consideration and on the previous history of the processes occurring in it. Third, the competing subsystems may influence, to a certain extent, the values of the current parameters (e.g., by enhancing the innovative activity or by increasing pressure on the competitor). The situation is therefore shifting, and each imbalance in the economic system can generate a variety of diverging outcomes.

It is important that dynamic models of competition such as (3), (4) allow taking this diversity into account and can be the basis for a mathematical description of nonequilibrium situations that arise as a result of the presence of cycled production–reproduction modes in the economy.

4. Conclusion

As a rule, *mainstream* mathematical models analyze either 'pointlike' states of market equilibrium or the resulting trends of sustained economic growth. These models *do not solve* the problem as we have formulated it, of simulating the transition from simple reproduction to growth. They are difficult to use as a tool for supporting decision making on economic policies. We believe that one cause of this state of affairs is that economic theorists still perceive the macro economy as a system exclusively implementing the reproduction of itself in the mode of *coproduction* and the production of consumer goods. Economic theorists do not consider the alternative approach to the macro economy as a population of macroeconomic subsystems performing the same functions but in the *cycled production–reproduction* mode.

In our opinion, it is precisely this approach that offers good prospects for creating fundamentally new economic models, describing:

— competitive interaction at the macro level;

— macroeconomic bifurcation states;

— states of dynamic inequilibrium of merchandise and cash flows in the implementation of innovations and subsequent changes in the behavior of producers, consumers, and monetary authorities.

The important feature of the proposed approach is that it does not focus on seeking a trend of sustained growth. On the contrary, it shows how the economy now enters the trajectory of economic growth, now falls into recession, now stagnates, now resumes growth again, all of it as a result of systematic transitions from one bifurcation state to another (Fig. 6).

With this interpretation of the macro economy, the center of gravity of research in economic theory shifts toward the analysis of the conflict of interest, which becomes acute every time radical innovations are introduced. As regards research in mathematical simulation, the following fields for advancing mathematical methods are pressing and important in this case:

— simulation of nonstationary and nonsynchronous modes of the functioning of economic systems;

— simulation of the interaction between merchandise and cash flow under nonstationary conditions;

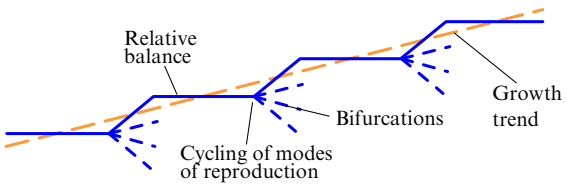

Figure 6. Sequence of bifurcations used to simulate economic growth.

— modeling the effects of positive feedback (effects of positive returns) on economic systems;

— simulation of bifurcation in economic systems, and determination of critical values of economic parameters that define the transition from one mode of operation to another.

The work was supported by RGNF funding (project No. 09-02-00747a).

References

1. Lancaster K *Mathematical Economics* (New York: Macmillan, 1968) [Translated into Russian (Moscow: Sovetskoe Radio, 1972)]
2. Sharaev Yu V *Teoriya Ekonomicheskogo Rosta* (Theory of Economic Growth) (Moscow: Izd. Dom GU VShE, 2006)
3. Glaz'ev S Yu *Teoriya Dolgosrochnogo Tekhniko-Ekonomicheskogo Razvitiya* (Theory of Long-Term Economic and Technological Development) (Moscow: VlaDar, 1993)
4. Quesnay F *Physiocratie* (Leyde et Paris: Chez Merlin, 1768) [Translated into Russian (Moscow: Eksmo, 2008) p. 279]
5. Marx K, Engels F *Izbrannye Trudy* (Selected Works) Vol. 8 (Moscow: Politizdat, 1987)
6. Maevsky V I *Izv. Akad. Nauk SSSR. Ser. Ekonom.* (6) 71 (1980)
7. Schumpeter J *Theorie der wirtschaftlichen Entwicklung* (The Theory of Economic Development) (Leipzig: Duncker & Humbolot, 1912) [Translated into English (New Brunswick, NJ: Transaction Books, 1983); Translated into Russian (Moscow: Progress, 1982)]
8. Chernavskii D S *Sinergetika i Informatsiya: Dinamicheskaya Teoriya Informatsii* (Synergetics and Information: Dynamic Information Theory) (Moscow: URSS, 2004)
9. Malkov S Yu *Sotsial'naya Samoorganizatsiya i Istoricheskii Protsess: Vozmozhnosti Matematicheskogo Modelirovaniya* (Social Self-Organization and the Historical Process: Potential Power of Mathematical Modeling) (Moscow: LIBROKOM, 2009)

PACS numbers: **02.50.–r**, 89.65.Gh
DOI: 10.3367/UFNe.0181.201107g.0758

High-growth firms in Russia: experimental data and prospects for the econophysical simulation of economic modernization

A Yu Yudanov

1. Introduction

The concept of the 'high-growth firm' or 'gazelle' was introduced in the 1980s by David Birch. It was established that the majority of both large and small companies grow slowly and contribute minimally to increasing employment and the gross domestic product (GDP) [1, 2]. But a small proportion of firms combine high dynamic stability and growth. Birch gave them the name gazelles to emphasize the similarity of these companies to the animal that is capable not only of reaching high speed but of sustaining it for a long time. In 1988–1992, by Birch's estimate, gazelles making up only 4% of the total number of firms created approximately 70% (!) of all new jobs in the U.S.

A Yu Yudanov Financial University of the Government of the Russian Federation, Moscow, Russian Federation
E-mail: yudanov@yandex.ru

Uspekhi Fizicheskikh Nauk **181** (7) 758 – 762 (2011)
DOI: 10.3367/UFNr.0181.201107g.0758
Translated by V I Kisin; edited by A M Semikhatov

This identification of the type of enterprise playing such an exceptional role in economic growth could not help attracting scrutiny. Despite some criticism (see, e.g., [3]), Birch's findings received representative confirmation [4–8]. The current assessment of the impact of gazelles on the economy has removed any doubt about the significance of this phenomenon. According to a review by a research group of the European Union (EU), "Often-cited studies suggest that anything from between 3% and 10% of any new cohort of firms will end up delivering from 50% to up to 80% of the aggregate economic impact of the cohort over its lifetime" [7, p. 6].

The amazingly large proportion contributed by a handful of gazelles indicates that the mechanism of growth of a mature market economy is subject to the so-called Pareto–Zipf principle, according to which the key role in the behavior of nonlinear multivariable systems is usually played by only a small number of high-performance factors. In this case, we witness an unevenly distributed 'growth energy' of the economy. Far from being 'spread' among all active businesses, it is concentrated in a small number of gazelles.

Do gazelles exist in Russia and do they play a significant role here? (See [9] for more general issues surrounding entrepreneurial activities.) We began studying gazelles in Russia in 2003 at the Financial University created under the auspices of the Government of the Russian Federation (Finuniversitet) [10–13].[1] The journal *Ekspert* (*Expert*) conducted an independent research project [14].[2] In 2007, the two groups joined forces. We studied three official, albeit not fully comparable, databases for 1999–2007 (and partly for 2008) of all Russian enterprises with revenues in excess of 300 million rubles. The information about each company included data on sales, fixed assets, noncurrent assets, receivables and payables, expenditures on research and development, and net profits. In fact, this project covered almost all large and medium businesses in the country, and the timeframe chosen for the study (1999–2007) fully covered the first strong economic expansion in Russia. In accordance with standard procedures, the set of permanent firms, i.e., companies that existed during the entire sample length (6.5 thousand companies during 1999–2007 and about 10 thousand companies for shorter five-year time intervals) were considered as approximations of the general set of firms of the country. Companies were identified as gazelles using the Birch algorithm, which requires that the revenue of each company grow by 20% or more every year over at least five consecutive years. The algorithm was adjusted to Russia by deciding to use the data after factoring out inflation. A substantive interpretation of statistical data relied on the array of data covering the most notable gazelles (about 500 data files), questionnaires, and in-depth interviews.

2. Description of the population of gazelles in Russia

According to direct estimates (Table 1), gazelles make up 7–8% of the number of permanent firms, i.e., they are about twice as numerous as in the West. The peculiarities of Russian accounting (see [15] for the details) makes us believe that even these high figures dramatically underestimate the number of gazelles and the correct assessment should be 12–13% of the population of companies. Contrary to the common joke, Russia should be called not the 'motherland of elephants,' but rather the 'country of gazelles,' offering the possibility of rapid and sustainable growth for a strikingly large percentage of firms.

Table 1. Number of gazelles in Russia.

Interval, years	Number of permanent firms	Number of gazelles *	Percentage of gazelles among permanent firms, %
1999 – 2003	6524	484	7.4
2000 – 2004	7348	527	7.2
2001 – 2005	8244	587	7.1
2002 – 2006	9381	744	7.9
2003 – 2007	10,174	830	8.2

* Including subsidiaries of large corporations. Source: database of medium-size businesses, Mediaholding *Ekspert*–Finuniversitet.

Table 2. Revenue dynamics for groups of companies (constant prices).

Groups of companies	Revenue, billion rubles		Average annual growth, %	Reveneue increment, billion rubles	Increment in revenue in % of total
	2003	2007			
Gazelles	285	2900	78	2615	23.1
Top-10* (Rosstat version)	1969	2985	11	1016	9.0
Top-10* (Ekspert-400 version)	2413	4560	18	2147	19.0
Permanent firms	12,393	23,707	18	11,314	100

* Gazprom, Lukoil, Surgutneftegaz, Nornikel, Transneft, Tatneft, Severstal, Magnitogorsk metallurgical works, Novolipetsk metallurgical works, AvtoVAZ. The Rosstat (Federal State Statistics Service) version takes only parent companies into account, while the Expert-400 version also includes consolidated data for subsidiaries. Source: database of medium-size businesses, Mediaholding *Ekspert*–Finuniversitet.

Growth rates of Russian gazelles were impressive (Table 2). They increased revenue annually by 78% on average, while the average growth rate of all permanent firms did not exceed 18%.

An estimate of the contribution of gazelles to national economic growth is somewhat ambiguous. This contribution can be regarded as quite large in view of the tiny start-up size of gazelles. Indeed, in 2003, gazelles generated a mere 2% of the total revenue of permanent firms. But this did not stop them from generating almost a quarter (23.1%) of the increment in this index over the period 2003–2007. At the same time, however, the contribution of Russian gazelles was much lower than that typical of the West (50–80% of increment in GDP).

Is it possible to give a rational explanation for the strange combination of properties of the Russian population of gazelles, namely, their large number against a lower impact on the economy? In our opinion, both these effects stem from the excellent possibilities of rapid growth in a young, emerging market economy. Indeed, this situation increases the number of gazelles: Russia offers a multitude of promising unoccupied niches, making long-term dynamic development possible. But Russian 'non-gazelles' also grow fast, and for the same reason of youthfulness of the economy. In other words, the group of gazelles in the West constitutes almost the entire engine of growth of the economy. In contrast, Russian gazelles play a relatively lesser role, not because they are more passive or weaker than their foreign counterparts, but

[1] The main participants in the project, in addition to the author of this article, were N N Dumnaya, G V Kolodnaya, V V Razumov, O E Pyrkina, V A Uspenskii, and E V Medina.

[2] Yu A Polunin, T I Gurova, A V Vin'kov, and O L Ruban.

because although they are important, they are nevertheless not the only engines of economic growth.

At the same time, it would be wrong to downplay the role of gazelles in the economy of Russia. Table 2 provides information on revenue growth of the 10 largest corporations (top-10) in Russia. Public opinion clearly links the revival of 1999–2007 with their enrichment using the global growth in prices of raw materials and fuel. However, the increase in revenue of gazelles exceeds the growth rate of the revenue of the top-10 corporations in Russia, even if the latter includes the revenues of their subsidiaries.

Obviously, direct comparison of the revenue of gazelles and resource corporations is not completely correct. Firms operate in different industries, create a different added value, etc. It is also appropriate to ask what the origins of growth of gazelles were: it is very doubtful that it could reach the scale we have witnessed in the economy were it not propped up by resource revenues. It is nevertheless worthy of note that the largest growth in revenue came not from resource giants — helped by the unprecedented situation with world prices — but from gazelles, although 'resource gazelles' are a rarity.

It appears logical to interpret Russian gazelles as real agents of the process of transformation of oil revenues into general economic growth, i.e., precisely those agents of economic diversification that became an obsession with our politicians. It is not impossible for our gazelles, once they mature and grow the muscle, to become the future non-resource-based engine for the Russian economy.

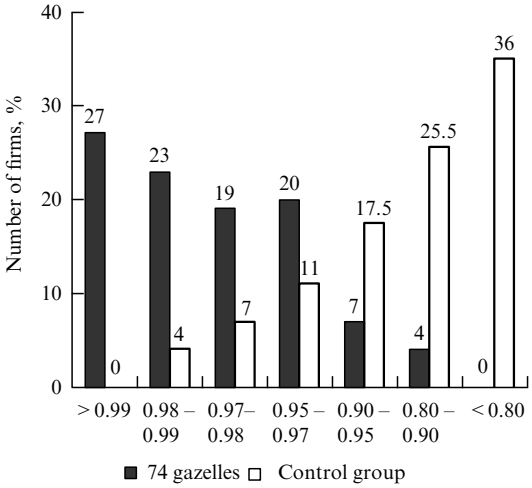

Figure 1. Degree of compliance to the exponential law for the revenue dynamics of the full set of identified gazelles that each year had the annual revenue growth rate greater than 20% in constant prices over the interval 1999–2006, and the data for nongazelles (equal number of 74 firms in a random sample from among the permanent firms for 1999–2006) to the exponential curve (percentage of firms with the corresponding determination coefficient R^2). Source: database of medium-size businesses, Media-holding *Ekspert*–Finuniversitet.

3. Exponential growth and entrepreneurial nature of gazelles

The exponential growth of many Russian gazelles was an unexpected phenomenon identified in the study but not yet described in the literature. It was first considered accidental, because revenues of companies typically demonstrate high levels of fluctuation due to variability in demand for their products. But it turned out that the exponential growth is typical for gazelles.

Figure 1 shows the degree of correspondence of revenue dynamics and the exponential law of growth for gazelles and for nongazelles. We chose long-life gazelles as representative gazelles. Specifically, we considered all 74 firms (out of 484 gazelles of the generation of 1999–2003; see Table 1) that succeeded in sustaining high growth rate until 2006. An equal number in a random sample of permanent firms played the role of the control group.

The growth dynamics of about 50% of long-life gazelles followed the exponential curve practically perfectly ($R^2 > 0.98$), while ordinary companies with this behavior were exceptions (4% of firms).[3] Almost all long-life gazelles (89%) were described satisfactorily ($R^2 > 0.95$) by exponential growth.

The enigmatic ability of many gazelles to grow by a constant percentage from year to year irrespective, as it were, of external factors was unmistakable. An unavoidable question is: why do the factors that constantly perturb the progress of other firms fail to force a gazelle to stray away from the exponential?

In nature, the typical case where exponential dynamics is found is the development of reproductive processes in the absence of resource constraints. For example, the population of rabbits brought to Australia grew exponentially until it inhabited every green valley of the continent.

Could it be that this absence of constraints (constraints on demand in this case) is the key to the nature of the stable rapid growth of gazelles? Indeed, most of the factors that cause the instability of the dynamics of a firm evolution actually reduce to fluctuations in the demand for its products. It appears logical to link gazelles' escape from demand constraints to their entrepreneurial or innovative (after Schumpeter) nature. The products brought to the market by innovators are so much in demand that every item supplied by their companies is certainly purchased. The growth rate in such circumstances is limited not by demand but by the ability to increase the supply of the product or, in other words, by the rate of expansion of specific internal assets: personnel trained in advance for reaching the targets set by the company, managerial staff, and dedicated equipment.

It is significant that the growth of these factors tends to be exponential. An entrepreneur capable of yearly training two leaders with initiative, who then train two assistant managers each, and so on, is no different in the sense of process dynamics from a doe rabbit. If we find that Russkii Standart bank had a stuff of 221 employees in 2000 and 36617 in 2006, it is clear that the rate of growth of this particular gazelle was constrained by nothing else but the rate of training high-class managers. Otherwise, the tiny bank that has recruited more than 36 thousand rookies would simply lose control over its operations.

Our interviews showed that the above line of reasoning is not mere speculation. Leaders of gazelles (Fig. 2) indeed interpret the situation with their companies as conditions of quasi-unlimited demand. Only 10–14% of gazelles[4] point to insufficient demand as a factor that hampered the fast growth of their company! At the same time, resource constraints,

[3] Additional research has shown that these companies are also gazelles, but have a shorter longevity.

[4] We deal with the pre-crisis period here.

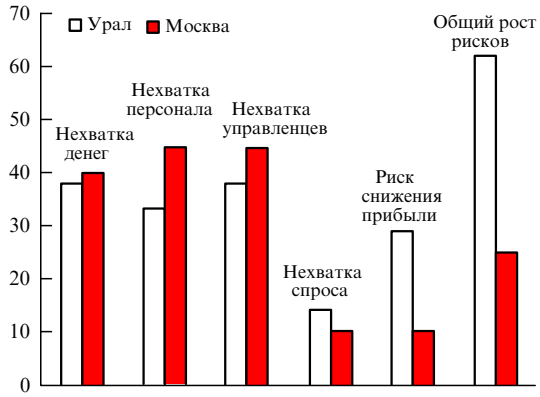

Figure 2. Answers of top managers of Russia's gazelles to the question about factors limiting the growth of their firms (by percentage of respondents). (Based on a survey of 20 gazelles in Moscow, November 2008, and 22 gazelles in the Ural region, March 2009.)

such as a shortage of money, problems with recruitment of personnel, and shortages of managerial staff, are regarded by gazelles as serious factors constraining growth (answers of 38–40%, 33–45%, and 38–45% of gazelles, respectively).

This pattern does not mean that gazelles are insensitive to the volume of demand. Rather the opposite: in all likelihood, a company can reach the rank of gazelle only after the problem of demand has been successfully resolved and the barrier of limited demand has been breached at least for some time. M Kershtein (Ramfood company, Meat products) formulated this idea almost word-for-word: ''We produce as much output — of a quality that suits us and in a variety required by the market — as we can. It seems that if we had an opportunity to double our output within two or three months, the market would swallow this up.''

The heretical idea that demand may not be the limitation of a company growth rate was theoretically developed by Penrose already in the 1950s [16, 17]: ''So long as there are profitable production opportunities open anywhere in the economy, a firm can take advantage of them if its resources are versatile, in particular, if its management is imaginative, flexible and ambitious.'' The thing to do is to adjust in the right manner to the demand that always lurks somewhere. ''Failure to grow is often incorrectly attributed to demand conditions rather than to the limited nature of entrepreneurial resources [of the company]'' [16, p. 540].

It is known that Penrose's concept failed to reach the status of generally accepted truth. The study of Russia's gazelles led us to understanding why this attractive idea was unsuccessful. We came to the conclusion that this sort of logic should be applied not to every company (as Penrose did) but only to entrepreneurial, innovative firms. Only such companies, gazelles among them, have sufficient entrepreneurial resources for cutting through demand constraints and reaching the stage of an ultrafast exponential growth trend. What Penrose regarded as a general rule is in fact by no means characteristic of the majority of firms as they slowly evolve in the conservative environment of a steady market. But the study of gazelles allows concluding that just the exponential growth — unconstrained by demand — of this small part of the population of firms constitutes the central mechanism driving the rapid changes in a market economy (see [18] for information on the model splitting of firms into conservative and innovative).

4. Gazelles and another approach to the problem of the modernization of Russia

Today, after decades of neglect, the question of the modernization of the economy has moved to the center of public attention and policy initiatives. The main emphasis is on stimulating the growth of hi-tech companies (like the creation of the Skolkovo center). This is undoubtedly an important task, because entrepreneurs building an innovative company in Russia without help and support face huge difficulties trying to overcome various obstacles. Professionals know, however, that in real life, the problem is not solved once the company has been created; far from it. The main hurdle is that an innovative enterprise in Russia, having reached a certain size, ceases to grow and never matures into a world-class player. Companies simply lack sufficient demand. In the simplified Russian economy, which shifted the focus towards primary products, sophisticated hi-tech products wilt in the limbo even despite unquestionably outstanding product characteristics.

''Russian innovative companies attempt to skip several institutional barriers in their evolution. They need access to capital at the early stage and later some help in conquering markets'' [19, p. 24]. Direct stimulation of innovators by the state at this later stage is almost pointless: what use is there in multiplying their number if the market offers no demand for their products?

This is where Russian gazelles may come to the fore. In terms of the structure of the industries, they and their counterparts in other countries are typically not hi-tech firms (Table 3). On the contrary, most of them are concentrated in conservative industries (trade, construction, food) or industries at a moderate technological level (machine building, chemistry).

It has been fully understood, however, that a strong hi-tech component does not grow where it feeds itself, i.e., satisfies the demand within hi-tech branches, but it grows where its product is demanded by the entire economy, including the saturation of all, including low-tech, industries with hi-tech products [20, 21]. Gazelles reign supreme in identifying and building demand for their products at the consumer end and are therefore natural consumers/implementers of new technologies. The fact that gazelles have this ability to stimulate consumer frenzy in any (including traditional) industries additionally expands the scope of use of innovations. Owing to gazelles, high-tech firms gain potential access to massive sales of their products.

We have collected documented examples of borrowing, adapting, and implementing technological advances in the files of a number of gazelles. Nevertheless, this has not yet become a large-scale phenomenon in Russia because manufacturers of hi-tech products in this country do not yet know which specific innovations are in demand by gazelles, while gazelles have no information on what Russian hi-tech can supply to them. Obviously, the current predominant policy of stimulation to create hi-tech companies requires supplements aimed at facilitation of their contacts with the agents generating demand for innovations, such as gazelles.

5. Conclusion: prospects for the econophysics approach to simulation

The study of the phenomenon of Russian gazelles is still in its infancy. But even the initial results indicate its considerable significance. Gazelles have proved to be brilliant representatives of healthy, nonoligarchic Russian business resulting in

Table 3. The sectoral structure of gazelle population.*

Industry	Gazelles, %	All permanent firms, %	Number of gazelles per 100 permanent firms
All industries	100	100	7.9
Wholesale and retail trade	42.3	39.3	5.5
Construction and building materials	20.7	13.0	8.1
Machine building	7.8	7.6	5.2
Food industry	5.2	7.1	3.7
Engineering (including oilfield services)	4.1	1.2	17.6
Chemistry, pharmaceuticals, perfumery	3.6	2.8	6.5
Transportation, logistics, communications	3.3	4.1	4.1
Consumer goods	2.5	1.4	9.2
IT and Internet	2.3	0.6	19.7
Business services	1.9	0.5	19.6
Agro-industrial complex	1.7	1.7	5.2
Hotels, tourism, entertainment, public catering	1.4	1.0	7.4
Other	3.2	19.7	0.8

* Source: database of medium-size businesses, Mediaholding *Ekspert*–Finuniversitet.

an appreciable impact, both quantitative (increase in GDP and employment) and qualitative (initiation of proprietary innovations and transfer of innovations from other sources), on the economy of the country.

From the standpoint of research, it appears promising to simulate the effect of gazelles on the development of high technologies in Russia in the framework of econophysical analogy to the phenomenon of a particle overcoming the potential barrier.[5] In this analogy, the innovative activity of a high-tech firm is regarded as the particle energy, which may be sufficient but is more often too small for the particle to overcome the 'work function for entering the market.'

Two potential barriers of different degrees of transparency have to be overcome for the successful development of a company. During the first stage of a company development, i.e., while the market tests the innovative product (annual revenue up to \$10 million, the first 'potential barrier'), the state support for innovative companies as such plays an important role; this factor is introduced into the model as an increased energy of particles.

At the second stage, when the firm reaches an annual turnover of about \$100 million, the main success factor is the access to the mass market of hi-tech products. Simulation of overcoming this second 'potential barrier' uses the concept of the tunneling effect. The 'transparency coefficient' of the barrier is then a function of the degree of development of the gazelle population, i.e., of the carriers of the external factor — the demand for innovative solutions — not constrained by the limits of hi-tech demand.

Next, based on the known quantum mechanical equations for the tunneling effect, the possibility of a mass emergence of hi-tech firms in some industries can be considered (tunneling through a potential barrier and the subsequent clusterization). The conditions necessary for the emergence and development of such a process can be estimated in the semiclassical approximation.

[5] This idea was suggested by O E Pyrkina (Financial University), who is currently working on the development of this model.

References

1. Birch D L *Job Creation in America. How Our Smallest Companies Put the Most People to Work* (New York: Free Press, 1987)
2. Birch D, Medoff J, in *Labor Markets, Employment Policy, and Job Creation* (Eds L Solomon, A Levenson) (Boulder, Co.: Westview, 1994) p. 159
3. Davis S J et al. *Small Business Economics* **8** (4) 297 (1996)
4. Kirchhoff B A *Entrepreneurship and Dynamic Capitalism* (Westport, Conn: Praeger, 1994)
5. Audretsch D B *Small Business Economics* **18** (1 – 3) 13 (2002)
6. Delmar F, Davidsson P, Gartner W B *J. Business Venturing* **18** (2) 189 (2003)
7. Europe INNOVA (2008): Europe INNOVA Gazelles Innovation Panel. Summary and Conclusions from Panel Discussions, http://www.europe-innova.org
8. Henrekson M, Johansson D *Small Business Economics* **35** 227 (2010)
9. Chepurenko A Yu *Mir Rossii* (2) 22 (2008)
10. Yudanov A Yu *Opyt Konkurentsii v Rossii. Prichiny Uspekhov i Neudach* (The Experience of Competition in Russia: Causes of Success and Failure) (Moscow: Izd. INTRAS–KNORUS, 2007)
11. Yudanov A Yu *Voprosy Ekonomiki* (2) 85 (2007)
12. Dumnaya N N *Novaya Rynochnaya Ekonomika* (New Market Economy) (Moscow: MAKS-Press, 2009)
13. Kolodnyaya G V *Skvoz' Prizmu Praktiki*: *Neoinstitutsional'naya Teoriya Firmy* (Through the Prism of Practice: Neoinstitutional Theory of the Firm) (Moscow: Finansy i Kredit, 2007)
14. Vin'kov A A, Gurova T I, Polunin Yu A, Yudanov A Yu *Ekspert* (10 (599)) 36 (2008)
15. Yudanov A Yu *Zh. Novoi Ekonom. Assotsiatsii* (5) 91 (2010)
16. Penrose E *Am. Econ. Rev.* **45** 531 (1955)
17. Penrose E *The Theory of the Growth of the Firm* (Oxford: Oxford Univ. Press, 1995)
18. Maevsky V I *Voprosy Ekonomiki* (11) 58 (2001)
19. Medovnikov D, Imamutdinov I "Proiti pubertatnyi period" ("To leave puberty behind") *Ekspert* (2 (641)) 24 (2009)
20. Hirsch-Kreinsen H, Jacobson D (Eds) *Innovation in Low-Tech Firms and Industries* (Cheltenham: Edward Elgar, 2008)
21. Polterovich V M *Voprosy Ekonomiki* (6) 4 (2009)