity[30].

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27 This is theorem 3.2 in Drèze (1997), building upon Dehez and Drèze (1984).

28 For instance you would expect lower real-estate values in regions of high unemployment.

29 Technically, the fixed prices of some number n of fix-price commodities freezes $n - 1$ relative prices; but the specification allows for n quantity constraints, leaving one degree of freedom towards accommodating the exogenous supply constraints. That degree of freedom corresponds to the relative price of group I and group II commodities.

30 In a two-period model with S states and J $<$ S assets, there is an (S-J+1)-dimensional continuum of equilibria, revealing that indeterminacy increases directly with the degree of market incompleteness (S − J).

5.3 The first theorem does not establish multiplicity[31]. Additional assumptions see to that. Thus theorem 3.1 (ii) in Herings and Drèze (1998) reads as follows[32] :

Theorem 2.1 : Under standard assumptions plus differentiability of the supply and demand functions of individual agents, there exists a connected set (i.e. continuum) *of different supply-constrained equilibria* – except for a null set of initial endowments (i.e. generically in initial endowments)[33].

Actually, when the rigid prices are compatible with a competitive equilibrium, a stronger result follows from an assumption of extended substitutability, i.e. the net demand for any commodity does not increase when the prices and/or supply possibilities of other commodities are decreased[34]. The stronger result is :

Theorem 2.2 : Under standard assumptions plus differentiability and extended substitutability, when the fixed prices for group II commodities are compatible with a competitive equilibrium, there exists a continuum of supply-constrained equilibria, ranging from the competitive equilibrium to arbitrarily small supply of the fix-price commodities[35].

The conclusion entails Pareto-ranked equilibria, i.e. coordination failures. When the rigid prices are incompatible with a competitive equilibrium, the continuum of equilibria is still there; but the Pareto reference is lacking, pending further research.

5.4 There remains to explain how supply-constrained equilibria come about. When new information arrives, an economy does not find itself automatically at a supply-constrained equilibrium. Some adjustment process, bringing about orderly rationing of supplies and no rationing of demands, is necessary to that end. I now describe such a process, thereby completing the picture sketched so far. It is an extension to downward price rigidities and supply rationing of the Walrasian tâtonnement process, which operates through prices alone. A significant first result is reported in Drèze (1999), following the earlier contribution in Drèze (1991a), also extended in Herings

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[31] Jean-Jacques Herings and I (see the appendix of Drèze (1997) and section 4 of Herings and Drèze (1998)) have produced examples where the rigid prices are compatible with competitive equilibria, yet all supply-constrained equilibria constrain to zero the supply of the fix-price commodities. (One worker is sick, or one machine breaks, and the whole manufacturing sector comes to a standstill !) These examples are extreme, but they proved helpful in identifying sufficient conditions for a more realistic structure of equilibria.

[32] The proof relies on a fixed-point theorem due to Felix Browder (not Brouwer !) (1960) published in *Summae Brassiliensis Matematicae* and extended to correspondences by Mas-Colell (1974).

[33] If there is a hidden rock in the middle of a bay, generically you can sail anywhere – but prudent sailors do not. Unlike that case, the genericity in theorem 2.1 is innocuous.

[34] This is equivalent to gross substitutability plus non-inferiority.

[35] This is theorem 3.1 (iii) in Herings and Drèze (1998). A similar result, proved by John Roberts (1987, 1988) for the special case of homothetic consumer preferences and constant-returns production, provided the inspiration for Drèze (1997).

et al. (1999). It is in the spirit of the existence theorem stated above, which it complements naturally, though with a less general specification.

There are again two groups of commodities, group I with flexible prices and group II with prices downward rigid *along the process* (thus, lower bounds are defined sequentially). My published paper concerns a real exchange economy, where resources are supplied inelastically to the market (they cannot be consumed directly, as with specialised labour and capacities). But the extension to production and elastic supply of resources should prove straightforward[36].

Participants in the exchange receive two kinds of signals : prices for all commodities, and quantity constraints on the supply of groups II commodities[37]. The process starts from arbitrary vectors of prices and supply constraints, say inherited from yesterday's allocation and today's revised expectations; these signals define the constrained budget sets of the agents. These agents express effective demands, the aggregation of which defines market excess demands. Prices of group I commodities adjust up or down, proportionately to excess demands, as under Walrasian tâtonnement. Supply constraints for group II commodities adjust up or down, proportionately to excess demands. These constraints are bounded below by zero and above by unconstrained supply. In case of excess demand at unconstrained supply, prices of group II commodities adjust upward. That is, prices of group II commodities are not raised until all possible quantity adjustments have been performed. This reflects the idea that "quantities move faster than prices", as suggested by Keynes (1936) and Leijonhufvud (1968).

These adjustment rules for the signals, and the reactions of the agents expressing the effective demands corresponding to the prevailing signals, define together a tâtonnement process in continuous time[38].

Theorem 3 : Under standard assumptions, plus differentiability and extended substitutability, the process is quasi stable, i.e. any limit point of a trajectory is a rest point of the process; and every limit point of a trajectory is a supply-constrained equilibrium.

This is theorem 4.1 in Drèze (1999). It provides a simple answer to the question : how do supply-constrained equilibria come about – for instance after a (positive or negative) shock to expectations ? Answer : through progressive adjustments of prices and quantities, as stipulated by the process.

It helps intuition to visualise how the process operates in an economy with given labour supply and productive capacities. Firms hire or fire labour as needed to satisfy effective demand. At full use of capacities, prices (i.e.

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[36] The result also holds in a monetary economy, with a mixture of real and nominal downward rigidities.

[37] The paper is written for the case of proportional rationing, germane to inelastic supply, but the result should hold for any allocation of the constraints among the agents defined by Lipschitz-continuous functions; see also Drèze (1991a) for a very general, discrete specification.

[38] The process is defined by a system of differenntial equations with discontinuous right-hand sides; appropriate techniques are described in Champsaur *et al.* (1977); the complications associated with discontinuities led me to analyse first the special case of fixed supplies.

mark-ups) are raised as needed to choke off excess demands. Similarly, wages are raised for types of labour in excess demand. All along, the markets for goods and services with flexible prices are progressively brought to clear through prices.

One advantage of this dynamic model over the static one underlying the existence theorems is that the initial quantity constraints for some goods are raised along the adjustment. That is, initially pessimistic expectations can be revised upward in the light of market observations. The multiplier process works up and down – though with an asymmetry : it can be stronger downward than upward, but never the other way around.

6 Landfall : some policy conclusions

Landfall after an ocean crossing is always exciting, relieving, and conducive to reflect upon the lessons of the passage. I draw three lessons from this lecture :

(i) we should take coordination failures seriously; (ii) we should try to obviate demand volatility; (iii) we should try to by-pass wage-price rigidities.

6.1 First, *we should at all times be aware of the possibility of underutilisation of resources*, labour and production capacities, *reflecting coordination failures,* sustained by price rigidities, as distinct from incorrect prices. This is where I depart from the work of the seventies, centred on price distortions. We tend to think about real rigidities as keeping prices and wages at levels inconsistent with attainment of a first-best allocation, mostly due to market power. The consequences of these distortions are then viewed as proportional to the distance at which prices stand from market-clearing levels, and to elasticities of supply and/or demand. Under coordination failures, the price distortion may be modest – in the limit inexistent – yet the inefficiencies sustained by the rigid prices may be substantial, according to the theorems. *Coordination problems magnify the consequences of price rigidities.*

The possibility of coordination failure is always there. It may not be easy to detect, as the underutilisation may be partly or wholly due to other causes, including wrong prices, including also the need to adjust progressively to major shocks like oil price hikes, a war, a major political transition or a currency crisis. There is thus an identification problem, of which again we should be aware, and we should rely on econometric models detailed enough to recognise that problem and progress toward it resolution. I note with interest that some recent macroeconometric work by Henri Sneessens and his associates[39] concludes to multiple equilibria and path dependency, suggesting an empirical extension of the theory.

[39] Cf. Lubrano *et al.* (1996), Shadman-Mehta and Sneesens (1997).

The dual of the identification problem is that we cannot infer from the observation of unemployment or excess capacities that prices are wrong. More worries for econometricians and policy makers.

6.2 Second, my coordination failures operate through the aggregate demand externality. So, *we should at all times be aware of the importance of the demand side* – a timely warning to European theorists and policy makers. Let me at once dispel a possible misconception. There is no immediate link from the recognition of the aggregate-demand externality to Keynesian fiscal or monetary stimulation. The nagging problem with coordination failures is their potential recurrence. If overcome today, they may reappear tomorrow, should expectations so dictate. Debt financed fiscal stimulation may need to be repeated ever and ever again, leading to unsustainable debt accumulation. As for monetary stimulation, interest rates may be right at a coordination failure. And there is a natural limit to successive reductions of nominal interest rates, namely zero; beyond that limit, expected inflation must take over to sustain negative real rates; current endearment with price stability does not favour that route. In coping with demand volatility, *the challenge is to define repeatedly sustainable policies*, the only policies apt to maintain longer run expectations at levels compatible with full employment today. This much we have learned definitively from the rational-expectations revolution.

The recurring threat of coordination failures suggests attempting to maintain continuously a slight demand pressure, while forestalling inflationary tendencies through a dynamic supply response[40]. Returning to a question raised at the outset, I have wondered whether the recent US performance might be due, in part, to greater immunity from coordination failures, due precisely to the demand pressure resulting from a low savings rate, permitted by the current account deficit, and accompanied with low inflation pressure, permitted by the stagnation of real wages. European economies in contrast might be more exposed to coordination failures, due no doubt to more entrenched rigidities, also due to the uncertainties surrounding European integration. You cannot possibly pursue a project of such ambition without creating institutional uncertainties – but you should attempt to minimise these. There is a lesson here for Mercosur.

One natural way of guaranteeing that demand-stimulation policies are sustainable is to concentrate them on investments with adequate social returns – not on digging holes and filling them again! The challenge is to identify investment projects that remain justified across the vagaries of private investment and its timing. Six years ago, a group of French and Belgian economists, convened by Edmond Malinvaud and myself[41], outli-

[40] This was the parting theme of my late friend William Vickrey (1993), and I am pleased to help keep his concern alive.

[41] Cf. Drèze and Malinvaud *et al.* (1994).

ned a "European initiative for growth and employment" in which we advocated additional investments in low-income housing, urban renewal, urban transportation and trans-European networks of transportation and communication. These seem to meet precisely the requirement of positive long-run social returns, little affected by short-run information flows[42]. Promoting these at times when other private investments are temporarily curtailed is an effective way of coping with volatility and even with persistent deficiency of aggregate demand. An operational proposal for housing is detailed in Drèze, Durré and Sneessens (1998). But the full long-run implications of the proposal remain to be investigated.

6.3 Third, I have established a solid *link between price-wage rigidities and coordination failures*, within a very general model and without special assumptions other than the obvious market incompleteness.

We must ask ourselves whether and how flexibility contributes to overcome coordination failures. Stiglitz (1999) argues that abrupt changes in relative prices, especially wages, have been destabilising during the recent East-Asia crisis. Drèze (1997) contains simple RBC-type examples where wage flexibility has no effect on employment, and my discussion there leads to the conclusion: "I thus see three cogent reasons why organised labour would resist the idea of fighting coordination-failure unemployment through wage flexibility:

(i) uncertain effectiveness, *specific* to the context of coordination failures;

(ii) inefficient risk sharing, *compounded* by the volatility of employment associated with coordination failures;

(iii) adverse redistributive transfers, *compounded* by the potential recurrence of coordination failures."

I have adduced above specific reasons why incomplete markets breed rigidities. We should address these reasons squarely. To begin with wages, the objective is to retain the merits of bounded flexibility of net earnings for *ex ante* risk-sharing efficiency, while restoring flexibility of wage costs to firms. This can in principle be attempted by adjusting to circumstances the substantial wedge (40% or more) between net earnings and wage costs. Labour taxes, mainly social insurance contributions, could vary in function of the level of unemployment – with low contributions when unemployment is high and conversely. See Drèze (1993) for a specific proposal. An altogether different alternative, equally worthy of attention, would proceed through a basic income obviating the need for downward wage rigidity; see e.g. Atkinson (1995)[43].

Regarding prices, I have stressed the problem of maintaining firm solvency in the face of unfavourable demand conditions when fixed charges are

[42] In particular, megacities raise problems that will be with us for many years.

[43] This link with macroeconomic stability should inspire the advocates of basic income...

substantial – leading to some kind of average-cost pricing, whereas efficiency would call for marginal-cost pricing. Cyclically adjusted labour taxes would reduce labour costs in recessions, hence contribute to downward price flexibility there. I have also wondered whether more efficient financial arrangements could increase price flexibility, a theme already explored inventively by Greeenwald and Stiglitz (1990, 1993) and authors concerned with the credit channel of monetary transmission.

Equity financing does not impose debt service in all states. Thus, promoting access to equity financing by small and median firms should be on the agenda. But equity financing raises the issue of control, and carries a puzzling equity premium. New forms of bonds could be devised, namely cyclically indexed bonds which call for lower repayments under unfavourable macroeconomic conditions, against higher repayments when they are favourable[44]. Creating assets indexed on macroeconomic aggregates, as advocated on independent grounds by Shiller (1993) or Drèze (1999a, section 5), could yield the unexpected dividend of facilitating marginal cost pricing[45].

There is thus scope for targeted policy intervention both on the demand volatility front and on the wage-price rigidities front. What is more, there is scope for operating on both fronts simultaneously. In the "European initiative" proposal referred to above, we advocated targeted investments, and we advocated promoting these through temporary, countercyclical labour-tax cuts. We were thus outlining precisely the combination of policies which emerges from my discussion today. With six years of hindsight, I marvel at how closely a collective policy proposal could anticipate the conclusions of theoretical research still in the making. I now realise that the research outlined here was not only motivated by policy issues, as announced at the outset. It was also inspired by the policy discussions. This illustrates the benefits from interaction between policy concerns and theoretical research. I regard that interaction as crucial for the long-term program of integrating micro- and macroeconomics into a unified discipline.

[44] In Belgium, some mortgage contracts stipulate postponement of repayments of the principal if the borrower becomes unemployed, and loans indexed on the gross operating surplus of not-for-profit firms are being considered.

[45] Translating that idea to the firm level no doubt raises issues of moral hazard and observability. Similar difficulties would arise if loans were indexed on prices charged by firms – an otherwise attractive idea, since it would be equivalent, for pricing purposes, to blowing up demand elasticities.

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