Review of Austrian Economics (2023) 36:43–60
https://doi.org/10.1007/s11138-020-00538-1

Business cycles and the internal dynamics of firms

Kushal K. Reddy[1] **· Vipin P. Veetil**[2]

Accepted: 13 December 2020 / Published online: 11 January 2021

Abstract
Most business cycle theories originate from a paradigmatic vision with a two fold simplicity. The first of which is that firms are bound through simple relations in which they influence each other anonymously via prices but not directly through non-price rivalrous competition. And the second is that firms have immutable and transparent cores. These presumptions yield an economy whose natural state is one of stability. Macroeconomic dynamics, or change more generally, is brought about by exogenous shocks. This paper develops an alternate vision for understanding business cycle dynamics. We consider the dynamics that emerge from micro changes that originate from deep within firms. Each firm is surprised by externally visible innovations of other firms because they cannot observe each others' high dimensional interiors. Innovations can cascade because of the complex microeconomic interrelations between the plans of firms. The interaction between external-observable attributes and internal-unobservable active cores of firms is capable of generating change without exogenous shocks.

Keywords Business cycles · Macroeconomic turbulence · Innovation · Coordination · Neutral variation

JEL Classification B52 · E14 · E32

1 Introduction

One of the central problems of macroeconomic theory is to explain the periodic downturns in economic activity known as recessions. The downturns are characterised by massive miscoordination between the plans of millions of economic actors.

✉ Vipin P. Veetil
vipin.veetil@gmail.com

[1] Department of Biotechnology, Indian Institute of Technology Madras, Chennai, 600036, India

[2] Department of Humanities and Social Sciences, Indian Institute of Technology Madras, Chennai, 600036, India

In the midst of a recession, workers tend to possess skills that entrepreneurs do not want to employ and entrepreneurs have projects which investors do not wish to fund. Firms have products that households do not buy and households have savings that firms do not borrow. Economic downturns are not periods of shortages everywhere but of positive and negative excess demands interspersed among many markets.

Such widespread miscoordination stands in sharp contrast to the perfectly coordinated Walrasian world. Most macroeconomic models solve this problem by introducing exogenous shocks in an otherwise stable economy.[1] This modelling strategy is a consequence of a two-fold paradigmatic vision. The first of which is the presumption that firms influence each other solely through prices, that too equilibrium prices generated by an meta-economic agent. Firms do not directly influence each others' profits, or very existence, through rivalrous product competition. This paradigm rules out diachronic antagonism between firms, economic actors relate to each other through synchronic dovetailing. The second aspect of the paradigmatic vision is that firms are simple transparent entities that choose input combinations and output levels when faced with equilibrium prices. Firms do not have active interior cores that are invisible to others. Rather firms are transparent and therefore incapable of cooking up surprises. Such a conception of the economic system leaves no room for endogenous change. There is no sense in which one agent's actions disturb the plans of other agents. After all agents are transparent to each other. The introduction of exogenous shocks therefore remains the only means for generating macroeconomic dynamics.

Microeconomic data however suggests that this paradigmatic vision is not in tune with reality. Perennial flux, not stability, is the characteristic feature of economic life. In the United States, for instance, every year tens of thousands of new firms are created and millions of individuals change jobs (Phillips and Kirchhoff 1989). In a typical year, nearly a third of those employed move from one firm to another (Bjelland et al. 2011). Nearly half of these workers change jobs across broadly defined industries. About a third of those employed move from employment to the unemployment pool, and a comparable number move in and out of the labor pool. All this means that the US labor force churns over more than once in a single year (Axtell et al. 2019). Despite the perennial flux at the microeconomic level, pronounced macroeconomic instability is a rare occurrence. Aggregate variables exhibit long periods of stability though microeconomic life is always churning (Stock and Watson 2002). An economy is somewhat like a tropical river with aggregate variables resembling the surface and microeconomic action the body beneath. Occasionally, micro subterranean turbulence works up to the macro level. Business cycle theory must therefore discover the complex relation between perennial micro flux and occasional

[1] While older literature used aggregate shocks, modern work argues that idiosyncratic firm level shocks can generate volatility when firms are related to each other on a network (Acemoglu et al. 2012). This modern literature uses networks as a mere amplification mechanism within an equilibrium-setting (Veetil Forthcoming, Sections 4.2 and 4.3). Networks are limited to serving as a loud speaker if you will to dampen the averaging out of millions of firm innovations in a large economy (Kirman 2016, p. 14).

macro stability. Why does micro flux sometimes generate reasonable stability in aggregate variables and at other times boil up to generate macroeconomic instability?

Schumpeter (1939) was the first to sketch an answer to the question. He argued that innovations within a market economy generate small local miscoordinations due to the inter-relations between the plans of the innovating agent and the plans of other agents. These local miscoordinations are capable of generating occasional massive global miscoordinations which are but recessions. While Schumpeter believed that micro innovations can generate sizeable macroeconomic effects, he did not develop an explicit mechanism through which micro forces generate macro turbulence. In fact, Schumpeter's business cycle theory remains incomplete in two ways. At the micro level he did not have a theory of the origin of novelty[2]. Nor did he have a mechanism by which micro disturbances cascade rather than average out in a large economy. We borrow insights from recent work in molecular biology and genomics to build the nano foundations of Schumpeter's business cycle theory (Wagner 2014). We argue that the intra-firm mechanism through which innovation emerges is intricately related to the inter-firm mechanism through which innovations cascade through the economic system. Unlike the standard approach, we do not relegate the arrival of microeconomic change to idiosyncratic productivity shocks. Implicit in such relegation is the presumption that the internal workings of firms that generate novelty has nothing to do with how these changes propagate through the economic system. In sharp contrast, we argue that the interaction among firms is driven by their internal features, though the internal features of one firm are not visible to another (Fontana and Buss 1994).

Naturally, our approach to Schumpeter differs from recent attempts at pouring Schumpeter's ideas within a general equilibrium mould and at introducing Schumpeterian innovations in a Keynesian world (Phillips and Wrase 2006; Dosi et al. 2010). In some senses, our paper may be viewed as a step towards developing an endogenous Austrian business cycle theory. Austrian economists embrace the idea that market competition is a rivalrous process (Hayek 1968; Lavoie 1985). But few have claimed that the rivalrous market process can generate macroeconomic turbluance. In fact, when it comes to macroeconomic instability, the Austrian school continues to depend on variants of Mises' business cycle theory which is built on exogenous monetary shocks to an otherwise stable system. Hayek's own work typifies this disjunction between Austrian micro and macro economics (Witt 1997). While Hayek (1937, p. 40) recognized that "endogenous disturbances are inevitable" amid the market process of mutual adjustments, his work on business cycles resembles the standard neoclassical orientation of pinning macroeconomic turbulence on forces that originate from outside the market economy. Schumpeter differed from Mises and Hayek in his orientation towards macroeconomic dynamics. He was of the view that macroeconomic turbulence originates from the ordinary workings of the market economy.

[2]Nor did Darwin. As DeVries put it in the *Species and Varieties: Their Origin by Mutation*, "Natural selection may explain the survival of the fittest, but it cannot explain the arrival of the fittest".

This paper is thematically related to Chapters 4 and 5 of Richard Wagner's (2020) book "Macroeconomics as Systems Theory". More specifically, Wagner argues that macroeconomic turbulence emerges from the clash of teleological plans of economic actors. While each agent perceives the actions of others as an exogenous shock, for the system as a whole these shocks are merely the consequences of the rivalry between plans, not all of which can succeed. We develop two aspects of Wagner's "systems orientation" towards macroeconomics. First, we expand upon the idea that the coordination problem in a macroeconomy emerges from the micro interdependencies between specific plans. We argue that such complex microeconomic interdependencies imply that local coordination between plans does not necessarily generate greater global coordination. The coordination problem of a production economy is intricate, thereby engendering great scope for miscoordination and macroeconomic turbulence. Second, we present nano-foundations as to why one firm's action shocks another firm's plans. Firms are not merely optimizing agents that move up and down isoquants in response to input-prices. If such were the case, firms would by and large be able to predict each other's behavior, leaving little room for surprise, disappointment of expectations, and ultimately macroeconomic turbulence. We characterize firms as entities with active but invisible cores (genotypic space) and a visible exterior (phenotypic space). Firms constantly search for new innovations within the genotypic space but these become visible through phenotypic changes only occasionally when a firm discovers a more profitable form. While movements in the genotypic space are gradual, changes in the phenotype are sudden. This is because multiple positions in the genotype space correspond to identical phenotypes, a feature known as 'neutral variations'. It has long been argued that nature does not take leaps (natura non facit saltus). However we do see technological and organization leaps within economic systems. The existence of neutral variations allows for nature to proceed gradually at one-level, while exhibiting leaps at another. Ultimately, firms with two-levels (one generating change and another exhibiting it) interlinked through a complex web of plans are the structural foundations of an ever-evolving and endogenously turbulent macroeconomic system.

The rest of the paper is organized as follows. Section 2 characterises the micro interdependencies between the plans of firms within a market economy. We draw the distinction between Austrian and Keynesian coordination problems, where the latter arise from the joint concern of all economic actors towards one or more macro variable. Section 3 introduces the idea of 'neutral variations' and develops the process through which novelty emerges in biological systems. Note that these processes are entirely distinct from the Darwinian process of the survival of the fittest. Section 4 develops the role of neutral variations and microeconomic plan interdependencies in generating macroeconomic turbulence. Section 5 notes how the ideas developed in this paper allow us to transcend the Frischian impulse-response dichotomy. Section 6 develops the relation between mind and society within a macroeconomy, with the bi-directional influence between mind and society being the endogenous driver of macroeconomic dynamics. Section 7 presents concluding thoughts. Overall business cycle research has a great deal more to do than offer reasons for the failure of the invisible hand.

2 The complex plan interdependency between firms

From an Austrian point of view, economic coordination problems emerge from the fact that the choice variable of one agent appears in the decision function of other agents. Or as Hayek (1937, p. 38) put it, “one person’s decisions are the other person’s data”. The interdependencies between plans reflect a variety of economic forces at work. Households’ inter-temporal consumption plans, or equivalently saving plans, must meet firms’ plans to borrow. Workers’ plans to acquire particular skills must meet entrepreneurs’ plans to create certain jobs. And one firm’s plans to produce an intermediary good must meet another firm’s plan to use that good as an input. The macroeconomy therefore is a web or ecology of interdependent microeconomic plans (Wagner 2012).

Much of macroeconomic theorising ignores Hayekian micro interdependencies. Instead they introduce macro variables into micro choice functions to generate interdependency between the actions of different agents, an idea first proposed by Keynes through his beauty contest analogy. We compare two characteristic models to illustrate the difference between the coordination problems which emerge from Hayekian and Keynesian interdependencies. Diamond (1982) presents a model with Keynesian interdependencies. In Diamond’s model, agents produce and consume coconuts. An agent however cannot consume coconuts it produces and must therefore exchange. The exchange ratio between coconuts is fixed at unity. The greater the likelihood of exchange in the market, the more the agents work to produce coconuts. The level of market activity therefore enters the decision function of all agents, thereby generating a dependency between their actions. Within this setting, the actions of all agents are inter-related only because they influence and are influenced by a common macro variable. This setup gives two equilibrium, one corresponding to a low level of economic activity and another corresponding to a high level. The coordination problem within this setting is how the system goes to one of the two Pareto ranked equilibrium. The resting of the system at the low activity equilibrium is called ‘a coordination failure’ because agents failed in mutually adjusting their plans to reach the Pareto superior equilibrium (Howitt 2001).

In contrast to Diamond’s model, Gualdi and Mandel (2016) present a model of Hayekian interdependencies in which macro variables do not enter micro choice function. In the Gualdi-Mandel model each firm buys inputs from a subset of firms and sells output to another subset of firms. Firms face two decision problems: ‘the proportions in which to buy inputs from different suppliers’ and ‘the price to charge for the output produced’. Each firm’s decision function has as an argument the choice variables of a subset of other firms. Microeconomic interdependencies arise because the proportions in which to purchase inputs depends on the prices charged by different suppliers and the profit maximizing price of each firm’s output depends on the demand from its buyers.

Note the contrast between the coordination problem in the Diamond economy on the one hand and the Gualdi-Mandel economy on the other. In the Diamond economy, a coordination problem arises because an aggregate variable enters the decision function of all agents, in the Gualdi-Mandel economy aggregate variables play no such role. Naturally, the question arises as to what causes coordination problem in the real economic system. While it may be reasonable to believe that real world economic actors have some interest in macroeconomic information, it is equally reasonable to postulate that economic actors are likely to have a comparable interest in micro variables like the prices of their inputs and the demand for their output. The relative significance of macro and micro variables will tend to vary across agents and across states of the economy. For many agents micro variables are likely to be of qualitatively greater importance than macro aggregates. Consider for instance an auto repair shop owner who in deciding whether to expand may be more concerned about the local demand for his service than the general price level (Wagner 1999, p. 72).

A recognition of the significance of micro interdependencies in generating the economic coordination problem sheds light on the difficulties involved in resolving it. More specifically, an increase in the coordination between two firms does not guarantee an increase in systemic coordination. A greater dovetailing of the plans of some subset of agents does not necessarily increase the coordination in the system as a whole. In fact, mutual adaptation of two or more agents to each others' plans is capable of decreasing the degree of coordination between all plans in the system. We call this the problem of local-global consistency[3]. Consider the following scenario. An entrepreneur plans to produce cotton shirts. He enters into contractual arrangements with suppliers of raw cotton and makers of machinery. He also puts out an advertisement to hire workers. Upon seeing the advertisement, some workers who do not have the skills to tailor shirts invest in learning tailoring. Note that the workers decision to learn tailoring increases the coordination between the plans of workers and the plans of the entrepreneur. As to whether this increase in local coordination generates an increase in global coordination depends on how well the entrepreneur's plan to produce cotton shirts fits within the constellation of all plans in the economy. If for instance the entrepreneur made his plans to produce cotton shirts without knowledge of another entrepreneur's plans to produce polyester shirts, then ex post sales may be less than ex ante expected sales. Or equivalently, the ex post realised size of the firm may be less than the ex ante expected size, and therefore too many workers may have developed tailoring skills. In the limit, the entrepreneur may have to abandon the project and shut the firm. The workers' attempt to coordinate their actions with those of the entrepreneur generates a decrease in systemic coordination because the entrepreneur's plan did not align with the plans of others in the system. More generally, as to whether the adjustment of one plan towards another plan generates systemic coordination depends on the relation of the latter to the economy wide nexus of plans.

[3] The problem is peculiar to a production economy with inter-temporal decision-making, it may be entirely absent in an endowment economy. The Edgeworth barter process for instance describes a setting without a local-global consistency problem. Consider an endowment economy with m agents and n goods. Suppose the initial distribution of endowments is not Pareto optimal. Edgeworth studied a process of successive bartering until a point is reached where no barter was possible to make individuals better off (Uzawa 1962). Note that in the Edgeworth barter process an exhaustion of gains from trade between two individuals necessarily exhausts some of the gains from trade in the system as a whole. In other words, an increase in the coordination between any two agents generates an increase in systemic coordination.

Yet another way to understand the coordination problem in a production economy is to see the production economy as a peculiar jigsaw puzzle. The peculiarity of the puzzle lies in the fact that there are multiple ways in which the pieces can fit together, each yielding a different pattern. This also means each piece of the puzzle is capable of fitting with multiple other pieces. (Our problem setting is reminiscent of Mises's (1935) observation that economic coordination problem arises from the partial substitutability between capital goods). Consider the following process of putting together the puzzle. In the first step, pieces of the puzzle are put together into stable blocks. In the second step, these stable blocks are put together to complete the puzzle (Simon 1962). It may well be that at the second stage, some of the stable blocks do not fit into a larger whole, though the individual pieces of the blocks fit together very well. In such a setting, the puzzle solver must disband some of the stable subcomponents, and rework the individual pieces to form other stable sub components which are likely to fit better within the larger scheme of things.

The teleological overtone of the aforementioned example is unintended. One may well think of the stable blocks as having come together through local coordination in input markets, as in the example of the entrepreneur and the workers of the shirt factory. In so far as there are a multiplicity of ways in which plans can fit together, where some ways are superior to others, the economic coordination problem of a production economy will be different from that of an endowment economy. The path to greater coordination using local interactions is unlikely to be monotonic. Some miscoordinated plans can generate a great deal of systemic miscoordination because other plans are dovetailed to the miscoordinated plan. A misfit plan is likely to generate a slew of other misfit plans due to local adjustments to it. Put differently, fitting well with a misfit plan means fitting poorly within the global interrelations between plans. Overall, the difference between local and global coordination renders the economic coordination problem sufficiently complex to allow for sizeable turbulence in response to innovations. Re-coordination of a production economy in response to an innovation will not be a simple monotonic process of local adaptations, but may involve numerous lapses and failures because locally suitably adjustments may not be globally suitable. As Wagner (2020, p. 139) notes, "plans are interdependent" and each of these interdependencies "can contribute to turbulence", a matter to which we shall turn in Section 4.

3 'Neutral variations' and leaps of innovations

One of the problems that remains unresolved in Schumpeter's business cycle theory, and more generally in theories of endogenous turbulence of the kind propounded by Wagner (2020), is why are economic agents surprised by new behaviors of others? More specifically, why is it that new behaviors do not arises slowly over time, thereby eliciting smooth adaptive responses. Put differently, why do innovations appear as leaps rather than slow changes? After all, is is precisely the 'leaps' of one firm that appear as 'shocks' to another, thereby disturbing its plans and sowing the seeds for macroeconomic turbulence.

Recent research on emergence of novelty in biological systems provides answers to this question. Consider a protein molecule made up of 100 amino acids. Each of the 100 positions can be filled with one of 20 amino acids denoted by a unique letter. This means there are 20^{100} different amino acid combinations with which to make the protein. The vast majority of these amino acid combinations may be unstable or dysfunctional, nature has however a way to continually generate new functional proteins with features that improve fitness within a given environment. Recent work on genetics by Andreas Wagner (2014) and his team at Zurich sheds light on how nature generates novelty by scouring such a library of super-astronomical possibilities[4]. The protein example is merely illustrative. More generally, consider the n digits long genetic code of an organism, with each digit being 1 or 0. There are therefore 2^n possible combinations of the genetic code. Suppose all members of a specie begin at one position in the genotype space, i.e. they have identical n digit codes. Over time through random processes of mutation some members of the specie take a step along one of the n directions in the gene space. One of Andreas Wagner's most startling findings is that many of these steps generate no phenotypic changes in the organisms. The computational experiments of his team at Zurich show that organisms can take large number of steps away from their initial position without any change in phenotype, functionality, or fitness within the present environment. Andreas Wagner calls such changes in the genotype as 'neutral variations'. All this means that overtime, a population with identical genetic makeup can develop sizeable genetic variation within, while exhibiting no noticeable change on the outside. The case of alcoholdehydrogenase, an enzyme used to detoxify ethanol is illustrative:

> In 1983, Martin Kreitman from Harvard University found that the DNA from a small sample of fruit flies contained more than forty-three different DNA text variants in this gene... what Kreitman did not find in the alcoholdehydrogenase gene was even more telling. Most of the mutations in this gene were silent. They changed the DNA sequence, but not the amino acid sequence of alcoholdehydrogenase (Wagner 2014, p.56).

Different members of the population of fruit flies therefore sit at different positions within the genotype space with respect to the enzyme alcoholdehydrogenase. All positions capable of detoxifying ethanol. The most significant aspect of Andreas Wagner and his team's findings for our purposes is not the neutral variations themselves but what they imply. More specifically, the neighborhoods of neutral variations in the genotype space may not themselves be neutral variations. Each of the neutral variations may be one or more steps away from a dramatic change in the organism's fitness or phenotype. Some of these changes will be disastrous like a DNA variant that renders a fruit fly incapable of detoxifying ethanol. But other variants may

[4]This is reminiscent of the Library of Babel as described by Borges (1962). The library contains all the books that can be written using 22 letters of the alphabet, comma, period, and space. Most books contains meaningless words strung together into meaningless sentences. Some books have a handful of meaningful words or some sensible sentences. Though the library contains large numbers of novels and scientific treatise, perhaps its own catalogue too, the vast majority of books are meaningless assortment of letters. In fact sensible books are lost among a super-astronomical number of senseless documents.

render a fly more efficient at processing ethanol. The large dimension of the genotype space makes it nearly impossible to predict the future directions of evolutionary change. Different neutral variants are one or a few steps away from widely different non-neutral variations. Some members of a species may be small steps away from a vast improvement in their fitness, others a few steps away from a small improvement, yet others one step away from breakdown. As to when the steps occur and new species arise through phenotypic changes partly depends on environmental factors that increase genotypic explorations. Note however that novelty does not emerge from blind variations but from systemic search in genotypic spaces that have very specific structures (Fontana and Buss 1994).

Andreas Wagner and his team's work focuses on the generation of novelty at the level of species. They do not therefore develop the implications of their findings for the dynamics of biological systems as a whole. Life on earth has gone through periods of rapid extinction of many species and the rapid flowering of new species (Raup 1986). While the process of discovering fitness improving genotypes by traversing the path of neutral variations involves marginal steps, at the level of the biological system as a whole phenotype changes appear to both arise and disappear abruptly over relatively short periods of time (Newman and Roberts 1995). These active periods of 'speciation' are interspersed among long durations of dormancy that mark little change in the composition of life on the planet. Biologists have so far looked for exogenous shocks to explain the active periods of extinction and creation of new species (Pope et al. 1998). From the exogenous shock perspective, the evolution of life on the planet is a consequence of the responses of life to periodic changes in the external environment, with the rhythm of changes in life reflecting the rhythm of changes in the non-living environment.

In sharp contrast to the exogenous view, Andreas Wagner's work presents the micro foundations for an endogenous theory of change. Consider members of a specie exhibiting neutral variations located at various points in the genotype space. In such a setting, a fitness improving step by one of the members is capable of generating a cascade of unpredictable changes among other members and even other species. A small mutation that improves the ability of some flies to process ethanol may prod other flies to take steps along their neighbourhood so as to survive under the new circumstances. Note that in the presence of neutral variations different members of the same species will respond differently to the new circumstances as each takes steps in some direction from its position in the genotype space. Some of these steps may generate further neutral variations that do not improve fitness, others may cause disfunction and death, yet others may lead to curious improvements in fitness. Indeed the phenotypic changes generated by such steps may be sufficiently large to cleave out whole new species. The movement of the members of one specie within its genotype space are also likely to prod such movements among members of other species. An improvement in the fitness of some members of one specie will affect other species within the ecosystem with whom it shares symbiotic and competitive relations (Kaufmann and Johnsen 1991). Within a system in which members of each species sit at different positions of neutral variations in the genotype space, small changes in some parts of the system can cascade across the system prodding members of one specie after another to explore the vicinity of its genotypic position for improved phenotypes. In other words, the presence of large numbers of neutral variations within each specie along with the interdependence between many such species is capable of generating cascades of changes in the biological system, where some of the cascades may be sufficiently large to generate sizeable extinctions and creations of species. The extent to which empirically observed extinctions and creations of species on the planet can be generated by the afore noted mechanism is an empirical question. And a question for biologists not economists. But the principle embodied in the afore sketched mechanism of endogenous change extends to economic systems, a matter to which we now turn.

4 Macroeconomic turbulence due to 'neutral variations' in economic systems

Let us characterize populations of firms with a n digit genetic code, where n represents the dimensions of choices about the *internal* organization of a firm. These n dimensions include decisions on the kind of formal and informal hierarchy within a firm, the kinds of protocols to follow in transmission of information up the hierarchy and commands down from the management, and the kinds of decisions to be left to workers at the ground level (Tullock 1997; DeCanio and Watkins 1998). To cut the gordian knot, suppose each of these n dimensions can be filled with one of m possible choices. Each firm therefore has m^n possible combinations of genetic codes or forms of internal organization. (Note that the genotype space can be super-astronomical for reasonable values of m and n.) Let us call the externally observable features of a firm as its phenotype, this includes the quantity and quality of products made by a firm. Within this setting we introduce the idea of "neutral variations", i.e. firms can exhibit the same phenotype while having different genotypes. With neutral variations, two firms producing identical products can be very differently organized from the inside. Furthermore, these neutral variations may have as their neighborhoods in the genotype space non-neutral variations that are very different from each other. In other words, each firm by taking a small step in the genotype space can exhibit very different phenotypes, i.e. make very different products and exhibit very different behaviors towards its competitors.

Consider the economic relations between many such firms with neutral genetic variations. These include complementary buyer-seller relations in the market for intermediary inputs and rivalrous relations in the market for output. Naturally firms make decisions about the future using expectations about the plans of others on whom their own plans depend. Assume firms have no knowledge about the genotypes of other firms but observe the phenotypes of other firms. In other words, firms do not have knowledge about the internal organization of other firms but are aware of each others' external behavior. Note that firms are concerned about not only the present but more so about the future behavior of other firms. After all, the success of one's plan depends on future behaviors of those with whom one shares complementary and rivalrous relations. Knowledge of present behavior is therefore valuable in so far as it is a useful predictor of future behavior. Firms may recognize that the future behavior of their competitors depend on changes in the inner-workings of the competitors, i.e. genotypic changes. But in so far as firms do not have access to the inner workings of other firms, they must predict future behavior from what they observe of the competitors from the outside, i.e. the phenotypic attributes. The presence of neutral variations means there is no simple mapping from genotype to phenotype. In other words, phenotypic similarities do not imply genotypic similarities. In so far as future phenotypic changes are an outcome of genotypic changes, firms have no reliable way of knowing the future phenotypic evolution of their competitors that generate new products and production relations.

An economic system is a network of relations between many such firms, each of which is capable of exhibiting neutral variations. In this setting, a small change like an innovation by one firm can trigger cascades of unpredictable novel innovations. A change in the phenotype and therefore the fitness of one firm incentivizes other firms to innovate, i.e. take steps along the genotypic space hoping to find a fitter phenotype, or equivalently products and behaviors that will succeed in the new environment. The existence of neutral variations means that firms making similar products today can produce vastly different products tomorrow due to a single step in their genotype space. Such changes can be tremendously disruptive for the economic system. Firms are likely to be surprised by the innovations of their competitors, whose phenotype they may have known well but whose genotype they knew little about. It is precisely the presence of neutral variations that produce true surprises. Put differently, if there were no neutral variations and there was a one-to-one mapping between genotypes and phenotypes, firms could deduce each others' position in the genotype space using knowledge of each others' phenotypes. This along with some knowledge about the genotype neighborhoods of their competitors would allow each firm to form reasonable expectations about the future evolution of others. In the absence of neutral variations therefore micro changes of one firm is unlikely to surprise another firm.

Each firm responds to the phenotypic changes in other firms by taking steps along its genotype space. While a firm may take steps in its genotype space to adapt to the new circumstances created by an innovation, these steps can generate altogether new and disruptive phenotypic changes. The high dimension of the genotype space implies that firms cannot a priori compute the phenotypic attributes that are likely to be found at different positions in the genotype space. New phenotypic changes arise from an experimental process of exploration (Eliasson 1991). In so far as the innovation of one firm incentivizes other firms to explore their genotype space for new products and attributes, the market process itself becomes the root cause of creative dynamics[5] (Buchanan and Vanberg 1991). In other words, the presence of neutral variations along with each firms dependence on others can trigger cascades of changes. The cascades emerge because each firm's environment consists of the decision and attributes of other firms. And each firm will attempt to develop fitter phenotypes in response to changes in its environment. These cascades of genotypic-phenotypic changes among interconnected firms can spread through the economic

[5]Put differently, the knowledge acquired through the market process generates creative responses that can be miscoordinating. Hayek (1937, pp. 50-51) was quite right in asserting the any equilibrating tendency of the market depends on structures of interactions that dampen miscoordinating creative dynamics.

network, potentially generating the death of many firms which find themselves maladjusted to the new environment and unable to find fitter phenotypes in the vicinity of their present genotypic positions. Such large scale extinctions of firms are one of the principle attributes of macroeconomic recessions[6] (Ouyang 2009).

Finally, in so far as improvements in local coordination do not necessarily coincide with an increase in global coordination (as discussed in Section 2), a firm's adaptive changes towards its buyers and sellers need not necessarily increase systemic coordination. This means that the process of adaptation to innovation will be slow involving a slew of errors and relapses. The system for instance can go through periods of increases in coordination among members in several subparts till the some of the big players recognize their mutual miscoordination with each other. These big players can be firms that have many buyers of inputs or seller of output (Koppl 2002), who do not interact with each other as frequently as with smaller firms in the economy. Alternatively the big players can be significant firms in different sectors of the economy who interact infrequently with firms from other sectors. When such big players recognize the incompatibilities with each other, they will change their products and production relations. This will however disturb the plans of the smaller firms which may have adapted to big players taking their plans givens. The process of re-coordination of the economy after an innovation is therefore non-linear involving several stages of increases and decreases in systemic coordination.

5 Beyond the Frischian dichotomy

We developed an endogenous theory of business cycles much like Schumpeter's own, except for a crucial improvement. While Schumpeter was cognizant of the fact that small micro innovations do not average out in large economy[7], he did not possess a mechanism for why firm level changes do not cancel each other. Recent advances in micro biology and genomics presents a solution to the problem. Small micro changes can generate cascades of innovations because one firm's phenotypic change incentivizes its competitors to look for fitter phenotypes by taking steps in its genotype space. Macroeconomic consequences emerge because no firm can use logical deduction to derive the future innovations of its competitors. The position of the competitor in its genotype space may be unknown to the firm, and even if it were known, the space itself may be too large to compute the phenotypic consequences of sequential

[6]Within an economy in which the coordination problem arises not from micro interdependence but from the presence of macro variables in micro choice functions (as in Keynesian models), one cannot meaningfully construe cascades of innovations that emerge from one firm responding to another's changes. The ability of one firm to influence another firm by independently altering the macro variables which affect all firms is likely to be small. After all, firms no matter how large are small relative to the economy as a whole.

[7]Schumpeter (1928, p. 382) says that the dynamics of the macro economy cannot be looked up as a "continuous process" which irons out at the discontinuous changes at the firm level. Similarly, Schumpeter (1935, p. 10) says "the phenomenon of the cycle cannot be defined and understood as a sort of average between independent changes in individual industries".

steps along that space (Witt 2009, Hypothesis 4 and 5). In principle the uncertainty in economic decision-making generated by innovation cascades can be large because of the high dimensionality of the genotype space coupled with the presence of neutral variations, which makes it nearly impossible for firms to predict the future behaviors of others on whom their own plans depend (Witt 2009, Hypothesis 6 and 7). Our application of Andreas Wagner's work to business cycle theory shows that economics has more to borrow from evolutionary biology than the simple Darwinian mechanism of variation, selection, and inheritance (Witt 1992; Levit et al. 2011). And these borrowings have the potential to integrate nano changes within firms to macroeconomic dynamics, i.e. integrate organization theory with macroeconomic theory.

Such a macroeconomic theory will however differ from the standard approach with regards to its treatment of change. More specifically, standard macroeconomic theory presumes the mechanisms that generate shocks which hit the economic system are disjunct from the mechanisms that drive the propagation of the shocks within the system (Frisch 1933). Real business cycle models for instance embody various mechanisms of the transmission of shocks within the economic system but do not relate these mechanisms to the origin of the shocks themselves. Similarly, the Mises-Hayek business cycle theory specifies a mechanism through which monetary shocks disturb economic activity but this mechanism has little to do with the mechanism that generates monetary shocks. And in standard New Keynesian models the origin of aggregate demand shocks are not related to the mechanism through which the shocks generate a decrease in economic activity. The endogenous Austrian business cycle theory developed in this paper differs from standard business cycle theories in its treatment of change. We do not embrace Frisch's (1933) impulse-response dichotomy, whereby the forces that initiate change (impulse) are distinct and independent of the structures that propagate change (response). Rather, within our setting, each 'response' is a new 'impulse' as firms interact in a diachronic manner. From our point of view, the mechanism through which micro economic change originates is intricately related to the mechanism through these changes propagate through the economic system. Innovations originate from firms seeking a competitive advantage by making marginal changes in their internal organization, some of which are capable of generating improvements in its external performance. When one firm generates an improvement in its external performance, other firms respond by changing their internal working to survive and thrive in the new environment. After all each firm's environment is little more than the behavior of those with whom it shares complementary and rivalrous plans. The changes in the behavior of one firm appear as an exogenous shock to another firm but these shocks are not external to the economic system as a whole. Rather they are generated amid the rivalrous process of competition (Lavoie 1985). As Wagner (2020, p. 46) put it:

> From the point of view of an individual, nearly everything in the world of experience arrives as an exogenous shock; however, from the point of view of a social system what are claimed to be shocks are actually clashes among plans that necessarily can never be fully coordinated.

6 Two visions of the micro-macro relationship

All sciences grapple with the problem of the relation between the parts and the whole. In social sciences the parts are individual minds and the whole is society. By society we mean the long chains of interdependencies through which different individuals are related to each other (Elias 1991). In the economic system, these chains emerge from rival and complementary relations between the production and consumption plans of different agents. The relation of parts to whole in social life is however very different from the relation of individual bricks to a house. There is no sense in which either the part or the whole is static, and their dynamics originate precisely from how they shape each other. Business cycle dynamics emerge from the bi-directional interaction between mind and society, where the two incessantly shape each other. The root cause of the dynamics being the rivalrous nature of economic competition (Lavoie 1985). The goals of some may require the failure of the goals of others, or the very annihilation of their economic position in the web of interrelations. Such tensions pervade the landscape of the economic system. Under certain circumstances, these tensions can generate structural breaks which are sufficiently large to register changes in aggregate variables. Schumpeter (2005) argued that we must not assume unchangeable structures in developing a business cycle theory, including the structure of the human mind and the structure of economic relations between minds. Schumpeter's theory stands in sharp contrast to business cycle theories which are built on immutable minds. Most macroeconomic theories work with minds that are not shaped by the process of exchange (Buchanan and Vanberg 1991). The minds appear as finished products at the very beginning of the exchange process and remain so at the very end. They develop no new quality, their view of each other remains unchanged. As Bakhtin (1981) put it, "the hammer of time shatters nothing, forges nothing". There is a woodenness to agents as they are fully characterized by immutable preferences, endowments, and production possibilities. There is no meaningful sense in which one can speak of "earlier" or "later" since nothing changes. At most the passing of time leads to the fulfilment of that which is sketched out in the very beginning as in economic models that converge to equilibrium prices defined by primitives that existed before the exchange process began (Uzawa 1962).

Furthermore, there are no layers to the actors that populate standard macroeconomic models. Their internal states and external actions appear at the same plane. In response to changes in market prices, individuals move along their indifference curves and production possibility frontiers. The individual as it were is completely transparent to himself and others (Berger 1989, p. 211). Desires, preferences and goals are clear, the only difficulty lies in achieving such aims in the face of technological constraints. In so far as multiple agents seek the same object, their narrow conflict is settled simultaneously through equilibrium prices that dictate each agent's share of the object. There are no irreconcilable conflicts between agents in their desire for objects or positions in the network of relations.

Such a conception of the economic system leaves no room for endogenous change. There is no sense in which one agent's actions disturb the plans of other agents. After all agents are transparent to each other. There are no visible phenotypes and invisible genotypes. The notion that invisible genotypes can drive the visible behaviour of economic agents, i.e. to locate the force-motif of economic action in buried but active cores is far from standard choice theory (High 2011). In the standard setting, macro dynamics cannot emerge from the inconsistencies within various aspects of an individual. There is no scope for an inconsistency between different aspects of an agent as each aspect is defined precisely to obliterate inconsistencies.

Standard macroeconomic theory faces the problem of immutable minds but changing macro variables. Much of macroeconomic theorizing resolves this problem by introducing exogenous shocks. These include monetary shocks, fiscal shocks, and unpredictable behavioural changes. Economic agents in this setting are mere placeholders through which exogenous shocks to production functions, preferences, money balances, or behavioural parameters effect macroeconomic change. Macroeconomic analysis revolves around determining the relationship between the distribution of the shocks and the responses of aggregate variables to the shocks. Such analysis amounts "to a disclosure of everything that has been given, already at hand and ready made before the world existed" (Bakhtin 1981). There is no sense in which macroeconomic theory studies the endogenous creation of novelty.

Most business cycle theories therefore have an other-worldly quality about them. Where by 'otherworldly' we mean the belief that the genuinely real is "radically antithetic in their essential characteristics to anything to be found in man, natural life, in the ordinary course of human experience" (Lovejoy 1936, p. 25). The static Walrasian system along with its macroeconomic implication of secular growth serves as the genuinely real. The observed microeconomic reality of the birth and death of millions of firms, and the observed macroeconomic reality of tumultuous changes in output and employment are viewed as deviations from the underlying unchanging truth. In contrast, Schumpeter viewed turbulence as an ordinary working property of an economic system. While most macroeconomists take the serene world of perfect coordination as the building block of their theories (Lachmann 1973), Schumpeter built his theory with the microeconomic flux that characterizes an economic system. In this sense, Schumpeter offers a this-worldly theory of macroeconomic turbulence.

One of Schumpeter's (2005, p. 112) three precepts in explaining macroeconomic dynamics is to "stop interpreting change from a line of development that has not been derived in an empirical way". He argues that the problem of macroeconomic change has nothing to do with extracting 'residuals' from macroeconomic time series, for such a procedure assumes a stable trend as the normal state of affairs. Schumpeter intended to develop a theory in which it would be impossible for macroeconomic variables to exhibit secular growth, and not because of external shocks but because of the very nature of economic life. He did not relegate the motif of change to forces outside the economic system.

Individuals influence each other and are influenced by each other, their preferences and abilities are formed through the creative process of mutual interactions (Schumpeter 1947). The market process is much like a conversation between two individuals, each of whom discovers new ideas by interacting with the other. These news ideas are not simply the sum of the material the two individuals bring to the table but altogether novel entities that could not have come about except through the meeting of the two minds. A conversation is not merely the exchanging of information, it prepares the mind for what has not been heard and sheds new light on matters heard long ago. In this sense, the conversation generates not only new ideas but new people in so far as they influence each others views, motifs, and possibilities (Elias 1991). This shaping and reshaping of individuals by each other generates incessant microeconomic change and dynamic tensions between individual plans, some of which at certain times boil up to the macro level by producing structural breaks in the network of economic relations, ultimately generating macroeconomic turbulence.

7 Concluding thoughts

Standard macroeconomic theory is built on a system with immutable minds that are synchronistically dovetailed to each other. Much of macroeconomic theory revolves around the nature of exogenous shocks that must be introduced within such a system to generate the empirically observed macroeconomic turbulence. Shocks vary along numerous margins including the agents they hit and whether they are real or monetary. Wagner (2020) presents a wholly different picture of a macroeconomy. He views the macroeconomy as populated with evolving agents intricately related to each other through a web of forward-looking plans. Not all plans are symbiotic, some plans are complementary, others rivalrous. The agents have "dueling teleological claims" as it were (Wagner 2020, p. 98). These duels generate the failure of some plans, which in turn produce further changes and opportunities.

We developed Wagner's 'system-theoretic' view of the macroeconomic in two ways. The first of which was to present a detailed picture of the microeconomic nature of economic coordination problems which distinguishes it from Keynesian coordination problems. The second, more importantly, was to develop nano foundations for why the innovations of one firm is capable of disturbing the plans of other firms. We characterized firms as entities with active but invisible cores and visible exteriors, with the active cores being the wellspring of innovation. Ultimately, macroeconomic turbulence emerges from the interaction between firms who can plan their future course of action based on knowledge of each others' visible exterior attributes. Future changes in these exteriors are difficult to predict because 'neutral variations' guarantee that there are no simple relations between the core from which changes originate and the exterior that depicts those changes. While each firm's actions shock other firms because of the presence of neutral variations, these shocks spread due to the complex microeconomic interdependence between the plans of different firms. The shocks that emerge from innovations are unlikely to have much macroeconomic effect in a Keynesian world where firms are related to each other only through their mutual concern from some aggregate variables.

In some senses, macroeconomic theorizing has come a long way since Frisch's (1933) seminal article on propagation and impulse problem. Much of the progress has however been in form rather than substance. Most macroeconomic models, irrespective of the nature and sophistication of the technical apparatus employed, ingrain the Frischian dichotomy between 'impulse' and 'response'. Frisch said that there need not be any simple relation between impulse and response but viewed the two as distinct forces at work. Macroeconomic theorizing has progressed along the lines of either introducing more refined impulses (shocks) or developing features that generate more intricate responses to shocks. This paper presents a motivation to develop a business cycle theory devoid of the Frischian dichotomy, one in which ‘change’ is an ordinary working property of the macro economy. This dichotomy can be surpassed by developing richer analytical formulations of decision-making firms and the relations between them.

References

Acemoglu, D., Carvalho, V.M., Ozdaglar, A., Tahbaz-Salehi, A. (2012). The network origins of aggregate fluctuations. *Econometrica*, *80*(5), 1977–2016.

Axtell, R., Guerrero, O., López, E. (2019). Frictional unemployment on labor flow networks. *Journal of Economic Behavior & Organization*, *160*, 184–201.

Bakhtin, M.M. (1981). *The dialogical imagination: Four essays*. Austin: University of Texas Press.

Berger, L.A. (1989). Economics and hermeneutics. *Economics and Philosophy*, *5*(2), 209–233.

Bjelland, M., Fallick, B., Haltiwanger, J., McEntarfer, E. (2011). Employer-to-employer flows in the united states: estimates using linked employer-employee data. *Journal of Business & Economic Statistics*, *29*(4), 493–505.

Borges, G.L. (1962). The library of babel. Translated by james E Irby. Originally published in 1941.

Buchanan, J.M., & Vanberg, V.J. (1991). The market as a creative process. *Economics & Philosophy*, *E7*(2), 167–186.

DeCanio, S.J., & Watkins, W.E. (1998). Information processing and organizational structure. *Journal of Economic Behavior & Organization*, *36*(3), 275–294.

Diamond, P.A. (1982). Aggregate demand management in search equilibrium. *Journal of Political Economy*, *90*(5), 881–894.

Dosi, G., Fagiolo, G., Roventini, A. (2010). Schumpeter meeting Keynes: A policy-friendly model of endogenous growth and business cycles. *Journal of Economic Dynamics and Control*, *34*(9), 1748–1767.

Elias, N. (1991). A Society of Individuals. Continuum.

Eliasson, G. (1991). Modeling the experimentally organized economy: Complex dynamics in an empirical micro-macro model of endogenous economic growth. *Journal of Economic Behavior & Organization*, *16*(1-2), 153–182.

Fontana, W., & Buss, L.W. (1994). The arrival of the fittest: Toward a theory of biological organization. *Bulletin of Mathematical Biology*, *56*(1), 1–64.

Frisch, R. (1933). Propagation problems and impulse problems in dynamic economics. In *Essays in Honour of Gustav Cassel* (pp. 171–205): Allen & Unwin.

Gualdi, S., & Mandel, A. (2016). On the emergence of scale-free production networks. *Journal of Economic Dynamics and Control*, *73*, 61–77.

Hayek, F.A. (1937). Economics and knowledge. *Economica*, *4*(13), 33–54.

Hayek, F.A. (1968). Competition as a discovery procedure. *The Quarterly Review of Austrian Economics 2002, Translated by Marcellus S. Snow*, *5*(3), 9–23.

High, J. (2011). Dr. Anderson and the Austrians: Price formation as a cumulative process. *Review of Austrian Economics*, *24*, 199–211.

Howitt, P. (2001). Coordination failures. An encyclopedia of macroeconomics.

Kaufmann, S.A., & Johnsen, S. (1991). Coevolution to the edge of chaos: Coupled fitness landscapes, poised states, and coevolutionary avalanches. *Journal of Theoretical Biology*, *149*(4), 467–505.

Kirman, A. (2016). Networks: A paradigm shift for economics? In *The Oxford handbook of the economics of networks* (pp. 13–46). Oxford: Oxford University Press.

Koppl, R. (2002). *Big players and the economic theory of expectations*. Berlin: Springer.

Lachmann, L.M. (1973). Macroeconomic thinking and the market economy: An essay on the neglect of micro-foundations and its consequences. The Institute of Economic Affairs.

Lavoie, D. (1985). *Rivalry and central planning*. Cambridge: Cambridge University Press.

Levit, G.S., Hossfeld, U., Witt, U. (2011). Can Darwinism be “Generalized” and of what use would this be? *Journal of Evolutionary Economics*, *21*, 545–562.

Lovejoy, A. (1936). *The great chain of being*. Harvard: Harvard University Press.

von Mises, L. (1935). Economic calculation in the Socialist Commonwealth. In Hayek, F.A. (Ed.) *Collectivist economic planning* (pp. 87–130): George Routledge and Sons.

Newman, M.E.J., & Roberts, B.W. (1995). Mass extinction: Evolution and the effects of external influences on unfit species. *Proceedings of the Royal Society of London Series B: Biological Sciences*, *260*(1357), 31–37.

Ouyang, M. (2009). The scarring effect of recessions. *Journal of Monetary Economics*, *56*(2), 184–199.

Phillips, B.D., & Kirchhoff, B.A. (1989). Formation, growth and survival: Small firm dynamics in the US economy. *Small Business Economics*, *1*(1), 65–74.

Phillips, K.L., & Wrase, J. (2006). Is Schumpeterian 'creative destruction' a plausible source of endogenous real business cycle shocks? *Journal of Economic Dynamics and Control*, *30*(11), 1885–1913.

Pope, K.O., D'Hondt, S.L., Marshall, C.R. (1998). Meteorite impact and the mass extinction of species at the Cretaceous/Tertiary boundary. *Proceedings of the National Academy of Sciences*, *95*(19), 11028–11029.

Raup, D.M. (1986). Biological extinction in earth history. *Science*, *231*(4745), 1528–1533.

Schumpeter, J.A. (1928). The instability of capitalism. *The Economic Journal*, *38*(151), 361–386.

Schumpeter, J.A. (1935). The analysis of economic change. *The Review of Economics and Statistics*, *17*(4), 2–10.

Schumpeter, J.A. (1939). *Business cycles: A theoretical, historical, and statistical analysis of the capitalist process* Vol. 1. New York: McGraw-Hill. Reprinted in 2005 by Bartleby's Books (Chevy Chase, MD) and Martino Publishing.

Schumpeter, J.A. (1947). The creative response in economic history. *The Journal of Economic History*, *7*(2), 149–159.

Schumpeter, J.A. (2005). Development. *Journal of Economic Literature*, *63*, 108–120. Written in 1932.

Simon, H.A. (1962). The architecture of complexity. *Proceedings of the American Philosophical Society*, *106*(6), 467–482.

Stock, J.H., & Watson, M.W. (2002). Has the business cycle changed and why? *NBER Macroeconomics Annual*, *17*, 159–218.

Tullock, G. (1997). *The economic theory of bureaucracy*. Upper Saddle River: Prentice Hall.

Uzawa, H. (1962). On the stability of Edgeworth's barter process. *International Economic Review*, *3*(2), 218–232.

Veetil, V.P. (Forthcoming). Schumpeter's Business Cycle Theory and the diversification argument. Evolutionary and Institutional Economics Review.

Wagner, A. (2014). *The Arrival of the Fittest: Solving Evolutions Greatest Puzzle*. New York: Penguin.

Wagner, R.E. (1999). Austrian cycle theory: saving the wheat while discarding the chaff. *The Review of Austrian Economics*, *12*(1), 65–80.

Wagner, R.E. (2012). A macro economy as an ecology of plans. *Journal of Economic Behavior and Organization*, *82*(2), 433–444.

Wagner, R.E. (2020). *Macroeconomics as Systems Theory: Transcending the micro-macro dichotomy.* London: Palgrave Macmillan.

Witt, U. (1992). Evolutionary concepts in economics. *Eastern Economic Journal*, *18*(4), 405–419.

Witt, U. (1997). The Hayekian Puzzle: Spontaneous order and the business cycle. *Scottish Journal of Political Economy*, *44*(1), 44–58.

Witt, U. (2009). Propositions about novelty. *Journal of Economic Behavior & Organization*, *70*(1-2), 311–320.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.