

## The Main Product's Life Cycle as an Innovative Development Indicator of Enterprises

Oleg Golichenko, Alexander Popov

Central Economics and Mathematics Institute, Moscow, Russia

Moscow Institute of Physics and Technology, Moscow, Russia

[golichenko@rambler.ru](mailto:golichenko@rambler.ru)

[alexander18124work@gmail.com](mailto:alexander18124work@gmail.com)

**Abstract:** The innovation process can advance in two possible directions. The first one is the support of the already existing markets and products, which could be feasible in their relatively slow evolution. The second is developing products priorly absent at the market, which implies expanding market products diversity. In this paper, we were striving to find answers to the following questions: 1) Which of the two mentioned ways dominates the Russian industry? 2) To what extent are the difficulties with Russia's economic development, particularly the slowdown and stagnation of economic growth, affect the scale of this dominance? To answer the questions concerned, we studied the life cycle of industrial enterprises' main types of goods and services from 2007 to 2018. The stable or growing life cycle value is regarded as proof of the successful implementation of the first path, whereas its instability proves to implement the second direction. Special attention was paid to innovative-passive enterprises' behaviour. They strained to retain their main product life cycle until the external economic conditions deteriorated. In this situation, significant changes in the product life cycle showed up; this gave the reason to believe these enterprises temporarily moving into the class of innovative-active ones. We also figured out that the entire population of innovative-active enterprises could be divided into two groups. The first one contains enterprises whose strategy was to maintain the market product diversity (range) at the same level, which is equal to lengthening the main products' life cycle as long as possible. The second group comprised the enterprises to expand the product diversity (nomenclature) due to the radical innovation implementation, rather than at maintaining the life cycle unchanged. Besides, the latter group is characterised by an attempt to reduce the life cycle during the economic crisis. According to this study, the first group included large enterprises while the second united small and medium-sized units.

**Keywords:** product life cycle, innovation development, innovative-active enterprises, new product development time, population of enterprises

### 1. Introduction

The concept of the product life cycle is broadly discussed in modern scientific literature. Raizberg, Lozovskiy, and Starodubceva (2007) consider the life cycle when the product circulates on the market. This approach is also advocated by Romanov, Basenko, and Zhukov (2009). Kotler, Keller, and Cunningham (2006), in turn, suppose the following statements to be correct:

- a) The product life cycle is limited.
- b) Product sales are distributed unequally throughout the cycle.
- c) Various cycle stages require various product promotion strategies.

Generally, five major life cycle phases get a distinction: research & development, a product launch on the market, growth in sales, market maturity, and a sharp decline in sales (Orcik, Tekic, and Anisic, 2013).

During the first phase – the research and development of a new product – the magnitude of starting the product's sales is nearby zero. The company's revenue from the product sales does not cover the cost of production yet. Simultaneously, the costs of developing and improving the quality of the product remain very high. These factors combined lead to significant losses and instability of the enterprise.

The second phase – the product launch on the market – is determined by the commitment to winning over the consumer, i.e. creating a customer base for this particular product. It is proved by a high percentage of the innovator company's costs to the marketing promotion of the product. The phase of significant growth in sales follows by the second phase. Within this stage, marketing activity and product modification, which give an enterprise a chance to retain the existing technological advantage, are carried on.

At the fourth phase – the phase of the market's maturity – the growth in competition leads to the market saturated with various product modifications. The number of competitors stabilises, product sales and profit margins are at the peak, and the cost of new customers' attraction reaches a minimum (Prasad, Jha, and Verma, 2019).

The final (fifth) stage – market squeeze – is characterised by many competitors and decreased product attractiveness for the customer. A gradual decline in product sales is also being noted. It is worth adding that the scientific community widely perceives the life cycle as a set of consecutive non-intersecting phases (Cao and Folan, 2011).

It is worth mentioning that upon getting into the maturity phase, the company strives to cling to it as long as possible to avoid the transition to the market squeeze phase. To achieve the just-mentioned goal, an enterprise attempts to either reduce the production costs of the existing product range or improve the product quality and attract and win over new groups of consumers. By such means, the company can support and even solidify the market demand for the product. Should these efforts prove unsuccessful, and the advent of the market squeeze phase becomes a grave threat, the enterprise would face the task of attracting auxiliary market demand through significant (sometimes radical) shifts in product quality and range.

In other words, the end of the maturity phase is already the right time to discuss fostering the enterprises' innovative activity, which we can do by following each of the two key directions. The first way is to focus on maintaining and incremental improvement of already existing products and markets. In this case, we talk about their slow evolution. The alternative solution consists in aiming to transform the old markets and create new ones. The activity should result either in the launch of new products on the market or expanding their diversity or forming a new market (Perilla Jimenez, 2019).

Both types of the innovation process, described above, usually develop in one of two following ways:

- 1) Process innovation and incremental product improvements (or both simultaneously)
- 2) Radical product innovations (introduction of new products, product range extension, a substantial transformation of the old market or creation of the new ones).

There are several approaches to define these types of innovations. The most common among them is the so-called enterprise-level approach, which implies that a new (or considerably improved) product of some enterprise could be regarded as a product innovation, whereas a modification of the production process (without any significant product change) is called a process innovation (Simonetti, Archibugi, and Evangelista, 1995). Priorly, another way of defining those notions was in place. That time one could designate product and process innovations in terms of the "first use". In this context, an innovation concerned could be considered product one only when it "goes beyond" (i.e. used outside) the innovation creator-enterprise; other innovative activity that occurs only "inside" the innovator firm leads to the creation of a process innovation only. From the consumer's perspective, product innovations aim to meet demand from the start. In contrast, process innovations have to be mainly focused on enhancing production means rather than on the final product. Nowadays, product innovation is unanimously perceived as a new product, either for the company itself or for the outside world, i.e. a local, national or international market (OECD and Eurostat, 2018).

Thus, the product life cycle's stable or slowly growing value is an indicator of the company's success in implementing the first direction of innovative development. In contrast, the indicator value instability may prove the enterprise to be endeavouring to follow the second. To pursue the first, primarily process, and incremental product innovations are put into use, whilst radical product innovations are utilised to sustain the other.

In this paper, we seek to find answers to the following questions: 1) which of the two mentioned innovative activity directions dominates the Russian industry? 2) how much do Russia's economic development difficulties, the slowdown and stagnation of economic growth particularly affect the scope of this dominance?

To answer these questions, we are to research the dynamics of the Russian industrial enterprises' main product's average life cycle. We stressed the enterprises that carried out innovations (so-called innovative-active) and ones that did not (they are called innovative-passive). The study will also examine the populations of large enterprises (from 250 to 999 employed, 1000-4999 employed and more than 5000 employed) separately from medium (100-249 employed) and small ones (99 employed or fewer). The data source is the form of the federal state statistical observation No. 4-innovation "Information on the organisation's innovative activity." In the data analysis, we calculated the value of the product life cycle indicator and the new main product's development time (the latter – solely for the enterprises that carried out technological innovations) - the time elapsed before replacing the old product with a new one.

## **2. Research Methodology**

We analysed the life cycle of industrial enterprises' main goods and services from 2007 to 2018. Constantly growing values of the product life cycle indicator match the successful retention of the already existing products. In its turn, unstable indicator values' dynamics imply implementing the second innovative activity direction. We have put under research the life cycle for various populations of enterprises. Namely, the study was carried out for the classes of large (250-1000, 1000-4999 and more than 5000 people employed), medium-sized (100-249 employed) and small enterprises (fewer than 99 employed).

The life cycle indicator has been calculated as follows. At the first stage of calculations, for each size class at a given period, we calculated the average "life" of the main product through statistics, which allowed us to divide enterprises of each size into five groups by the lifetime of the main product: 0-1 year, 2-5 years, 6-10 years, 11-20 years and more than 20 years respectively. For each group, we introduced the average life indicator of its main product: 1 year, 3.5 years, eight years, 15.5 years, and 20 years, respectively. Furthermore, each size class's main product's average lifetime was determined as a sum of the life indicators of their main product of these five groups above, taken with their particular weights in the class. The group's share in a class was defined as the group's share in the total number of organisations within the concerned class. At the second stage, the main product's life cycle was derived for the united set of classes as a whole. To do this, we calculated the share of each classes' production among the products manufactured by all classes combined. We then summed up the average life cycles of classes with these counted weights, which gave us a weighted average life cycle indicator.

### **3. Behavioural models of enterprises' populations in the context of the economic crisis**

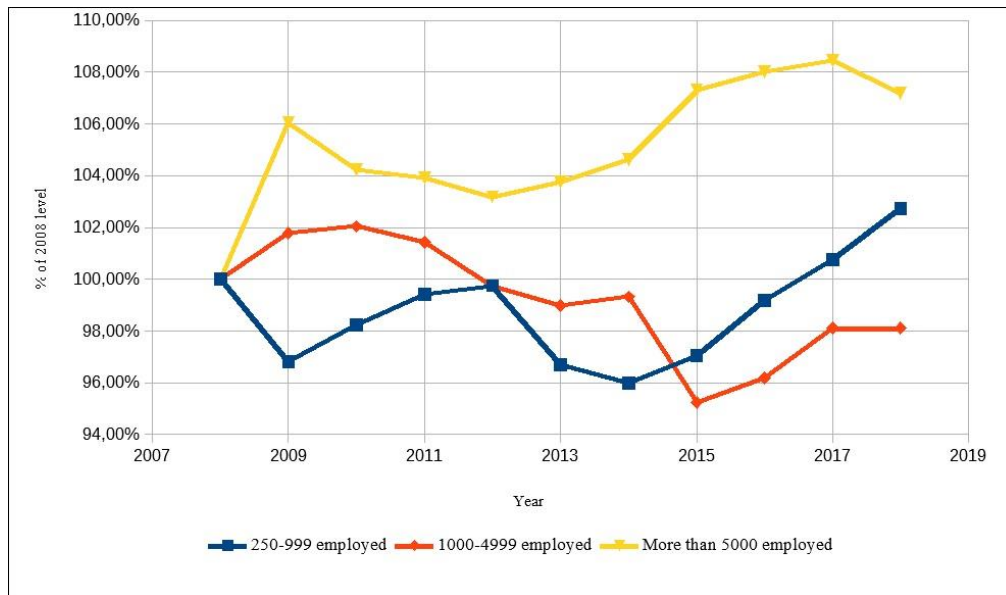
In this section, while considering typical models of enterprise's response to the economic crisis, we distinguish two types of their populations. They are classes of large enterprises and small and medium ones.

#### *3.1. Large enterprises*

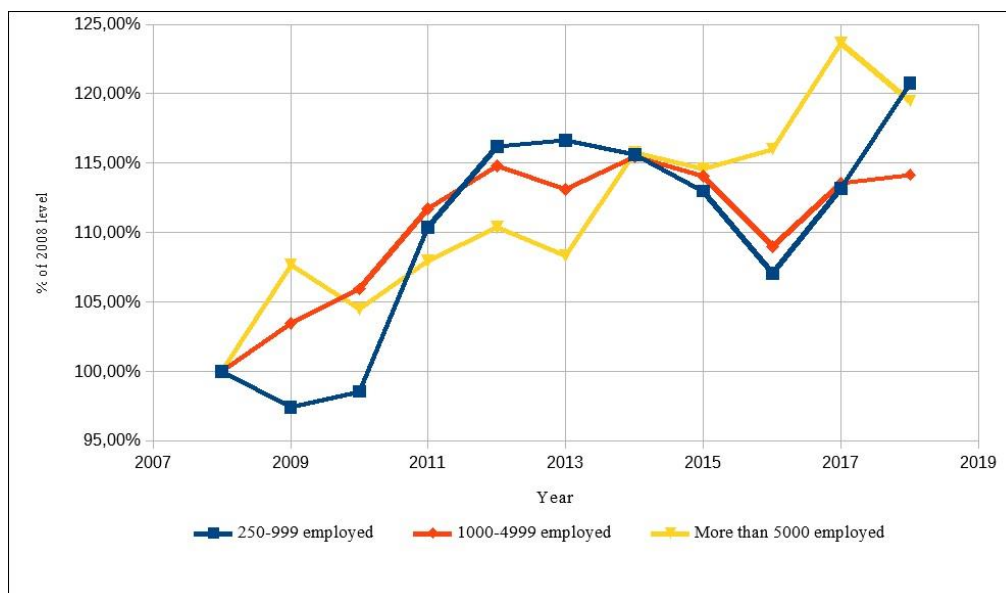
Among large innovative-active enterprises, ones with the number of employees within 250-999 people amount to about 13% of produced goods and services in the total sales. A subclass with 1000-4999 employees accounts for about 48%. In contrast, the enterprises with more than 5,000 people employed contribute almost 26%. For innovative-passive enterprises, i.e., not implementing any technological innovations, the share of large enterprises' sales (data for 2018) is nearly 68%, including 36.4% (250-999 employed), 27.3% (1000-4999 employed), 4% (more than 5000 people employed). Innovative-active large enterprises, namely the class with more than 5000 employees, responded to the 2008 crisis by a significant increase (by 6%) in the average life cycle of the main product in 2009. However, a three-year drop followed this dynamics of the average life cycle of the main product (Figure 1). Generally, this decrease was limited to 2% from the level of 2009 in 2012. Generally, this decrease was limited to 2% from the level of 2009 in 2012.

Within this period, the time spent on developing a new product grew and limited the enterprises' ability to increase the principal product life by enhancing its nomenclature (Figure 2).

Nevertheless, from 2013 to 2017, one can observe an increase in the indicator mentioned above to 108% out of the 2008 level. This time, the stable nature of the dynamics and gradual growth of the life cycle indicator makes one think that during these years the innovation process took the shape of slow evolution aimed at maintaining existing level of production and retention of the already existing markets. Generally, the class demonstrates the progressive dynamics of this indicator over the concerned years. The overall growth over the entire period amounted to about 7-8% of the 2008 level. It is worth mentioning that this gradual hike required a 20% increase in product development time by 2018 (Figure 1).



**Figure 1:** Main product's life cycle growth rate for large innovative-active enterprises



**Figure 2:** New main product's development time for large innovative-active enterprises

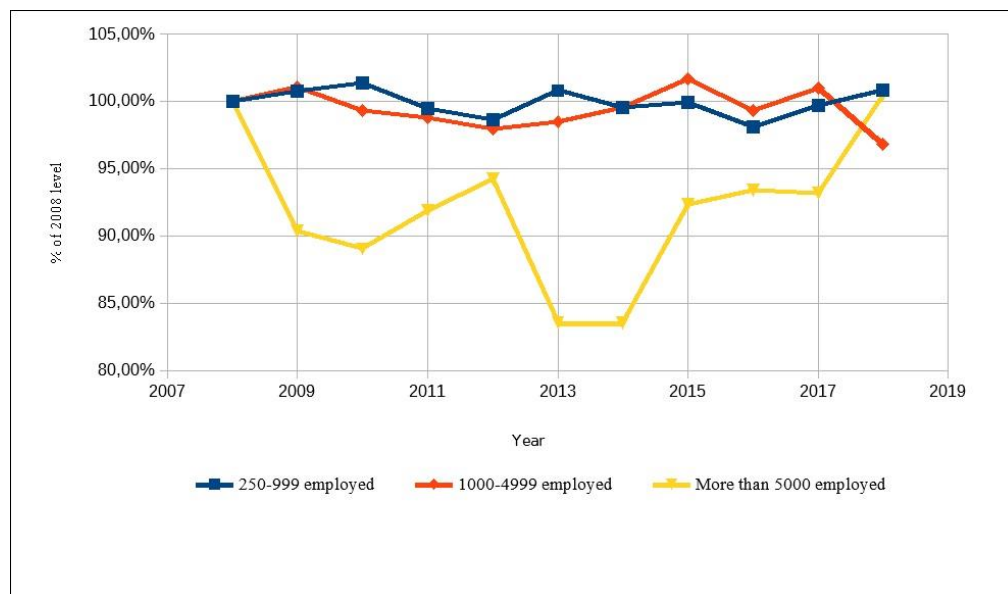
Stable positive growth, which both indicators reach in 2013-2017, indicates a primary focus on the gradual improvement of the existing main product, which implies the evolutionary type of innovation.

As for innovative-passive enterprises with 5,000 or more employed, the main product life dynamics appears to be notably worse (Fig. 3). It would be enough to say that merely within 2012-2014, the life cycle indicator had fallen by almost 10%.

Should we apply this approach to enterprises with 1000-4999 employed, we will get a picture quite different. This subclass of large enterprises (dominating by output among innovative-active ones) in 2008-2011 shows a slight increase in the main product's life cycle (Figure 1). Concurrently, up to 2013, this process was accompanied by the extension of the new product's development time. The latter implies that this class's enterprises are prone to maintaining the already mastered main product's life cycle as their priority. The subsequent decline in demand for this product during the acute phase of the systemic crisis (2014-2016)

turned out to be a significant hurdle towards tackling this problem, which resulted in a sharp decline in the main product's life cycle by 2015. This fall proved to be impossible to compensate fully in the years ahead. Attempts undertaken to switch to the new product's manufacturing failed since the time of the product's development had been decreasing slightly in 2014-2015, though showing an upward trend later on (Figure 2). It is worth noting that this innovative-passive enterprises' class showed stable values of the main product's life cycle indicator. It was hovering around the 2008 level throughout the entire period under review.

Innovative-active enterprises employing 250-999 people addressed both the crisis of 2008-2009 and the sharp phase of the systemic economic problems in 2014-2016 with a decline in their life cycle with the indicator's succeeding recovery. By 2018 the growth accounted for 10% from 2014, whereas a 10% rise in the new product's development time's growth rate characterized the rebound period. Innovative-passive enterprises of this class demonstrated virtually no change in the life cycle indicator in relation to the level of 2008 throughout the researched period (Figure 3).



**Figure 3:** Main product's life cycle growth rate for large innovative-passive enterprises

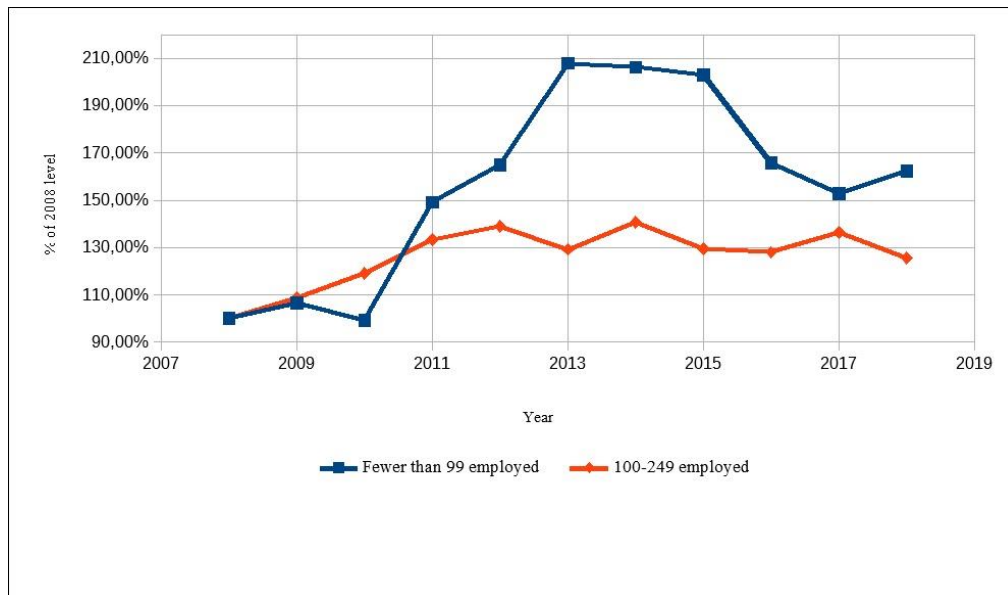
Thus, the analysis performed allows us to draw two conclusions. Firstly, all three researched subclasses of large enterprises reacted differently to crises in the economy (accompanied, among other things, by a downturn in demand for the main product). It is corroborated by different dynamics of the main product's life cycle indicator in the reviewed subclasses. Secondly, the stability of life cycle growth indicators and the growth rate of development time majorly points out the evolutionary nature of the large enterprises' innovation activity, which consists in improving the existing product rather than creating a radically new one.

### 3.2. Small and middle-sized enterprises

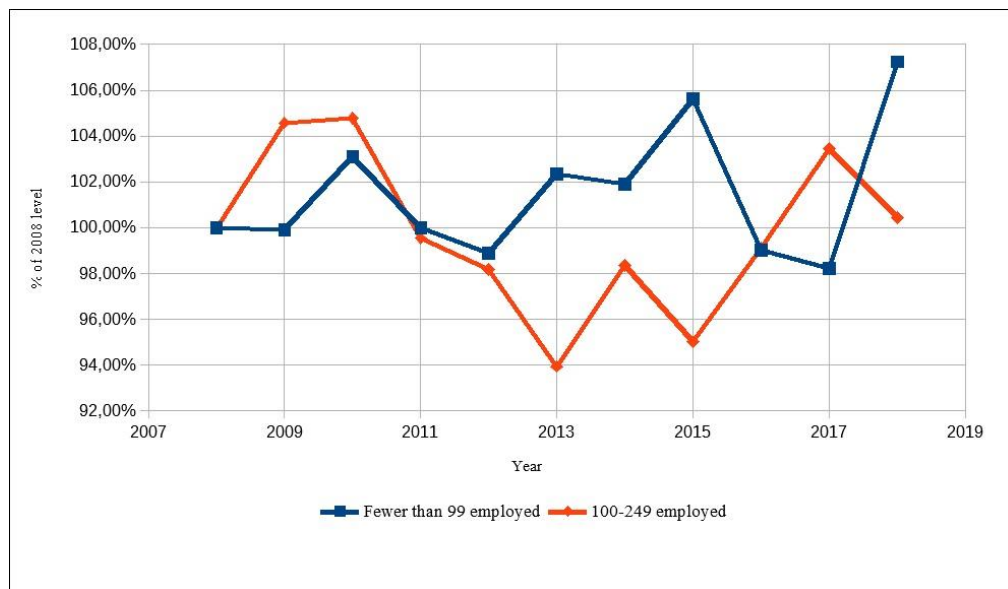
The analysis shows two different types of small enterprises' reactions to crisis phenomena (Figure 4). At the first crisis (2008-2009), they were eager to increase the new product's development time (i.e. create a better new product to retain the consumer who experienced stagnation in real incomes). After a modest decline in this indicator's value in 2010, enterprises were extending the main product's development time until 2013 (the value of the indicator almost doubled with respect to 2010).

The upturn in development time reduced enterprises' ability to enhance their products, which led to a decrease in the main product's lifespan in 2011-2012 (Figure 5). By 2013, however, the situation had stabilised, and the life cycle value of the updated core product had returned to 2010 levels.

The enterprises' response to the downturn in 2014-2016 was quite the opposite: they strained to significantly broaden their products' diversity, increasing the time to develop the product and simultaneously reducing the main product's life cycle.



**Figure 4:** New main product's development time for small and medium innovative-active enterprises



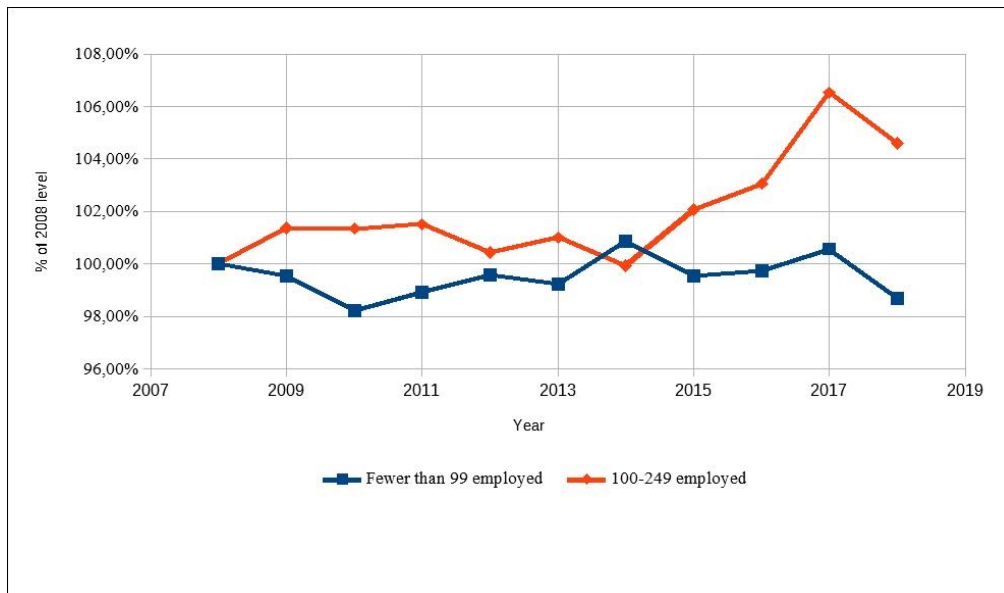
**Figure 5:** Main product's life cycle growth rate for small and medium innovative-active enterprises

There was a solid (for almost a third of the initial) cut in a new product's development time, which led to an acceleration of upgrading the enterprises' main products. Finally, these circumstances resulted in a 4-5% contraction in the main product's lifetime.

Innovative-passive small enterprises in the reviewed period showed no aspiration for significant modernization of the main product, which is confirmed by the stable shape of a life cycle indicator curve (Figure 6).

Next to small enterprises, namely, enterprises with 100-249 employees, demonstrate a slightly different innovative behaviour. Their life cycle indicators and product development time dynamics reveal the difference (Figures 5 and 6).

Despite the sharp contraction in the economy during the acute phase of the crisis of 2008-2009, these enterprises succeeded in maintaining the lifetime of the main product (sometimes even in increasing it). Simultaneously, just like small enterprises, in 2009-2012, they prolonged the time for new product development.



**Figure 6:** Main product's life cycle growth rate for small and medium innovative-passive enterprises

Additionally, this process's scope concerning a similar one among small enterprises was less distinct, yet very substantial statistically (the development period by 2013 increased by more than 35% from the pre-crisis level, which amounted to about 3-5 months in absolute values). This strategy's purpose was to replace the main product with a new or significantly improved one. The strategy's success is evidenced by the shape of the lifetime rate curve, which reached a local minimum after 2010; in 2013, the life cycle rate diminished by more than 12% as to 2008.

This class's reply to the 2014-2016 crisis was different from one in 2008-2009. In 2014-2016, there is no upward trend in a new product's development time. On the one hand, it designates the absence of noticeable efforts to replace the obsolete main product with a considerably (radically) improved one. On the other hand, it is a clear evidence of exerting efforts towards alleviating the maintenance of the previous main product's life cycle due to its incremental enhancement and shortening of production costs (i.e. process innovations). This conclusion is confirmed by the dynamics of the main product's life cycle indicator – it got back to the 2008 level during 2015-2018.

Innovative-passive enterprises employing 100-249 people handled the declining consumer demand, accompanying crises, via undertaking efforts to maximize the maintenance of the existing main product on the market; after 2014, the product lifetime indicator grew by about 5%. Since these enterprises were not involved in technological innovations, they most likely used other methods of supporting the main product's life cycle (e.g. marketing). However, later the enterprises depleted their available options for using non-innovative methods to support the life cycle and could temporarily turn into innovative-active ones.

#### **4. Comparative characteristics of different populations' behaviour models and their interconnection**

The deterioration of Russia's economic development indicators in 2008-2018 directly affected the end consumers' effective demand. Early on, we emphasized multiple types of Russian enterprises' modes concerning their way of fighting descending sales. These kinds of behaviour significantly depended on the strategy chosen by the observed population of enterprises. As part of one of these strategies, manufacturers faced a task of retaining main product demand from the consumer experienced a decline in real income or curbing the fall in this demand. Additionally, a somewhat different strategy seems possible as well. It is occurring when one cannot prevent a substantial drop in the main product demand. Thus, the enterprises might not see a solution in maintaining the life cycle of the prior product. Instead, they are more likely to enter (or establish) new markets, which follows the new leading product development and implementation. The first of them was generally adhered to by large enterprises. The second strategy, in turn, was more typical of small and medium-sized ones. Basically, a comparison between innovation-active and innovation-passive populations of small and medium-sized enterprises shows that the development and implementation of

innovations reduce the life cycle by about 5% for the innovation-passive ones. Hence, the innovative activity of populations of Russian small (and, to some extent, medium-sized) enterprises is seemingly pointed not at maintaining the already existing life cycle of essential goods but rather at reducing it. Thus, innovative-active enterprises supposedly focus more on producing and promoting new products to the market.

Ultimately, it is precisely the populations of small (and medium) enterprises that serve as drivers of growth in the variety of goods and services on Russian markets (Golichenko and Popov, 2020). Enough to say that life cycle values for small and medium innovative-active enterprises fluctuate within 7.5-9 years. The life cycle of the main product of innovative-active large enterprises stands in 10-15 years. New product development time differs significantly too. For small and medium-sized ones, the indicator's value hovers from several months to a year. In contrast, large enterprises show the life cycle value estimated in years from two to twelve.

The results obtained in this study are similar to those of Fritsch and Meschede (2001). They earlier pointed out that small enterprises spend on product innovation much higher share of R&D expenditures than larger ones. The innovation activity of the latter usually came down to process innovations. Simultaneously, Fang (2009) insists that large enterprises on competitive markets are more likely to profit from creating their own product innovations. Moreover, some above-mentioned papers show that innovative-active small enterprises are more eager to implement radical innovations than large ones, in spite of the fact that, as Kijkasiwat and Phuensane (2020) state, small and medium companies face remarkable difficulties in accessing external finance. This proneness reflects an increased share of R&D expenditures in contrast with large companies

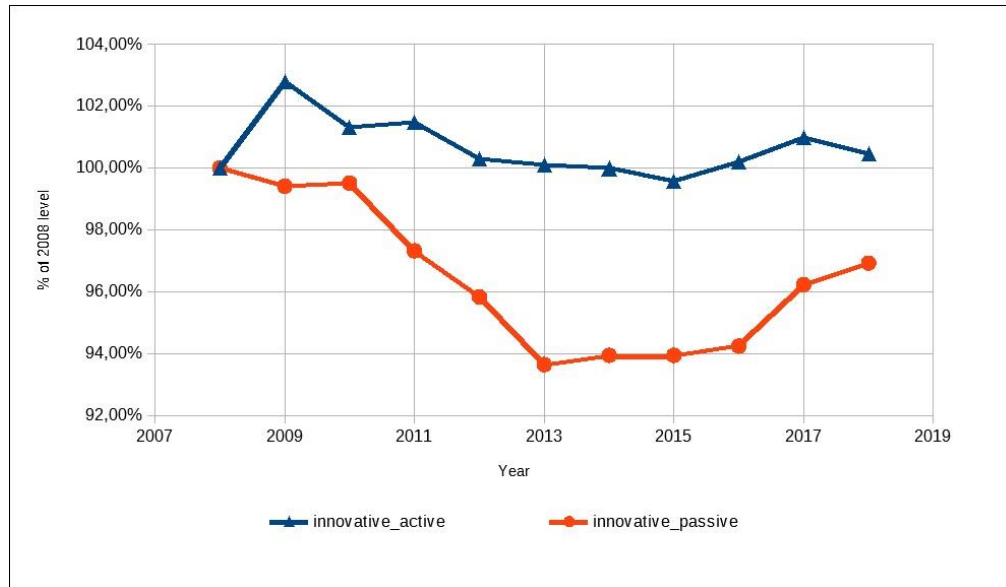
Things change significantly regarding the share of enterprises involved in innovative activities: the proportion of innovative-active units for large companies is almost twice more significant as for small and medium-sized ones (Robbins and O'Gorman, 2016). Our findings from this study prove to be closer to the just-mentioned article. However, this strategy of small and medium-sized enterprises' behaviour had no notable impact on the strategic choice of innovative-active enterprises in Russia. One may explain it by the resource dominance of large enterprises among innovative-active ones (as well as in the economy). It would be enough to say that the number of employed for small and medium innovation-active enterprises is ten times lower than one for innovative-active large companies. Consequently, large enterprises (hiring more than 250 people) in 2008-2018 dominated the innovative-active classes in the volume of products manufactured. The size class employed 1000-4999 people manufactures almost half of the produced goods among all enterprises combined. Consequently, the widespread strategy of innovative-active enterprises' behaviour came down to tackle the problem of maintaining or limiting the decline in demand for the main product during the crisis years. Concurrently, some researchers, for instance Mashal (2017), and Chege and Wang (2020), indicate the significance of the innovative activity of small and medium enterprises in developing countries' economies and assert that innovations bring higher growth rates of both revenues and diversity of products. However, this situation has no connection to the Russian economy, which is characterized by strict government supervision over the large (especially, state-owned) firms more like Chinese (Jia, Tang, and Kan, 2020). The state financial support of large enterprises usually takes place at the expense of maintenance of SMEs' innovative activity, which is narrowed to only their own meagre resources.

During the 2008-2009 crisis, enterprises' innovative processes aimed at preserving demand for the main product (i.e. at its slow evolution) turned out to be quite effective (Figure 7); the dynamics of the average life cycle confirms it. In the context of crisis, by 2009, this figure increased by about 3% compared with 2007. In subsequent years a fall of a moderate depth appeared. The most significant decline in 2015 accounted for only 0.5% of the 2008 level. In 2016-2017 the life cycle increased and exceeded the 2008 level. In 2018, we see a slight drop in the life cycle, while its value still higher than the values of 2008. The enterprises achieved the results simultaneously with growth in a new product development time from 6.7 years to 7.3 years. At the same time, innovative-passive enterprises tried to come up with a solution to the trouble. However, they seem to make no strides on this path. The research period showed a significant downward trend in the main product's average life cycle (Figure 7), with the largest drop (by 6% from 2008) in 2014. During the period of slow growth in the life cycle in 2018, the indicator slightly increased and reached 94.5% of the 2008 level, which generally did not change the dominating downtrend.

Summarizing those above, we can underline two circumstances:



- 1) The driver of the variety of goods' growth on the market yields merely a tiny influence on the Russian innovation processes since the degree of innovative activity of small and medium-sized enterprises is immensely lesser than the magnitude of similar activity in large enterprises;
- 2) The innovative activity of Russian enterprises is more aimed at maintaining existing goods rather than at expanding their diversity. The use of innovations allows enterprises to prolong the main product's life cycle significantly.



**Figure 7:** Main products' life cycles' growth rates of enterprises

## 5. Conclusion

Thus, in carrying out this research, we found that the entire population of Russian innovative-active enterprises can be divided into two groups by the type of their innovative behaviour. The first one is comprised of enterprises that tried to maintain an existing diversity of goods. The core idea of their strategy converged on the facilitation of the manufactured products' slow evolution to maintain the existing market via prolongation of the main product's life cycle. To attain it, enterprises were exerting efforts towards fostering the main product's incremental improvements or utilising process innovations. The second group included enterprises aspired not to retain the previous market by maintaining the life cycle of the leading products manufactured but to expand the variety (nomenclature) of manufactured products. This goal demanded the implementation of substantially advanced (radical) innovations. One of the outcomes of this strategy's implementation consists in reducing the life cycle of manufactured products.

The study showed that the main product's slow evolution was conducted by large innovative-active Russian enterprises (subclasses employing more than 250 people). Thus, responding to the 2008 crisis, innovative-active enterprises with more than 5,000 employees managed to significantly increase (by 6%) the main product's life cycle. In the context of systemic crisis after 2013, they encouraged growth in this indicator to 108% from the 2008 level. In their turn, small and medium innovative-active enterprises reacted to both the 2008-2009 and the systemic crisis that erupted after 2013 via adherence to a more radical type of innovative behaviour, which is namely the second type of innovation strategy. Furthermore, from 2010 to 2013, enterprises employing up to 99 people raised their new main product's development time to the level twice as high as early on. At that period, the life cycle values were fluctuating around 102-103% of the 2008 level and in absolute terms amounted to 7.5 – 8.5 years.

It is important to note that the impact of the "innovative" nature of small enterprises' innovative activity on the Russian economy scale is of strictly limited importance. This statement derives from the large enterprises' dominance in the Russian economy as a whole and among the innovative-active ones. It would be enough to say that manufactured products of large innovative-active enterprises account for about 87% of all innovative-active ones. Hence, we can count an evolutionary type of innovation activity as prevailing in the economy.

Finally, one cannot neglect to mention the peculiarities of the innovative-passive firms' behaviour in crisis years. For these enterprises, the main product's life cycle had remained steady until a significant deterioration in their activities' external economic conditions transpired. The enterprises then responded with a significant drop in product life cycle, which proved their willingness to transition into the category of innovative-active ones. To the greatest extent, this model of behaviour matched innovative-passive large enterprises employing more than 5,000 people.

## 6. References

- Cao, H. and Folan, P. (2011) "Product Life Cycle: The Evolution of a Paradigm and Literature Review from 1950-2009" *Production Planning & Control: The Management of Operations*, Vol 23, No.8, pp 641-662.
- Chege, S.M. and Wang, D. (2020) "The influence of technology innovation on SME performance through environmental sustainability practices in Kenya", *Technology in Society*, Vol 60, issue C
- Fang, X. (2009). "Process Innovation, Product Innovation and Firm Size", [online], University of Illinois at Chicago, [researchgate.net/publication/228778789\\_Process\\_Innovation\\_Product\\_Innovation\\_and\\_Firm\\_Size](https://www.researchgate.net/publication/228778789_Process_Innovation_Product_Innovation_and_Firm_Size)
- Fritsch, M. and Meschede, M. (2001) "Product Innovation, Process Innovation, and Size. Review of Industrial Organization", *Review of Industrial Organization*, Vol 19, No. 3, pp 335-350.
- Golichenko, O.G. and Popov, A.B. (2020) "The Main Product's Average Life Cycle Length as an Indicator of the Innovation Development Strategy" (in Russian), Paper read at the XXI Russian Symposium, Moscow, Russia, November.
- Jia, C., Tang, X., and Kan, Z. (2020). Does the nation innovation system in china support the sustainability of small and medium enterprises (SMEs) innovation?. *Sustainability*, Vol 12, Issue 6, 2562.
- Kijkasiwat, P. and Phuensane, P. (2020) "Innovation and Firm Performance: The Moderating and Mediating Roles of Firm Size and Small and Medium Enterprise Finance", *Journal of Risk and Financial Management*, Vol 13, No. 5, pp 1-15.
- Kotler, P., Keller, K.L. and Cunningham, P.H. (2006), *Marketing Management (12th ed.)*, Pearson-Prentice Hall, Toronto.
- Mashal, A. (2017) "Do Non-Financial Factors Matter for SMEs Performance? Case from Jordan", *Business and Economics Journal*, Vol 8, issue 4
- OECD and Eurostat (2018). *Oslo Manual: Guidelines for Collecting, Reporting and Using Data on Innovation. 4th Edition, The Measurement of Scientific, Technological and Innovation Activities*, OECD Publishing, Paris/Eurostat, Luxembourg.
- Orcik, A., Tekic, Z. and Anisic, Z. (2013). "Customer Co-Creation throughout the Product Life Cycle", *International Journal of Industrial Engineering and Management*, Vol 4, No. 1, pp 43-49.
- Perilla Jiminez, J.R. (2019) "Mainstream and Evolutionary Views of Technology, Economic Growth and Catching up", *Journal of Evolutionary Economics*, Vol 29, No. 3, pp 823-852.
- Prasad, R.K., Jha, M.K. and Verma, S. (2019). "A Comparative Study of Product Life Cycle and its Marketing Applications", *Journal of Marketing and Consumer Research*, Vol 63, pp 62-69.
- Raizberg, B.A., Lozovskiy L.S. and Starodubceva, E.B. (2007) *Product Life Cycle. Modern Economic Dictionary (5<sup>th</sup> ed.)*, (in Russian) Infra-M, Moscow.
- Robbins, P. and O'Gorman, C. (2016). "Innovation Processes: Do They Help or Hinder new Product Development Outcomes in Irish SMEs?", *The Irish Journal of Management*, Vol 35, No. 1, pp 88-103.
- Romanov, A.A., Basenko, V.P. and Zhukov, B.M. (2009) *Product Life Cycle and Development* (in Russian), Academy of Natural Sciences, Moscow.
- Simonetti, R., Archibugi, D. and Evangelista, R. (1995). "Product and Process Innovations: How are They Defined? How are They Quantified?", *Scientometrics*, Vol 32, pp 77-89.