Analyze the Relationship between the UK and the EU from a Historical Perspective by Game Theory

Enyuan Wang[*]

Department of Faculty of Business and Law, University of Portsmouth, Portsmouth, United Kingdom

*Corresponding author: guanghur.ren@gecacademy.cn

Keywords: Game theory, payoff, Brexit, United Kingdom, European Union.

Abstract: Brexit in 2020 has aroused widespread concern in the international community on the relationship between the United Kingdom and the European Union. This article uses a review method to summarize the reasons for Britain's entry into the EU and Brexit from the perspective of payoff in game theory, and to predict the future relationship between the two parties. The first part combines the changes in payoff between the two parties when the UK joined the European Community to explain the reasons why the UK finally joined the EU. The second part is about the three main game models of Brexit and the analysis of payoff. Finally, from the perspective of game theory to predict and explain that the most likely future relationship between the UK and the EU is the Norwegian model. This article is of great significance to the study of the current international situation. It has analysis and reference significance for countries that may leave the EU in the future, such as Poland and Sweden.

1. Introduction

The European Union is currently the world's largest economy [1]. If only considering the country, the UK is the fifth largest economy in the world. In December 2020, the UK officially announced Brexit. This behavior has brought about tremendous changes to the current international situation. Brexit has set a precedent for countries to withdraw from the regional cooperation alliance. It will not only put a huge test on the governance of global multilateral cooperation, but also weaken the EU's international status and global influence. Therefore, since the UK announced its formal Brexit on December 31, 2020, the interest relationship between the UK and the EU and the international situation have become the focus of global attention.

Regarding Brexit, there have been many documents analyzing the interest relationship between the UK and the EU from the perspective of game theory and establishing a game model. Because game theory can more clearly analyze and solve the basis and feasibility of each player's choice of strategy [2]. For example, game theory can easily solve the limits of hegemonic stability theory [3]. Most of the literature only analyzes the game of Brexit, however, there are few studies on Britain's entry into the European Union and predicting the future shape of the United Kingdom and the European Union. Therefore, this article will use the timeline as a clue to summarize the relationship between Britain and the European Union through the literature from the perspective of payoff.

Besides, game theory can help to study the predicted and actual behaviors of players in games and their optimization strategies [2]. Among them, the rational person hypothesis is an important concept and premise hypothesis in game theory. The hypothesis of rational person means that the subject of decision-making is full of reason, neither emotionally nor blindly following, but proficient in judgment and calculation [4]. National governments can be regarded as rational people, they will only choose the most profitable decision.

Through game theory perspective, this article can help analyze the current international politics and economy, predict the future international situation and the change of future status of the UK and the EU. At the same time, it plays a role in predicting and analyzing the possible future choices of

Germany and other EU countries, and can also provide references for other countries such as Denmark and Poland.

The remaining paper reviews and summarizes different games from the perspective of payoff. Section 2 reviews that payoff from the background analysis and then introduces the change of payoffs from 1950 to 1973 that Britain did not want to join the European Community (EC) until it was rejected twice. Section 3 mainly introduces the progress of Brexit based on Brexit three game models of McCulloch and Guely. Section 4 mainly introduces papers about the prediction of future trade relations between the UK and the EU through payoffs. Section 5 summaries the reasons for the UK's change, and discuss the impact of the Brexit game on other countries and the international situation.

2. 1950- 1973 Britain joined EC

Although there are very few games theory analyses on joining the EU in 1973, the analysis in many scholars' articles clearly reflects the concept of game theory's payoff. Therefore, this article summarizes the article that analyzes the decision-making between the UK and the EU from the perspective of payoffs, and tries to help readers understand this issue from the perspective of game theory.

2.1 Payoff and strategy of Britain not joining the EC from the geographical, economic and political aspects

Before the establishment of the EC, the six Western European countries initiated the invitation to the United Kingdom in the Schumann Plan [5]. Some scholars analyzed the payoff of different strategies in the UK from the perspective of geography, politics and economy.

From geographical perspective, the payoff for Britain to join the European Community was less than that for not joining [6]. Because the United Kingdom was an island country independent of the European continent and other overseas colonies were also far away from the European continent, not joining the European Community would enable the United Kingdom to strengthen its ties with the colonies and increase its payoff. Payoff that joins the European Community was opposite. Therefore, from a geographical point of view, the benefits of not joining the European Community were greater than the benefits of the United Kingdom. The strategy of the United Kingdom was not to join.

In addition, in the further study, the reduction of political payoff was also one of the reasons why Britain chose not to join the EC [7]. The geographical location had led British politics to adopt a policy of non-interference in continental European affairs, which was not participating in continental European politics and diplomacy. Joining would reduce the UK's right to speak and affected its relationship with the Commonwealth. As a result, the payoff reduced compared with keeping the status quo. Therefore, from a political point of view, the payoff for the UK not to join the EC was greater than for joining. The British strategy was not to join.

Scholars analyzed the payoff of Britain joining the EC and not joining the EC from an economic perspective, and they believed that Britain's strategy was not to join the EC [8-9]. Because joining would make Britain separate from the independence of the empire and prevent Britain from free trade with the Commonwealth and other countries and reduce Britain's economic payoff. If you didn't join, you could keep the status quo. Therefore, from an economic point of view, the best strategy for the UK should be not to join.

From the perspective of game theory, in terms of geographic location, politics and economy, not to join the EC was a dominant strategy. Therefore, for the first time, Britain rejected an invitation to join the EC.

2.2 Britain wanted to join the EC but was rejected by France twice

As the economic gap between the UK and the six EC countries continues to narrow, the UK's payoff has changed. Therefore, the British strategy was changed to join the European Community, but it was rejected by France because it was afraid of the decline of its status due to Britain's

participation. Many scholars analyzed the game of France's two rejections of Britain's participation in the EC from the perspective of Britain and France.
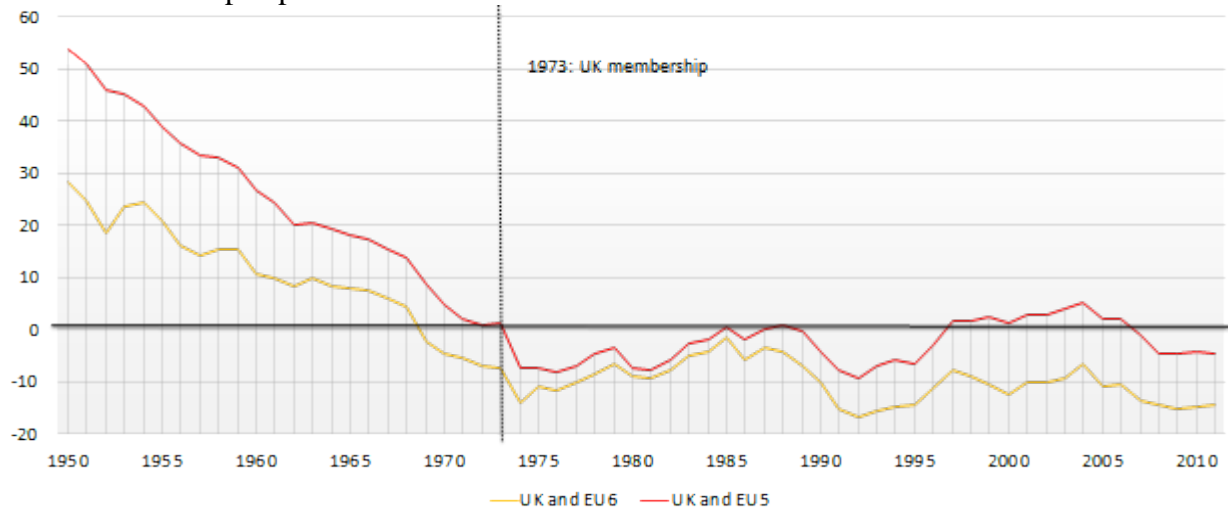

Figure 1. Percentage difference between the UK's GDP per capita and EU founding members' (EU6) and EU5 (excludes Luxembourg) between 1950 and 2011[10]

From the perspective of the UK, the British payoff has changed under the influence of the national liberation movement, which led to the British wanting to join the EC [6]. British Commonwealth not only began to gradually split politically, but also received worse and worse economic treatment [10]. Therefore, the payoff of trade with the Commonwealth was reduced and the benefit of not joining the EC is reduced.

After Britain joins, it would receive the support of the EC, and the payoff would increase because the strength of the EC had continued to increase [11]. Figure 1 intuitively showed that the gap in GDP per capita between the UK and the EC was narrowing. So, the UK believed that the EC would help Britain solve the problems caused by the domestic economic difficulties and the depreciation of the pound sterling. At this time, the payoff for the UK to join the EC was greater than not to join. Therefore, the British strategy was to choose to join.

However, France rejected the British request twice. Some scholars suggested that the entry of the UK would affect the dominant position of France [7]. France was also worried that the United States would intervene in more European affairs through the UK [8]. Although Britain's accession strengthened the EC, the benefits for France would be small because it would reduce its influence from the dominant position of the EC. Therefore, for France, the rejected payoff was greater than the agreed payoff. In the end, France rejected the British application for accession twice.

2.3 Britain joins the European Union

Scholars studied the changes of French payoff with development of West Germany [12]. Due to the severe economic imbalance and recession in France and the rapid economic development of West Germany, France was worried that the re-emergence of West Germany would shake its dominant position. So, it needed British power to contain West Germany [11]. At this time, the British economy was gradually lagging behind the six countries of the European Community. Therefore, France did not agree with the decline in the payoff of Britain's accession. In summary, France's dominant strategy was to agree to Britain's accession.

For the UK, at this time, the strategy had not changed because the payoff for joining the EC was still greater than the payoff for not joining. After more than ten years of negotiations, Britain finally joined the European Economic Community commonly known as the Common Market.

3. 2020 Brexit

This part would summarize the Brexit game from the perspective of the UK, the EU and the British Prime Minister's perspective on three different game models. In order to better understand the content of the following article, here are some basic concepts of game theory.

In game theory, if there is an optimal choice that has nothing to do with the strategies that other competitors may adopt, it will be called a dominant optimal strategy. If each participant chooses the dominant optimal strategy, then this situation will be defined as a Nash equilibrium [3]. Nash equilibrium means that any player who changes his strategy unilaterally in this situation will reduce his own profit [13]. A complete information game refers to a game in which each participant has accurate information about the characteristics, strategies, and profit functions of all participants. Incredible threat means that although it is optimal beforehand, it is not optimal afterwards, so it is unreliable.

3.1 UK perspective of Brexit game

Many scholars thought that the most important factor leading to Brexit was economic factors [14-15]. UK must bear high EU membership fees [16]. At the same time, the UK had to endure the constraints of the EU single market [17]. Therefore, the payoff of UK for staying in the EU became low. Therefore, changes in the background had led the UK to want to leave the EU.
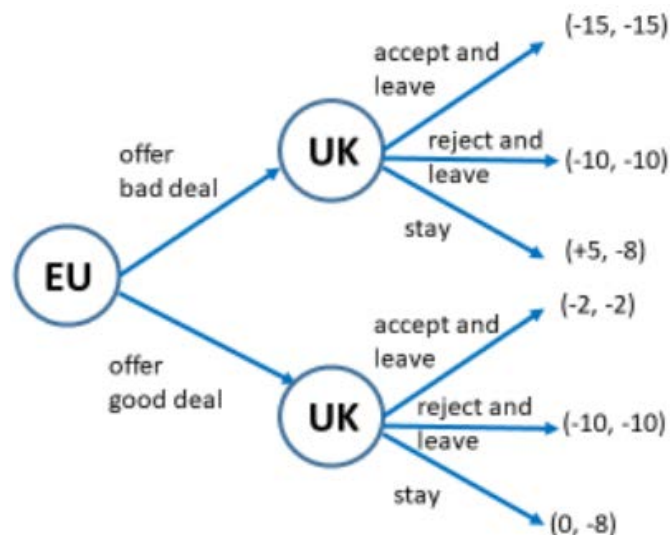
3.2 EU perspective of Brexit game

Figure 2. Extensive form of the game proposed by McCulloch [18]

McCulloch's established a game model (as shown in Figure 2) to analyze the Brexit between the EU and the UK. This paper pointed out that the only Nash equilibrium in this model was that the EU provided bad deals and the UK stayed in the EU [18].

Through the further study of McCulloch's game model and analysis from political perspective, scholars concluded that a good deal from the EU to the UK would bring a very bad payoff to the EU [19]. Because if the UK not only left the EU smoothly but also got a good deal, it would accelerate the division of other EU member states and caused confusion and decline in the status of the EU. Therefore, in this game model, the EU's payoff for a good transaction was much lower than a bad transaction. So, the EU would give a bad game and the UK would choose the strategy of not leaving the EU.

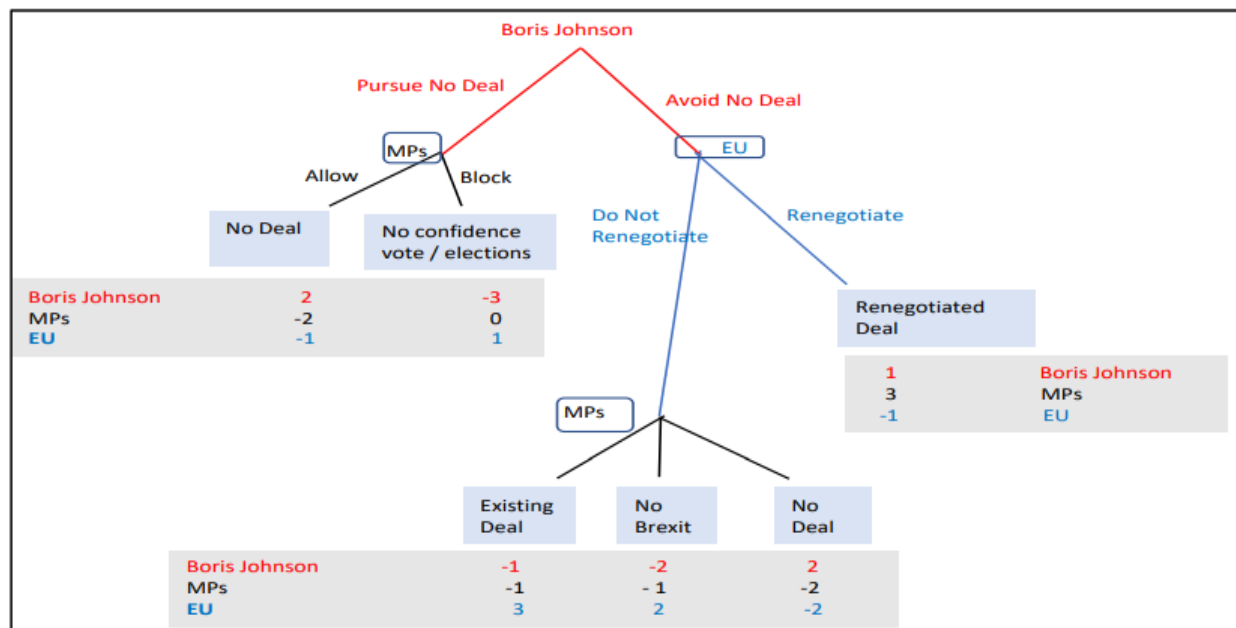## 3.3 British Prime Minister's perspective of Brexit game

Figure 3. Extensive form of the Brexit End Game in Guely's model [19]

After the EU gave a deal to the UK, Boris announced in January 2020 that if the EU did not accept the existing agreement, the UK would leave the EU without that deal [19-25]. However, some scholars have concluded from the perspective of game theory that this had been an incredible threat.

In Figure 3, Guely raised a game theory model from Boris's perspective and pointed out that this was a complete information game [19]. After analyzing Boris' payoff through reverse induction, scholars concluded that there had been two Nash equilibriums in this game, where the UK had an existing agreement to leave the EU and the UK did not leave the EU.

4. The game between the UK and the EU after Brexit

Some scholars predicted the relationship between the UK and the EU in the future. There were three widely accepted options for the trade strategy between the UK and the EU after Brexit. First option was to "be a Norway" and joined the European Economic Area. Second option was to "be a Switzerland" and negotiated a bilateral agreement with the EU. Third option was to act alone as a member of the World Trade Organization [18]. The following summarized the research based on the concept of payoff in game theory and explained why the future relationship had been most likely to be the Norwegian model.

4.1 "Be a Norway"

From the perspective of the United Kingdom, some scholars believed that the Norwegian model could minimize the trade costs of Brexit [26]. Because the Norwegian model would not damage the British economy and allowed the free movement of people. The Norwegian model could bring the highest payoff to the UK.

However, there still were some disadvantages for the UK in this situation. Because the UK still needed to pay membership fees to the EU and must comply with most EU laws. Although the UK did that, they had no seat in rulemaking [27]. So, the payoff of the UK's Norwegian model strategy might not be high as some scholars thought.

But in general, the Norwegian model still brought the highest payoff to the UK compared with other options. The Norwegian model was also the favorite trade model of most parliamentarians who supported Brexit in the future, and it was also the best strategy for the UK.

Regarding the EU, the other side of this game, some scholars believed that the Norwegian model could not only bring high economic payoff to the EU, such as the United Kingdom's dues and trade, but also politically [28]. Due to the particularity of the Norwegian model, the EU could formulate new rules and laws. Therefore, the Norwegian model strategy was also the model that the EU most hope to achieve, because it could bring positive returns to the EU.

4.2 "Be a Switzerland"

From the perspective of the United Kingdom, some scholars believed that the Swiss model would bring less economic benefits to the United Kingdom than the Norwegian model. This paper had shown that although the Swiss model would continue to trade with the EU to a certain extent, it had been restricted in many ways like economic and political [29-30]. For example, under the Swiss model, the banking industry and other service industries in the UK were subject to market access restrictions. Since the British banking and financial industries account for 80% of the economy, the Swiss model strategy would bring very negative returns to the British economy. In general, they thought that the Swiss model would bring less payoff to the UK than the Norwegian model.

From the perspective of the EU, although the Swiss model strategy brought positive payoffs similar to the Norwegian model economically and politically, the Swiss model tended to restrict the number of EU labor forces [31]. This strategy greatly reduced the EU's overall payoff. Because accepting this quota meant the end of the free movement of people, which was unacceptable by the EU. Therefore, the Swiss model's payoff to the EU was lower than the Norwegian model. The EU preferred to reach the Norwegian model.

4.3 "A member of the World Trade Organization"

From the perspective of the United Kingdom, some scholars believed that the decline in bargaining power, the reduction in trade volume and the decline in income would have a very negative impact on the benefits of the British economy [32]. Therefore, even if the UK completely abolished tariffs, it would face a bad payoff economically. This strategy was the lowest payoff for the UK. Britain wanted to avoid this strategy.

As to the EU, this model would also bring negative benefits because of tariffs and restrictions on the import and export of services [33]. The payoff of this strategy was equivalent to the previous no-deal Brexit strategy. Therefore, under this strategy, the EU's payoff was also the lowest. The EU wanted to avoid this strategy either.

5. Conclusion

This article summarizes the relationship between the UK and the EU through three perspectives of accession, Brexit, and future by game theory.

When joining, the UK did not join at the beginning because of the influence of geographical, economic and political factors. However, with the development of the EU economy and the prominent political problems in the UK, the payoff for joining had increased. The UK wanted to join, but it was hindered by France. The UK could not join until 1973 that the payoff in France changed due to the rapid development of Germany.

After a while, the economic payoff of the UK staying in the EU has been continuously reduced. Facing Britain's proposal to leave the European Union, the European Union gave a bad deal based on some game models. By analyzing the model, scholars found that British Prime Minister Boris made an incredible threat statement about Brexit. Regarding Guely's game model, there were two Nash equilibriums where Britain's abandonment of Brexit and acceptance of the existing agreement to leave the EU. In the end, Britain chose the latter.

In the future, there were three types of trade relations between the UK and the EU that are most widely accepted and recognized by scholars. They were the Norwegian model, the Swiss model and being a WTO member. The negative payoff brought by the Swiss model to the British banking industry was too serious. Similarity, the negative economic impact of being a WTO member on the

UK's economy was equivalent to a no-deal Brexit. Therefore, the Norwegian model was considered to have the least impact on the British economy and the most promising model for both the UK and the EU. Although it also had some disadvantages, it was the best strategy in these options.

This article has the significance of analyzing the international situation and predicting the future trade relations between the UK and the EU. At the same time, this article also provides some experiences for other countries that want or are likely to leave the European Union, such as Denmark and Poland.

References

[1] Warlouzet L. The EEC/EU as an evolving compromise between French Dirigism and German Ordoliberalism [J]. JCMS: Journal of Common Market Studies. 2019, 57 (1): 77 - 93.

[2] Snidal D. The game theory of international politics [J]. World Politics. 1985, 38 (1): 25 - 57.

[3] Snidal D. The limits of hegemonic stability theory [J]. International organization. 1985, 39 (4): 579 - 614.

[4] Binmore K. Rational decisions [D]. Princeton University Press, 2008.

[5] Campos N, Coricelli F. Why did Britain join the EU? [D] A new insight from economic history. Vox EU. 2015.

[6] Pescatore P. Some critical remarks on the Single European Act. Common Market L [J]. Rev. 1987, 24: 9.

[7] Bayoumi, T, Is Regionalism Simply a Diversion? Evidence from the Evolution of the EC and EFTA [D]. Regionalism vs. Multilateral Arrangements, NBER/University of Chicago Press, 1997.

[8] Crafts N. The Growth Effects of EU Membership for the UK: a Review of the Evidence [D]. University of Warwick CAGE Working Paper. 2016, 280.

[9] Oliver T. Theory and Brexit: can theoretical approaches help us understand Brexit [D]? LSE Brexit. 2017.

[10] Aitken N.D. The effect of the EEC and EFTA on European trade: A temporal cross-section analysis [J]. The American Economic Review. 1973, 1:881 - 92.

[11] Miller M.H, Spencer JE. The static economic effects of the UK joining the EEC: A general equilibrium approach [J]. The Review of Economic Studies. 1977, 1; 44 (1): 71 - 93.

[12] Maskin E. Nash equilibrium and welfare optimality [J]. The Review of Economic Studies. 1999, 1; 66 (1): 23 - 38.

[13] Bongardt A and Torres F. The political economy of Brexit: why making it easier to leave the club could improve the EU [J]. Intereconomics. 2016, 51 (4): 214 - 9.

[14] Perisic B. Britain and Europe: A history of difficult relations [J]. Institute for Cultural Diplomacy, 2010, 1 - 10.

[15] Busch B, Diermeier M, Goecke H, Hüther M. Brexit and Europe's future: A game theoretical approach [J]. IW Policy Paper, 2016.

[16] Exton G. Brexit and game theory: A single-case analysis [D]. Merici. 2016, 2.

[17] Ott U. F, Ghauri P. N. Brexit negotiations: From negotiation space to agreement zones [J]. Journal of International Business Studies. 2019, 50 (1): 137 - 49.

[18] Schwuchow SC, Pitsoulis A. Though this be madness: A game-theoretic perspective on the Brexit negotiations [J]. SSRN 3000515, 2018.

[19] Guely, V. Can Game Theory Solve Brexit [D]? https://www.academia.edu/download/60714223/Victor_Guely_-_Can_Game_Theory_Solve_Brexit_Final20190926-73391-yagwkc.pdf, 2019, 17 - 22.

[20] Margariti G, Chet-udomlap N, Swanson M, Target C. The Application of Game Theory to Brexit Negotiations [D]. JOHN F KENNEDY SCHOOL OF GOVERNMENT CAMBRIDGE MA CAMBRIDGE United States, 2020, 1.

[21] Tadelis S. Game theory: an introduction [D]. Princeton university press, 2013.

[22] Clarke H.D, Goodwin M, Goodwin M. J, Whiteley P. Brexit [D]. Cambridge University Press, 2017.

[23] Sampson T. Brexit: the economics of international disintegration [J]. Journal of Economic perspectives. 2017 Nov, 31 (4): 163 - 84.

[24] Doyle J. Rational decision making [J]. MIT encyclopedia of the cognitive sciences. 1999, 701-3.

[25] Macey-Dare R. Game Theory Paths to No Deal Brexit and a Dis-United Kingdom [J]. SSRN 3748317. 2020.

[26] Dhingra S, Sampson T. Life after BREXIT: What are the UK's options outside the European Union [D]? 2016.

[27] De G. P. What future for the EU after Brexit [J]? Intereconomics. 2016, 51 (5): 249 - 51.

[28] Fossum J. E, Graver HP. Squaring the Circle on Brexit: Could the Norway Model Work [D]? Policy Press; 2018.

[29] Oliver T. European and international views of Brexit [J]. Journal of European Public Policy. 2016, 20; 23 (9): 1321 - 8.

[30] Emerson M. Which model for Brexit [J]? InAfter Brexit, 2017, 167 - 188.

[31] Jenni S. Is the Swiss model a Brexit solution [D]? The UK in a Changing Europe. 2016.

[32] Schoenmaker D. The UK financial sector and EU Integration after Brexit: The issue of passporting [J]. In The Economics of UK-EU Relations, 2017, 119 - 138.

[33] Begg I. Brexit: why, what next and how [J]? InCESifo Forum, 2016, 30 - 36.