A QUANTITATIVE APPROACH TO INCLUDE TIME AND INNOVATION IN TRADITIONAL MARKET ANALYSIS

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Abstract

The rationale for most economic regulation, be it sector specific or antitrust, relies on the comparison of the analyzed market against the perfect competition model. Thus, it is based on the use of static equilibrium models.

However, those models do not consider some important features that exist in the markets, like innovation, time, investment, technology or product differentiation. In this paper, we make an attempt to incorporate some of these variables in the traditional static analysis. Specifically, we propose a quantitative model to assess the effect of innovation and time in market dynamics. Our methodology should be understood as a first step before proceeding with the traditional market assessment, allowing the analyst to identify if the static assessment is of consequence for the market under scrutiny.

Once defined and justified, we try to apply the model to the telecommunications industry. In order for that, we will propose specific measures for innovation periods and relaxation times. We will make a first estimate for those periods and its relationship, and provide an interpretation for the results.
Introduction

Sector regulation and antitrust decisions implicitly rely on the perfect competition model. For mainstream economists, a market in perfect competition is the optimum for the social welfare. This was shown by the economist Arrow, who proved that a market in perfect competition allocated resources in a Pareto-optimal way.

As a consequence, regulators and antitrust authorities strive for redressing the real markets so that they may conform to the ideal of perfect competition, in the confidence that in this way the social welfare will be increased. It is because of this, for example, that authorities are concerned with the existence of monopolies or, more generally, agents with market power.

However, there are plenty of important features that are actually observable in the markets, but are not considered in the perfect competition model or other similar static models. In fact, when these models assume a certain state of the art, they assume away features such as innovation, technology or investment, which play a crucial role in the markets and in the social welfare.

Moreover, being static, they are not able to include a variable fundamental in human conduct and so in economics, as is the time. All actions, be it productive or equilibrium processes, involve and require time. There is no such a thing as an instantaneous process.

Finally, it is very likely that innovation, technology and investment lead to some degree of product differentiation, another feature widely observable in actual markets, but assumed away and even seen suspiciously in perfect competition models. After all, one of the conditions for equilibrium is the homogeneity of the goods sold in the market.

It is very difficult to say how the disregarding of features such as those exposed above may impact the market analysis and thus the regulatory and antitrust decisions deriving from it. But there is a general consensus that those features should be somehow incorporated into the traditional analysis, to make it more robust and less prone to errors.

One of the main obstacles to that inclusion is related to the difficulties for quantifying such phenomena, implying that lack of figures supposes lack of rigor. Economic analysts are generally comfortable with numeric measures such a price elasticities (which allows them to define the analyzed market), market shares (to identify agents with market power) or cost and margin analysis (to qualify the behavior as anticompetitive or to regulate ex ante the prices). But no such a quantitative measure is provided in text books to ascertain how innovative is a market.

In this paper we propose a quantitative approach that may overcome such obstacles and provide some numerical comfort to the analyst, so that he may be willing to incorporate time and innovation
to his static analysis. Our proposal relies on the concept of *relaxation time*, as used in Physics to measure the time that a system takes to go back to equilibrium once a perturbation is introduced.

We do not confine ourselves to the theory realm, and after proposing and justifying our model, we will try to make a concrete application for it, showing thus that it may be applicable to actual market analysis. Specifically, we will try to apply it to the telecommunications market, in which both sector specific regulation and antitrust are usually very active.

This paper is structured in the following way. As a first step, mainstream economic theory on perfect competition will be revisited, reviewing its shortcomings and efforts made to overcome them. In the second section, we will introduce our proposal for a quantitative approach to dynamic features of the market, based on the role of time and innovation in the market operation. After that, we will provide an application of the defined approach to the telecommunications market and an interpretation of the results obtained. Last section concludes with some policy recommendations.

**Dynamic market analysis: state of the art**

**Description of the model of perfect competition**

As already stated, sector regulation and antitrust decisions are implicitly based on the neoclassical model of perfect competition. This model consists of a timeless situation of static equilibrium, based on the following assumptions:

1) The market is atomized; all providers are small relative to the total market.

2) The product is homogeneous and undifferentiated, so that the only variable left for competition is price.

3) There is perfect information for all parties involved; the information is correct, certain and free.

4) Each firm faces a horizontal demand curve: it can only sell at a specified price, but any quantity can be sold at that price.

5) There are no transaction costs (in particular, there are no barriers to entry or exit)

It can be shown that, under the above conditions, there is a situation of perfect competition with the following features:

a) Marginal cost, minimum average cost and market price are equal

b) There are no profits for any firm
c) Resource allocation satisfies the Pareto optimality\(^2\)

Any separation of the previous assumptions would imply that the companies would not face a horizontal demand curve, making possible for them to set a price above its marginal cost (i.e., to have market power). This would lead to a situation of lower social welfare than that of perfect competition, since some customers would not be able to buy the product at the higher price.

The welfare losses caused by the existence of market power in comparison to a situation of perfect competition are usually categorized as follows.

First, there is a loss from static inefficiency. Since the price is above the perfect competition level, fewer exchanges are made than would be with prices at that level. Along with this loss, mainstream economists refer to the misuse of those resources devoted to lobbying and influencing governments in order to maintain market power position (rent-seeking activities).

Second, there is a loss from productive inefficiency. The reason is that the firm with market power can operate with less efficient technology than that which would be required in a perfect competition situation. Thus, marginal costs increase with respect to the situation of perfect competition. In consequence, production is even more restricted in order to maximize the profit, compared with the situation in which costs would be those required in a perfect competition situation.

Finally, there is a loss from dynamic inefficiency, since the incentives of the firm with market power to innovate are lower than those of the normal firm.

**Limitations of static equilibrium models**

Criticism to the static efficiency approach for sector regulation and antitrust has come from several and prestigious sources.

Gilbert (2005) states that “Dynamic competition to develop new products and to improve existing products can have much greater impacts on consumer welfare than static price competition, and antitrust policy should take dynamic competition into account when evaluating mergers or conduct in innovation intensive industries.” Antitrust enforcement should start from a sound analysis of competitive effects in the new economy, even if dynamic, innovation-driven industries have a number of characteristics that challenge conventional approaches.

Vickers (1995) concludes that “Reasoning about competition problems requires better theoretical understanding, and of course empirical analysis, of how competition works. In particular it requires frameworks that explicitly address effects on productive efficiency. (...) The concept of competition as equilibrium resource allocator is not the only model of a modern economist.”

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\(^2\) Pareto optimality is obtained if there are no interchanges that can improve the welfare of any member of the system, without worsening the situation of any other member.
From another point of view, Dixit and Pindyck (1994, chapter 9) conclude that prices can be in any given moment above or below those of the equilibrium, appearing to show extraordinary profits or predatory behavior, as a natural consequence of the uncertainty and irreversibility of investments. Thus, in order to evaluate possible anticompetitive circumstances it is necessary to analyze the prices evolution over long periods of time; a snapshot can show misleading results. In summary, prices, the main variable of traditional antitrust policy, are unreliable as indicators of anticompetitive behavior.

Evans and Schmalansee (2001) reckon that “where dynamic competition is actually or potentially important as a source of economic benefit, basing antitrust policy on the notion that perfect competition is the attainable ideal is unlikely to serve consumers well.” According to these authors, market power for some period of time is a necessary condition for dynamic competition, as is also that leaders charge price well above marginal costs and earn high profits, adjusting borne risks. In new economy industries, the key determinant for performance is the vigor of dynamic competition, and that is often ignored by traditional antitrust analysis.

Pleatsikas and Teece (2001) review and evaluate some of the traditional techniques used to define markets and measure market power in antitrust analysis, revealing the limitations of them when applied in high technological contexts, when static analytical frameworks are employed. Normally, this leads to too narrowly defined markets and consequently to an overestimation of market power. They suggest that a qualitative analysis to define markets is likely to be less flawed than the traditional one, and recommend the use of analysis of rents to identify if the market power is potentially troublesome.

Gual (2007) criticizes the use of unilateral effects in merger policy. In this context, he concludes that, even if economic analysis should provide the basis for merger examination, “economic models are unavoidable abstractions of the real world that have to be handled with extreme care when used in important policy matters such as merger decisions. Despite the tremendous progress of industrial organization theory over recent decades and the phenomenal improvement in quantitative methods, the range of uncertainty regarding the appropriate model of competition for real-life industries is huge, and merger policy should be deployed with a broad portfolio of analytical tools”.

Herrera-González (2012) criticizes the static equilibrium models as a reference for regulatory decisions, and more specifically on the model of perfect competition, on two different grounds: feasibility and desirability of the model.

Regarding feasibility of the model, it is argued that the existence of a horizontal demand curve is a theoretical impossibility. This is because it runs counter the law of marginal utility:\footnote{The value of each additional unit decreases as the quantity of the supply of a good increases, because the additional unit is allocated to satisfy needs of a lower rank}

It is impossible
that demand curves are horizontal, because additional units of a good are always less valuable for individuals.

With respect to its desirability, the model of perfect competition considers inefficient all activities that are contrary to its assumptions of equilibrium. For example, the assumption of homogeneity of products implies that product differentiation is a reflection of market power and therefore inefficient. However, the consumers’ preferences make product differentiation not only sustainable but also desirable, to better meet the specific needs of each individual. In sum, the model of perfect competition considers inefficient several usual activities of companies, which have proven to be desirable for individuals and society: product differentiation, innovation, discounts, convenient location, advertising, economies of scale and scope ... Therefore, it is argued that the standard of perfect competition is not a desirable goal for the social welfare.

**Approaches to dynamic market analysis**

Conscious of the severe limitations of static equilibrium models for taking regulatory and antitrust decisions that actually increase social welfare, some efforts have been carried out by scholars in order to improve the market analysis by taking into account dynamic effects such as those assumed away by the model of perfect competition.

Porter (2001) proposes a change from a “Profitability/Price-Cost Margin standard” to a “Productivity Growth standard” for antitrust policy. According to this author, goals for antitrust policy are in the traditional view, in order of importance: 1) Profitability (Allocative efficiency); 2) Cost reduction (Static efficiency); 3) Innovation (Dynamic efficiency). But the hierarchy of goals should change, since the role of competition is to increase a nation’s standard of living and long-term consumer welfare via rising productivity growth. So innovation (Dynamic efficiency) should be the main goal of antitrust policy, followed by value improvement (as a more subtle measure of static efficiency) and finally by profitability (Allocative efficiency). He proposes a framework based on his Five Forces model for strategic analysis.

In the same line, but without a concrete proposal on how to achieve it, Pera (2008) states that “a proper application of the efficiency framework would be the examination of practices not in terms of their effects on consumer welfare, but rather in terms of their effects on total welfare and wealth” (Emphasis added)

Sidak and Teece (2009) analyze the possible application to antitrust of new theoretical developments, such as evolutionary theory, the theory of organization and behavior of the firm, or the strategic management foundations of innovation. They state that these theories “have only recently caught the attention of antitrust scholars. Because of this recent awareness, the enforcement agencies are not confident about discarding conventional wisdom, despite that fact that many within the agencies know that much of that conventional wisdom is deeply discredited.”

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**Regulatory Services**

**Telefónica, S.A.**
According to these scholars, law in the USA has started to move in this direction, but “the pace is glacial, however, in part because antitrust economics has trouble articulating, quantifying, and operationalizing dynamic concepts”.

More focused on sector regulation, De Bijl (2004) defines a conceptual framework for the analysis of public policy in which dynamic efficiency is explicitly incorporated. The author proposes to measure efficiency by means of qualitative proxies. First, efficiency drivers have to be identified; then, they are classified into four categories: market structure and entry, anti-competitive practices, competition policy and regulation, and technology. Finally, a table is developed with different scenarios of efficiency with its features. The objective is to provide a framework that allows the policymaker to anticipate which policies will allow the shift from one scenario to another, and so be able to reach the desirable scenario in which both static and dynamic efficiency are high. For the author, this is only possible through a state of high dynamic efficiency and low static efficiency.

The paper by De Bijl is actually based on another work (Bennet, De Bijl and Cannoy, 2001) in which the framework is applied to the telecommunications market in the Netherlands. As a result of their analysis of three cases, they define some principles for telecommunications policy.

For Huerta de Soto (2010), dynamic efficiency is the one that should be considered in regulatory decisions: “the truly important goal is not so much to prevent the waste of certain means considered known and ‘given’ as to continually discover and create new ends and means, and thus to foster coordination while accepting that in any entrepreneurial process new maladjustments will always appear and hence a certain amount of waste is inevitable and inherent in any market economy” (p.11). Dynamic efficiency may be described as the capacity of an economic system to stimulate entrepreneurial activity and coordination.

The necessary and sufficient condition for dynamic efficiency to exist is that each individual be able to appropriate the results of his entrepreneurial creativity, specifically of his exchanges of goods and services.

The author also suggests how to apply the dynamic efficiency to the theory of regulation and to antitrust legislation. The objective would be to identify restrictions on the exercise of entrepreneurship caused by regulatory or antitrust decisions. From the diagnosis of the inefficiency problems, reforms should be devised with the purpose of removing the existing obstacles to creativity and coordination.

Starting from this insight, Herrera-González (2012, chapter 9) applies the dynamic efficiency framework to current telecommunications regulation in the European Union, concluding that the main features of asymmetric regulation, i.e access regulation and price control, interfere with dynamic efficiency.
From an empirical point of view, also focusing on the telecommunication market, Howell (2008) compares the situation in New Zealand before and after the introduction of sector specific regulation. The comparison is carried out on two set of indicators: the traditional ones related to static efficiency, and other group related to dynamic efficiency. Results show that, after the enactment of regulation, static efficiency indicators improved, while dynamic efficiency ones significantly worsened.

Proposal for a quantitative approach to dynamic market analysis

In this section we propose a quantitative approach to introduce two dynamic variables, namely time and innovation, in the traditional static approach. The proposed methodology consists of adding a previous filtering step to the traditional static analysis, so that if the market fails to comply with the proposed test, static analysis is discarded.

In order to describe the theoretical basis for the proposed test, we first review the role of time in the competitive process. After that, we do the same with innovation. Finally, the proposed test is explained.

The role of time in the action of economic agents

All actions attempted by individuals have a resource in common: they need time. There is no such a thing as an instantaneous process. From the simplest productive process to the complex attainment of the equilibrium in the market, all processes require time. The inclusion of time in economic models has several and important consequences, whose general description is beyond the scope of this paper.

Here, we will focus on how time affects the plans of individuals. In most cases, individuals are not able to satisfy their needs with just one action; they need to devise plans of actions in order to reach their goals. These plans may be very simple (such as the set of actions needed to have lunch) or very complex (as may happen in any project carried out by a firm), but in all cases involve the implementation of successive actions and the pass of time. The individual does not expect to get a profit after each action, but once the plan is accomplished.

Therefore, the relevant parameter to explain the decision of the agent is not the margin he makes in a single operation, but the relationship between the value of resources he invests during the project and the value of resources he is able to get as a result, informed of course by the time preferences of the agent. The plan may thus be represented by the expected sets of resource outlays, of resource inlays and of moments in time in which each of them happens. This is usually called the business plan by entrepreneurs, but plans are not exclusive of business people.
Decisions that involve investing are thus taken considering the future outcomes of the plan. But agents are aware that they do not have perfect information about the future. Therefore, they know that their business plans are likely to confront changing circumstances and they need to be ready to adapt it to them in a dynamic way.

As a result, the selection of investment plans is not time neutral, as reflected in widely accepted investment decision tools such as Net Present Value or Internal Rate of Return. Plans that are better suited to adapt to changing conditions are in general preferred:

- Plans with shorter payback time are usually preferred to those with longer ones, even if the latter have higher cash flows at later times. Shorter paybacks decrease the risk that changes in the market may hamper the business plan. They also add strategic freedom to the owner as it has more liquid assets at an earlier time, which are easier to redeploy if new unexpected business opportunities appear.
- More scalable investments are generally preferred to one-offs. They are easier to finance, allow the owner to test the market reaction to the first tranches of investment and reduce losses if the plan is stopped; also, in some cases, allow for the first assets to start producing cash flows that may be used to finance a part of the later investment tranches, thus reducing total capital at risk.
- Delays in the implementation influence decision making. There is a lead time between agent decision making and market implementation that influences competition in the market and business plan execution.
- Because of innovation, uncertainty increases with time. More specifically, radical innovation may render suddenly obsolete the assets, or conversely, prolong its useful life. Thus, the assessment of the duration of business plans, which is a critical parameter of present value, is very likely to vary over time.

Business plans need to be continually adjusted to changes in the environment. Entrepreneurs must react to actual and anticipated changes, if they want to survive in the market. This adjustment, being a revised or a whole new set of actions, will of course take time, during which new developments may occur and so on.

**Effects of innovation in the market dynamics**

It is not the purpose of this paper to explain why or how innovation occurs. But it is an uncontestable fact that innovation happens in most markets, with different paces and effects. It is not possible to determine *a priori* the effect of an innovation on the market. Spectacular scientific breakthroughs may seem quite impressive for connoisseurs, but have no effect whatsoever when exploited for business purposes. On the contrary, minor adjustments requiring only some rudimentary knowledge may alter completely the structure and the way in which a market works.
Thus, we propose to classify innovation according to its observed effects in the market, as the only criterion that seems objective from an economic point of view. Depending on their impact on the market, two types of innovation have traditionally been considered:

- **Incremental or gradual innovations**: those having gradual or incremental impact on the market. They suppose an alteration of some specific aspect of the existing products, processes or technologies but keep intact the bulk of them. It marginally improves some parameter but without altering the competitive positions of agents. Of course, most successful innovations are of this category.

- **Radical innovations**: they change former competitive advantages and suppose a re-structuration of the market, giving place to new entries and exits.

The effect of gradual innovation may be captured using the experience curve (Henderson, 1973). This is done by measuring the decrease in average inputs per unit with the cumulated number of units produced⁴. Thus, the slope of the experience curve is a measure of the trend of the impact of gradual innovation on the costs of firms in an industry.

One well known example of experience curve in the particular case of electronic devices is Moore’s law, which is the observation that, over the history of computing hardware, the number of transistors on integrated circuits doubles approximately every two years. It was first formulated in 1965 and has held true from 1958 up to this moment.

The effect of radical innovation cannot be so easily captured, since it may affect all aspects of the industry and the business plans of every individual company in very different ways. If we assume that radical innovation is identifiable *a posteriori*, then the average innovation period for an industry \( t_{RI} \) may be measured and used to characterize the “innovativeness” of a concrete market. We define \( t_{RI} \) as the average time between the introductions of successive radical innovations in a given industry.

As may be expected, empirical observation shows that \( t_{RI} \) changes from industry to industry. Highly innovative industries should have very short \( t_{RI} \), while mature industries will tend to have longer \( t_{RI} \).

**Market equilibrium in the presence of time and innovation**

So far, we have seen that entrepreneurs devise and implement plans of actions in order to satisfy their goals, actions that necessarily involve the pass of time. As times passes, the environment in which the entrepreneur acts may change, forcing the entrepreneur to adjust his previous plan to the

⁴ The slope of the experience curve is related to innovation, but not only to it: “The experience curve is the result of the combined effects of learning, specialization, investment and scale. The effect of each of these is an approximation, and so the experience curve effect itself is also an approximation.” (Henderson, 1973). However, it is the best estimation available and since scale and investment can be separately assessed, it may be considered a reasonable predictor of the influence of gradual innovation on the costs of firms in one industry.
new reality. If there were time enough between change and change, the entrepreneur would likely be able to accomplish his plan as originally intended.

On the other side, we have described innovation as a phenomenon ubiquitous in the markets. We have classified innovations into two categories, according to its effects: incremental and radical. After an innovation in a market, entrepreneurs have to revise their business plans and adjust to the new reality. For our purposes, we will suppose that changes in business plans only happen after what we have called a radical innovation. Of course, minor adjustments to plans also have to be made in answer to incremental innovations, but we will suppose that they do not involve any structural change in the market, that is, no entrepreneur is going to enter or exit the market as a consequence from an incremental innovation.

If the entrepreneur is able to accomplish the revised plan of actions before a new radical innovation happens in the market, then we could suppose that the market reaches equilibrium, because all plans would have been carried out and would be coordinated. The model of perfect competition would likely reflect such a market with a certain degree of accuracy.

So, as a first step before proceeding with a static market analysis, we propose to analyze the dynamic operation of markets by looking at the impact of innovation and reaction times on business plans and market structure. In order to do so, we propose to use and measure something similar to what in Physics is called relaxation time ($\tau$), that is, the time that a system takes to go back to equilibrium once a perturbation is introduced in it.

To apply this concept to economic theory, assume we start with a market in equilibrium. An innovation is then launched that perturbs the equilibrium. The effect of the innovation is usually twofold:

1. It changes the underlying economics of the market, and thus the market is likely to settle in a different equilibrium.
2. It takes some time for the market to relax into the new equilibrium. Making a parallel with Physics, we shall call this parameter as well relaxation time ($\tau$).

Observe that static economic models are able to explain the first phenomenon, the features of the new equilibrium after the innovation. In our test, we propose a model to quantify the second one.

Once an agent decides to introduce an innovation in a market, it takes some time for it to be fully implemented and for its effects to start accruing. We shall name this parameter lead time ($t_1$).

After the lead time has elapsed, the rest of agents, specially current and potential competitors, react to the innovation. This process also takes time for them: they have to acknowledge that the

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5 Of course, they will react only if (they anticipate that) the innovation will be successful. Recall that from an economic theory point of view, we are only interested in those innovation with effect in the market.
innovation has happened, assess its potential impact on their business plans, find out possible reactions to the innovation, assess their merits, decide on the reaction and then implement it. We shall call this time reaction time \((t_{RC})\).

It directly follows that:

\[
\tau \geq t_{LT} + t_{RC}
\]

Relaxation time will always be greater than the sum of lead time and reaction time, except in the infrequent case that only one innovation-reaction cycle follows the introduction of an innovation.

How this affects a given parameter reflecting the structure\(^6\) of the market is illustrated in the following figure.

![Diagram of Structure of the market](image)

The above refers to the market reaction to a single innovation. However, as we have discussed in previous sections, radical innovations keep happening, and do it on average every \(t_{RIK}\), where the innovation period is different for each market.

\(^6\)For example, number of competitors, concentration indexes...
Analyzing the relationship between both parameters ($\tau$ and $t_{RI}$), we are in conditions to formalize our theoretical insight that a market may reach equilibrium if entrepreneurs are able to accomplish their adjusted plans before the advent of a new radical innovation.

a) When $t_{RI} < \tau$ the market never reaches equilibrium, because a new radical innovation is likely to happen before the market has arrived to the new equilibrium, inducing a new relaxation cycle.

b) When $t_{RI} \approx \tau$ the market stays most of the time out of equilibrium. 
In this case, the part of time that a market stays in equilibrium is $\frac{t_{RI} - \tau}{t_{RI}}$. Therefore, even if the market sometime settles, it would be very difficult for an external observer to discover it, and in any case the market would be out of equilibrium again before implementation by an external observer of any meaningful decision based on this equilibrium.

c) When $t_{RI} \gg \tau$ the market may be considered in equilibrium for most of the time.

As a conclusion, static equilibrium models would yield meaningful economic conclusions only for markets in which this condition is met, that is, only in markets in which innovations happen over much longer periods than the relaxation time.

If this condition is not met, static equilibrium models are not able to explain the functioning of the market and traditional static analysis should be discarded.

**Summary**

Our approach to incorporate time and innovation to traditional static analysis for regulation and antitrust decisions can be summarized in the following methodology.

1) Identify industry in which the analysis is to be made. The industry would normally be wider than the reference markets considered in antitrust or ex ante analysis in European regulation. Otherwise there is a big risk of not being able to identify radical innovations, which by definition change the structure of the market. Moreover, no geographical definition is required, because radical innovations are normally global in their nature.

2) Estimate the average time between radical innovations for that industry ($t_{RI}$)

3) Estimate the relaxation time for the industry ($\tau$).

4) Compare $\tau$ with $t_{RI}$
   a. If $t_{RI} \gg \tau$, proceed with traditional analysis
   b. Otherwise, stop analysis.

In the next section, we apply the proposed methodology to the telecommunications industry.
Application to the telecommunication industry

The topic that things are easier said than done is applicable to the proposed methodology. The problem we confront now is how to estimate the two temporal parameters involved in the test, namely average time between innovations \( (t_{ri}) \) and the relaxation time \( (\tau) \) of actual telecommunication markets.

Assessment of the innovation rate in the telecommunications market

To assess the innovation period in the telecommunications market, we need to identify innovations that have had a radical impact in the market. We have used two criteria to select them:

1. They had either created a new line of business or seriously eroded the competitive advantages of previous market leaders.
2. They are generally acknowledged to have had a significant effect in monetary turnover.

Consistent with these criteria, the degree of technical innovation involved is not relevant. For example, we have discarded innovations like Power Line Communications (PLC), which were technology breakthroughs but failed in the market. On the contrary, we have selected some others, like mobile prepaid cards, which technically involved just some fixes to the billing systems of mobile operators, but have made a lasting impact on the market and society.

We have started our analysis around 1970 in order to cover at least 40 years. We have taken as date of the innovation the year when they were first put to the market any place in the world. That means that the technical invention may actually have happened several years before (microwave radio links, for instance, were invented in 1951).

Also, since telecommunications technology has been global since its first inventions in the XIX century, we assume that once an innovation has been launched anywhere in the world, its development will be tracked by operators and entrepreneurs in the rest of the geographical areas, and the potential impact of its eventual launch there being incorporated to the business plans of all agents.

Finally, as the telecommunications industry is a quite complex one, involving many different services and networks that only partially overlap across space, time and customer segment, we have decided to make a separate assessment for three quite distinct product markets: fixed telephony, mobile services and data services.

We have built two checks of consistence in the analysis, based on the consensus that the existence of legal entry barriers affects negatively innovation in the market (see Herrera-González, 2012, p. 132). The first check involves estimating two \( t_{ri} \) one for the whole considered period and another one for the period since the liberalization of the fixed market. If the analysis is robust, then the first \( t_{ri} \) should be longer than the second one, because innovation decreases in legal monopolies or oligopolies. For
the other two markets, this check is not very useful since the legal market structure has hardly evolved (i.e., legal oligopoly in mobile services due to spectrum scarcity; free of entry in data services).

The second check involves comparing \( t_{\text{RI}} \) across the product markets. Since fixed telephony has been a legal monopoly for most part of the considered period, but the mobile services market was only during a minor part of it, and data services has never suffered of legal barrier entries, we should expect the \( t_{\text{RI}} \) for fixed telephony to be higher than that for mobile services, and both of them higher than the \( t_{\text{RI}} \) for data services.

The analysis for each of the specified products markets is summarized in Tables 1 to 3\(^7\). In the last column, we provide a short explanation on why the innovation is considered radical.

<table>
<thead>
<tr>
<th>Year</th>
<th>Innovation</th>
<th>Challenger</th>
<th>Service impacted</th>
<th>( t_{\text{RI}} ) (years)</th>
<th>(Criterion No) Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969</td>
<td>Microwave long distance (LD) links</td>
<td>LD companies (MCI, Sprint)</td>
<td>National long distance</td>
<td>-</td>
<td>(1) Lower fixed investments and economies of scale: LD economies became competitive.</td>
</tr>
<tr>
<td>1979</td>
<td>Mobile cellular</td>
<td>Mobile operators</td>
<td>National long distance</td>
<td>10</td>
<td>(1, 2) Voice services available on the move.</td>
</tr>
<tr>
<td>1990</td>
<td>Fixed cellular</td>
<td>Mobile</td>
<td>Rural telephony</td>
<td>11</td>
<td>(1) Possibility to offer basic fixed services through mobile tech (VHF, G1) to expensive areas.</td>
</tr>
<tr>
<td>1991</td>
<td>Copper pair twisted alongside coaxial</td>
<td>Cable TV operators</td>
<td>Fixed telephony in new cable areas</td>
<td>1</td>
<td>(1) New cable deployments lay a parallel PSTN network.</td>
</tr>
<tr>
<td>1991</td>
<td>Call-back</td>
<td>Start-up call-back companies</td>
<td>International voice</td>
<td>0</td>
<td>(1, 2) Lowering of international calls price.</td>
</tr>
<tr>
<td>1992</td>
<td>International mobile roaming</td>
<td>Mobile</td>
<td>International voice</td>
<td>1</td>
<td>(2) Roam to other countries while maintaining the national number.</td>
</tr>
<tr>
<td>1995</td>
<td>SMS</td>
<td>Mobile</td>
<td>Low traffic data lines</td>
<td>3</td>
<td>(2) Add text services to voice communications and substitute for short calls.</td>
</tr>
<tr>
<td>1996</td>
<td>Prepaid mobile cards</td>
<td>Mobile</td>
<td>Payphones Second residence lines Low traffic lines</td>
<td>1</td>
<td>(1) Possibility of making and receiving calls without signing any contract, causing low traffic lines to become more expensive.</td>
</tr>
<tr>
<td>2003</td>
<td>VoIP over Internet</td>
<td>OTT</td>
<td>Fixed telephony</td>
<td>7</td>
<td>(1) Complete lack of entry barriers to international voice market.</td>
</tr>
<tr>
<td>2004</td>
<td>VoIP over cable</td>
<td>Cable TV</td>
<td>Fixed telephony in older cable areas</td>
<td>1</td>
<td>(1) Cable full substitute of copper lines.</td>
</tr>
</tbody>
</table>


\(^7\) This analysis relies on Soria-Bartolomé (1999), conveniently updated.
In the case of fixed telephony, we stop our analysis in 2004. We consider that from this date on the former fixed telephony market has evolved into two:

- A commoditized declining market for voice only fixed lines, in which very few incentives to innovate remain
- A thriving convergent broadband communications market, in which voice is just one application out of many, which can no more be analyzed separately of the data market that we discuss below.

### TABLE 2. RADICAL INNOVATIONS

<table>
<thead>
<tr>
<th>Year</th>
<th>Innovation</th>
<th>Challenger</th>
<th>Service impacted</th>
<th>$t_{si}$ (years)</th>
<th>(Criterion N°) Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979</td>
<td>Mobile cellular</td>
<td>Mobile operators</td>
<td>None (new market)</td>
<td>-</td>
<td>(1.2) Voice services available on the move.</td>
</tr>
<tr>
<td>1991</td>
<td>Digital mobile networks</td>
<td>Mobile operators</td>
<td>Analog mobile</td>
<td>12</td>
<td>(1) Improved mobile capabilities and worldwide scale. It enabled new mobile operators to enter the market.</td>
</tr>
<tr>
<td>1992</td>
<td>International mobile roaming</td>
<td>Foreign mobile</td>
<td>Mobile telephony</td>
<td>1</td>
<td>(2) Roam to other countries while maintaining the national number.</td>
</tr>
<tr>
<td>1995</td>
<td>SMS</td>
<td>Mobile</td>
<td>Short mobile calls Paging</td>
<td>3</td>
<td>(2) Add text services to voice communications and substitute for short calls.</td>
</tr>
<tr>
<td>1996</td>
<td>Prepaid mobile cards</td>
<td>Mobile</td>
<td>Low traffic mobile connections</td>
<td>1</td>
<td>(1) Possibility of making and receiving calls without signing any contract, causing low traffic lines to become more expensive.</td>
</tr>
<tr>
<td>2000</td>
<td>GPRS</td>
<td>Mobile</td>
<td>SMS</td>
<td>4</td>
<td>(2) Mobile data access with low speeds of 56-115 kbps. MMS, presence or PTT services also available.</td>
</tr>
<tr>
<td>2003</td>
<td>UMTS</td>
<td>Mobile</td>
<td>GSM data</td>
<td>3</td>
<td>(2) Mobile data access with speeds of 384 kbps (no impact in voice market)</td>
</tr>
<tr>
<td>2004</td>
<td>WiFi enabled smartphones</td>
<td>WiFi providers</td>
<td>UMTS data</td>
<td>1</td>
<td>(1) Possibility for devices to access the Internet without needing a wired connection (use of a WiFi connection without using the available minutes on your smartphone’s data plan)</td>
</tr>
<tr>
<td>2006</td>
<td>VoIP over HSPA</td>
<td>OTT (Skype, others)</td>
<td>Mobile voice</td>
<td>2</td>
<td>(1) Complete lack of entry barriers on voice services for smartphone users.</td>
</tr>
<tr>
<td>2009</td>
<td>Messaging over HSPA</td>
<td>OTT (WhatsApp, others)</td>
<td>SMS</td>
<td>3</td>
<td>(1) Complete lack of entry barriers on text services for smartphone users.</td>
</tr>
<tr>
<td>2009</td>
<td>LTE</td>
<td>Mobile companies</td>
<td>UMTS data</td>
<td>0</td>
<td>(1.2) Mobile broadband speeds up to 100 Mbps.</td>
</tr>
</tbody>
</table>

Average $t_{si}(1979-2013)$: 3.09

<table>
<thead>
<tr>
<th>Year</th>
<th>Innovation</th>
<th>Challenger</th>
<th>Service impacted</th>
<th>tRI (years)</th>
<th>(Criterion N°) Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971</td>
<td>Public Switched Data Networks</td>
<td>Telephone companies</td>
<td>In-house IT teams/IT outsourcers</td>
<td>-</td>
<td>(1,2) Telephone operators able to compete with private data networks.</td>
</tr>
<tr>
<td>1978</td>
<td>Dial up access to BBS²</td>
<td>Start-ups, private individuals</td>
<td>Public data services</td>
<td>7</td>
<td>(1) Residential segment able to access data networks.</td>
</tr>
<tr>
<td>1982</td>
<td>Videotex over PSTN (Mintel)</td>
<td>Telephone companies</td>
<td>Public data services BBS</td>
<td>5</td>
<td>(1) Users able to buy online, book trips, receive emails and chat in the same way as internet.</td>
</tr>
<tr>
<td>1985</td>
<td>Metropolitan fiber networks</td>
<td>Fiber CLECs</td>
<td>Public Switched voice &amp; data</td>
<td>3</td>
<td>(1) Increase of competition in the local loop market at certain areas.</td>
</tr>
<tr>
<td>1987</td>
<td>EDI (EDIFACT standard)</td>
<td>EDI service providers</td>
<td>Public data services</td>
<td>2</td>
<td>(2) Enable the exchange (send and receive) of commercial documents.</td>
</tr>
<tr>
<td>1988</td>
<td>Cyber-café</td>
<td>Start-ups</td>
<td>Public data services Dial up</td>
<td>1</td>
<td>(1) No need to contract a full-time access in order to use data services.</td>
</tr>
<tr>
<td>1992</td>
<td>ISDN</td>
<td>Telephone companies</td>
<td>SME &amp; residential data</td>
<td>4</td>
<td>(2) Significant increase of data rates for broadband access, up to 128 kbps.</td>
</tr>
<tr>
<td>1995</td>
<td>Commercial Internet access</td>
<td>ISPs, telephone companies (dial-up)</td>
<td>Public data networks Videotex Proprietary e-mail providers</td>
<td>3</td>
<td>(1) Relative freedom of entry to the data services market</td>
</tr>
<tr>
<td>1995</td>
<td>Cable modem</td>
<td>Cable TV</td>
<td>Residential dial-up</td>
<td>0</td>
<td>(1,2) Cable companies able to offer broadband services in addition to TV contents / 3-play offers.</td>
</tr>
<tr>
<td>1998</td>
<td>ADSL</td>
<td>Telephone companies</td>
<td>Cable modem Dial-up</td>
<td>3</td>
<td>(2) Broadband access using fixed telephony line at higher speeds (matching cable speed) and simultaneous with voice services.</td>
</tr>
<tr>
<td>1998</td>
<td>WiFi hotspot</td>
<td>WiFi companies</td>
<td>Cable modem ADSL Mobile data Cybercafés</td>
<td>0</td>
<td>(2) Increase the reach of internet access covering wide areas.</td>
</tr>
<tr>
<td>2000</td>
<td>Residential</td>
<td>Fiber CLECs</td>
<td>Cable modem</td>
<td>3</td>
<td>(1) Broadband access using fiber with higher speeds and TV</td>
</tr>
</tbody>
</table>

---

² BBS: Bulletin Board Systems
TABLE 3. RADICAL INNOVATIONS

<table>
<thead>
<tr>
<th>Year</th>
<th>Innovation</th>
<th>Challenger</th>
<th>Service impacted</th>
<th>$t_{RI}$ (years)</th>
<th>(Criterion No) Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>WiMAX</td>
<td>WiMAX CLECs</td>
<td>Rural data</td>
<td>0</td>
<td>(1) Adequate rural broadband coverage.</td>
</tr>
<tr>
<td>2000</td>
<td>GPRS</td>
<td>Mobile</td>
<td>Dial-up</td>
<td>0</td>
<td>(1) Mobile data access with low speeds of 56-115 kbps. MMS, presence or voice services available.</td>
</tr>
<tr>
<td>2003</td>
<td>UMTS</td>
<td>Mobile</td>
<td>Dial-up</td>
<td>3</td>
<td>(1, 2) Mobile data access with speeds up to 384 kbps, but with no impact in voice market.</td>
</tr>
<tr>
<td>2004</td>
<td>IPTV</td>
<td>ADSL operators</td>
<td>Cable triple play</td>
<td>1</td>
<td>(1, 2) Telcos able to offer pay TV services through broadband connections.</td>
</tr>
<tr>
<td>2006</td>
<td>HSPA</td>
<td>Mobile</td>
<td>Cable modem ADSL</td>
<td>1</td>
<td>(1) Mobile data access with speeds over 7 Mbps.</td>
</tr>
<tr>
<td>2007</td>
<td>DOCSIS 3.0</td>
<td>Cable</td>
<td>ADSL Residential fiber</td>
<td>1</td>
<td>(1) Ability to provide broadband speeds up to 100 Mbps through cable.</td>
</tr>
<tr>
<td>2009</td>
<td>LTE</td>
<td>Mobile companies</td>
<td>UMTS data</td>
<td>0</td>
<td>(1) Mobile broadband speeds up to 100 Mbps.</td>
</tr>
</tbody>
</table>

Average $t_{RI}$ (1971-2013) 2.21


The figures thus estimated for average time between innovations should be taken as an upper bound for the actual figure. Even if we are confident that all innovations collected in these tables are generally acknowledged as radical, it may be the case that we have overstepped other innovations also regarded as radical.

Moreover, we have focused on those innovations easily perceived from the outside, i.e., product innovations. Any process, organizational or other type of innovations may also have a radical impact on the industry affected, but are not easy to grasp for an external analyst. Finally, we have leave out innovation in other markets that may have also had a radical impact on the telco industry (for example, all innovation in the Internet).

So, it is very likely that more radical innovations should have to be included in the tables above, for the same period, driving down the average length of time between radical innovations.

Our estimation complies with the specified checks of consistence, so we think it is a robust estimation. It can be observed, as anticipated, that:
1) Average $t_{ri}$ for fixed telephony decreased after liberalization

2) Average $t_{ri}$ for fixed telephony is higher than for mobile services, and these two higher than the average $t_{ri}$ for data services.

It is clear from this figures that telecommunications markets are highly innovative and dynamic. Even when they were still subject to legal monopolies, a remarkable number of entrepreneurs successfully innovated around regulation, and legal monopolists also were active in launching new services and competing in the fringes of their legal franchises.

Another observation is that innovation intensity has been high during a long period of time. We think that incumbent players have not the capacity to slow down innovation, even if they wished to do so. As may be seen in the following table, challenges have come not only from the telecommunications industry, but from pure start-ups and also from players in other industries in search of possible economies of scope. A review of the main sources of the technological innovation underpinning those market innovations shows that many of them are exogenous to the telecommunications market:

<table>
<thead>
<tr>
<th>Source</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitive rivalry between telecom operators</td>
<td>Prepaid mobile cards</td>
</tr>
<tr>
<td>Digitization of information (and convergence of transmission technologies)</td>
<td>Cable modem</td>
</tr>
<tr>
<td>Spillovers from computer markets</td>
<td>EDI, WiFi</td>
</tr>
<tr>
<td>Military research</td>
<td>Internet, microwave links</td>
</tr>
</tbody>
</table>

In conclusion, we think we have a good and robust estimation of the innovation rate in the telecommunications market, and that its upper bound may be established in 3 years of average time between innovations, but it is likely to be lower.

**Assessment of the relaxation time in the telecommunications market**

Innovations are observable with certain facility, so the proposed method to estimate the $t_{ri}$ is quite straightforward and common to any other industry. Of course, some discussion may arise related to the radical nature of one or other innovation, but in general terms, we think that innovation rate is measurable with a high degree of consensus.

Unfortunately for our purposes, relaxation times are much more difficult to observe. Industries, in particular the telecommunications industry, are very complex and decisions of market players are usually the reaction to several previous developments. We propose to estimate a lower threshold for this parameter, by using a variation of the shock analysis used by econometricians. The idea is to assess empirically how the telco industry reacted to an easily identified shock in its structure, and
measure the time it took to reach a new stable market structure. We will assume that the market structure is stabilized once the first exit/consolidation takes place after the shock.

European mobile markets between 1990 and 2010 offer a good probe to assess those times, for several reasons. Firstly, during that period, those markets had only a limited number of players, that used the same technology\(^9\) to offer similar services to end customers, and barriers to entry/exit deriving from the spectrum regime considerably decreased the influence of potential entrants from outside the market.

These markets were also subject to clearly identifiable shocks: the award of licenses to new players\(^10\). The main reaction that may be observed is the exit or consolidation by some players as a result of the change in market conditions that the new licenses trigger. We have analyzed the two biggest markets that have experienced radical changes in industry structure: the UK and Italy. The results are shown in the Annex.

We begin by estimating lead time (\(t_{LT}\)), for it is the more straightforward of the two components of relaxation time. As we have seen in the previous section, \(t_{LT}\) is obviously a lower limit of \(\tau\). In our case, we measure \(t_{LT}\) as the time it takes for an operator to launch commercial services on its own network since the license is awarded.

Reaction time (\(t_{RC}\)) to the entry of a new player is harder to measure, but we have identified two cases in which the license granting has been followed by changes in the market structure: the fourth GSM license in Italy and the fifth UMTS one in the UK.

Results are summarized in Table 5 below.

<table>
<thead>
<tr>
<th>Event</th>
<th>(\tau)</th>
<th>(t_{LT})</th>
<th>(t_{RC})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog licenses in the UK (1982)</td>
<td>-</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>GSM 1800 licenses in the UK (1991)</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>GSM 1800 licenses in Italy (1998, 1999)</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>UMTS licenses in the UK (2000)</td>
<td>10</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Minimum</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Maximum</td>
<td>10</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Average</td>
<td>6.5</td>
<td>2</td>
<td>4.5</td>
</tr>
</tbody>
</table>

---

\(^9\) Contrary to the USA or most Latin American and Asian countries, European regulation mandated the use of a single technology (GSM first, UMTS afterwards) to all mobile players for all digital licenses.

\(^10\) Usually, the launch of new technologies in Europe has been done by issuing new licenses. As spectrum trading was tightly restricted (when not forbidden), the award of licenses captures both the entry of new players into a too thinly populated market and the launch of new technologies.
We can observe that it took one to three years for a new mobile operator to launch services after it had secured the license. Hiring people, obtaining building permits and property leases, deploying the network, setting up the information systems and implementing a commercial offer and distribution network, require time. Note that this assessment of $t_{CT}$ is a lower bound, for a sizable part of the work is usually done after deciding to apply for the license, but before actually getting it.

These lead times are similar to the ones that can be observed in other segments of the market. Deploying a greenfield fixed network (copper, cable or fiber) in a town or neighborhood takes also two to four years.

If we turn to the reaction time, we can see from the cases of Italy and the UK that it is longer than lead time. If we look at the evolution of GSM operators in Italy, we can see that the fourth license was granted to the Blu consortium in 1999. Blu launched services in 2000. At that time, their business was failing to meet their objectives and Blu shareholders refused to pay for an additional license that would have secured them additional UMTS spectrum. Blu business continued to develop poorly, never reaching more than 4% market share in the market, and in 2002 they exited the market and sold their assets to their competitors, even before knowing whether the two new UMTS licensees would eventually launch their services (one of them, IPSE 2000, actually never launched them).

The case of UMTS operators in the UK was similar. In 2000, the British mobile market had four well established operators, with balanced market shares (between 20% and 30% each) that had remained stable for some years. That year a new agent (H3G - Hutchison Whampoa) got a license. It launched services three years later in 2003, and market shares began to diverge. H3G quickly built up its share, and O2 from the incumbent pack grew as well to 30%, at the expense of Orange and T-Mobile, whose market shares fell well below 20%. As a result, two of the trailing operators (Orange and T-Mobile) decided to consolidate their network operations in 2009 through their joint subsidiary Everything-Everywhere. After its implementation in 2010, the market went back to four network players ten years after a fifth operator was licensed.\footnote{\textsuperscript{11} It could be argued that the consolidation of H3G and T-Mobile of their networks operations in MBLN in 2007 (not implemented until 2009) constitutes a previous instance of market consolidation, and thus the relaxation time should be 9 instead of 10. This, however, changes in no way the results of the analysis.}

Summing up, our estimation shows that the relaxation time for the telco market could be in the environment of 5-6 years, with lead times around 2 years.

**Conclusion for the telecommunication market**

The results above suggest that telecommunication markets are unlikely to reach equilibrium in any moment. We have seen that average $t_{RI}$ is below 3 years, whilst the average $\tau$ is around twice, at 5-6

\footnote{\textsuperscript{11} It could be argued that the consolidation of H3G and T-Mobile of their networks operations in MBLN in 2007 (not implemented until 2009) constitutes a previous instance of market consolidation, and thus the relaxation time should be 9 instead of 10. This, however, changes in no way the results of the analysis.}
years. Even if we look at the shorter $\tau$ we have found, it is also 3 years, and in many cases lead time by itself is close to this value.

Regarding the robustness of the analysis, it should not be forgotten that the estimated $t_{RI}$ is a maximum of what the actual may be, while the $\tau$ is, on the contrary, a minimum for the actual relaxation time.

Conclusions

In this paper, we have tried to pick up the gauntlet thrown by Sidak and Teece (2009), when they complain of the glacial pace in which new development in economic theory are applied to antitrust (and sector regulation, we would add) and attribute it to the trouble in “articulating, quantifying, and operationalizing dynamic concepts”.

Therefore, we have proposed to incorporate two essentially dynamic concepts (time and innovation) to the traditional static analysis for sector regulation and antitrust. Our starting point is that every action takes time, and that actions are always part of more complex plans of individuals, devised to satisfy their needs. As plans take time, the environment conditions may change while they are carried out, making necessary adjustments to the original plan if it is to succeed. These adjustments take, in turn, some more time.

On the other hand, innovation is ubiquitous in the market. When an innovation happens, the entrepreneur may be forced to adjust his original plan to the new circumstances. We have assumed that this only happens when the innovation has radical effects on the market.

So, entrepreneurs react to radical innovation and this adjustment takes time. Only once these adjustments are implemented, may the market be considered in equilibrium, and thus the traditional static analysis provide meaningful results.

Based on the referred insight, we propose a quantitative approach to ascertain which markets or industries are bound to be in equilibrium. For that, two time periods have to be measured and compared: the average time between innovations ($t_{RI}$) and the relaxation time of the market ($\tau$).

If $t_{RI} \gg \tau$, then the market is in equilibrium for most of the time, and traditional analysis may be applied with some degree of rigor. Otherwise, the market is mostly in dynamic evolution, and traditional static analysis will provide false or senseless results.

The actual challenge of the proposed method is, of course, the estimation of above referred parameters. We think that the estimation of $t_{RI}$ is quite straightforward and robust, even if it involves a deep historic knowledge of the market under scrutiny. It is just a matter of identifying radical
innovations occurred in the market, identification that we are confident will generally find a great consensus. Besides, the so estimated \( t_{RI} \) is very likely to be a lower bound of the actual value, due to innovations indiscernible for outside observers (process innovation) and innovations in other markets affecting the relevant one.

More difficulties present the estimation of the relaxation time \( (\tau) \). We think that the method for obtaining this value is more market-specific. For the telecommunications industry, we have proposed a variation of “shock analysis” using historical evolution from some European mobile markets. Other procedures may be proposed, of course. But it should not be forgotten that both the lead time (time it takes to adjust the plan and implement the new actions) and the reaction time (time for the market to reach a new equilibrium once the adjusted plan is implemented) are lengthy affairs. In fact, in highly dynamic markets, it is very likely that new innovations appear even before the adjusted plan is carried out.

Overall, the proposed approach has a sound theoretical basis. Of course, procedural problems remain, specifically to refine the estimation of the relaxation time. Still, we think that the tool we are proposing is at least on the right direction, allowing the incorporation of dynamic concepts to traditional analysis. Assessing the innovation and relaxation times of an industry should be the first task of market analysis for authorities, in order to decide to proceed or not with the traditional analysis.

Policy Recommendations

We can not resist offering some policy recommendations based before closing this paper.

First of all, we are acutely conscious that there is a relationship between innovation and regulation, relationship that has been generally omitted during the analysis made in this paper. We have referred to it when building the consistence checks in the estimation of the innovation rate, but have not gone further. The truth is that regulation is not neutral with respect to the innovation rate; besides, most analysts tend to think that regulation negatively impacts innovation.

So, there is the theoretical possibility for a market to be in equilibrium due to excessive regulation, not to its intrinsic features. Intensive regulation may reduce the innovation rate and increase the period between radical innovations, up to a moment in which it is above the relaxation time. If this is the case, when applied to this market, our approach will show that traditional analysis is applicable for it, maybe justifying more regulation and thus driving the innovation rate lower. In sum, when performing the proposed approach, regulatory and competition authorities should not forget the
current state of regulation in the market and be aware of possible false positives in heavily regulated markets.

Secondly, the question remains of what to do if the proposed test fails. If the authority concludes that the market is not in equilibrium and thus traditional analysis is not applicable, what then? In absence of other models, there is a big temptation of keeping using the static ones, assuming that it would provide the best proxy. Of course, we do not think this is the case.

If the proposed test is not met, it means that the market is dynamically competitive, so the rate of innovation is such that agents have to keep reacting in order to survive. But this innovation can only be radical if it satisfies consumers, more than the previous state-of-the-art. Therefore, prevention of innovation would be harming for welfare. However, intervention in dynamic competitive markets based on static models is bound to have false positives and to interfere with innovation, as explained above\textsuperscript{12}.

From the market perspective, this means that when the threat of innovation driven entry (or erosion of competitive advantages) is frequent and credible, it can be expected that the competitive behavior of agents will be disciplined by it. When making their business decisions, incumbent operators will not only consider the potential outcomes \textit{ceteris paribus}. They will also consider the risk of triggering innovation in competitive technologies or business models that may lead to entry of new competitors into the market or current competitors acquiring new advantages.

In sum, our policy recommendation is not to intervene (be it on sector regulation or on antitrust basis) on markets found to be dynamically competitive according to the proposed approach.

\textsuperscript{12}See also Kirzner (1985).
References


Specific references for shock analysis in the UK and Italy

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• Wikipedia.
• Economic journals such as Financial Times, The Wall Street Journal...
Annex: Market structure evolution after new licenses in UK and Italy (Shock analysis)

Source: Internal research based on several sources. See references.
Source: Internal research based on several sources. See references