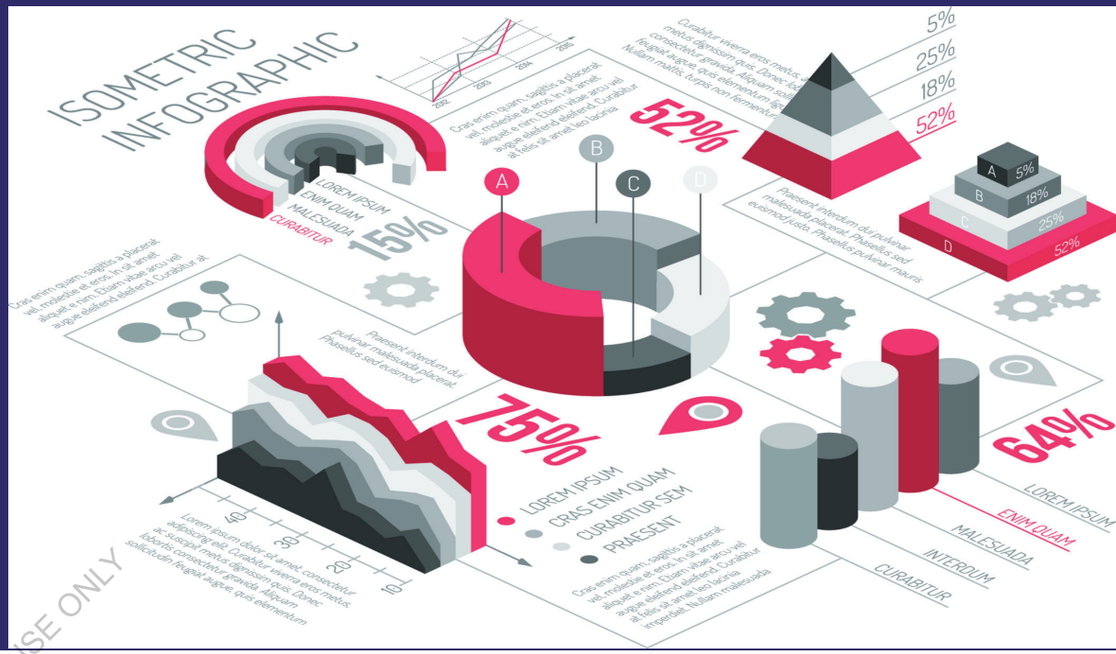
Data on defaults in Argentina, Uruguay, Russia, Mexico have been collected. According to these data, models have been developed to forecast the rate of decline in GDP per capita, consumer price index, wages and national currency against the US dollar. These models have been applied to predict a possible default in Ukraine. The forecast showed that 0.86 is likely to default in 2020 and the country's economy to reach 2019 is possible no earlier than 2025. At the same time, the GDP per capita will fall by 82.63%, the consumer price index will increase by 1.8 times, compared to its last value in 2017, the level of remuneration due to the country's default in the first year will fall by 22, 5% against the last value of this indicator in 2017, the national currency rate against the US dollar will increase by 226% compared to the last value in 2018.



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Predicting the consequences of default

Born in 1951 in the city of Dnipro. I received higher education in the specialty "Automation and telemechanics" at the mining institute of the city of Dnipro and after twenty years of of break return to my “alma mater”. It is an active work in the field of microeconomics and I have over a hundred publications on this topic.

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Content

Introduction

Recently, Ukrainian politicians and the media have been very fond of raising the topic of default in their speeches. The uncertainty of the consequences and the likelihood of default scares the population. In 2012, the news of Greece's sovereign default became quite loud news. For a long time, the country managed to hide official statistics and obtain new loans, but later it was revealed. The question that worries Ukrainians today is whether our country is facing the same consequences? Is our government also hiding unpleasant news from us? And what will happen to the population during a default? What are the consequences? That is why the topic of the thesis is very relevant today.

The purpose of the study is to assess the state of the country, to build models of forecasting the financial and economic state of the country through a time-dependent default.

The object of the study is the behavior of financial and economic indicators through default in Ukraine.

The subject of the study is behavior prediction models financial and economic indicators due to default in Ukraine

Research methods: regression analysis, correlation analysis, delay analysis of the influence of input factors on the output, construction of the corridor of the forecasting range.

The scientific novelty of the results obtained: the work of Gilles Dufrennett and Anne-Charlotte Paret, "Sovereign Default in Developing Countries", namely their forecasts of the four major sources of vulnerability in the country; behavior prediction models were first developed financial and economic indicators of Ukraine through default.

Chapter 1.
Theoretical provisions and literary review of the problem

1.1 Basic concepts of default

Default – a credit condition that occurs when a borrower fails to pay his or her debts or payments, a breach of the borrower's payment obligations to the lender, an inability to make timely payments on debt, or to perform other terms of the loan agreement. This term refers to any type of debt waiver (that is, it is to some extent synonymous with the concept of bankruptcy), but is generally used more narrowly, referring to the waiver of central government or municipal government [3].

There is a difference between the concepts of default and default, insolvency and failure to pay, and bankruptcy, which is recognized by a commercial court as a financial failure. [1]

1.2 Types of default situations

In practice, there are the following types of default:

- technical default;
- sovereign default;
- corporate default;
- cross default.

Technical default

Technical default arises because of temporary difficulties. The cause of a technical default may be a failure of the payment system or unforeseen circumstances. Usually the situation is quickly rectified and has no consequences [13].

Sovereign default

A sovereign default refers to the inability of the debtor State to fulfill its monetary obligations. The sovereign default leads to a downturn, which causes the country to suspend the payment of foreign debt. The effects of a sovereign default are of a lasting nature and are represented by economic stagnation, loss of credibility with international creditors, depreciation of the national currency, investment deficits, declining export cash flows, declining GDP and continuous litigation [13].

Corporate default

A corporate default occurs when a country, business or individual is unable to pay interest on the bonds. Corporate default is considered to be actual bankruptcy, that is, the recognition of the debtor bankrupt bankruptcy. In other words, corporate default is a default situation in which the debtor defends himself in court against the pressure of creditors [14].

Cross default

Cross-default occurs as a result of signing a credit agreement with certain conditions, when the failure to perform specific items under one credit agreement leads to default on other credit programs [14].

1.3 What is the impact of a negative and positive country default

1.3.1 Negative impact

Default is feared by almost everyone, because it entails a whole host of negative consequences for the national economy of the country. We would like to mention a list of the main ones [22]:

1. The image of the defaulting state is diminishing.

A country that is unable to repay a loan is losing its political position internationally. Her financial rating suffers. It is no longer trusted by neighbors.

The fact is that at the heart of modern economic relations at any level is mutual trust - and, as a consequence, a willingness to give a certain amount of money to the needy.

Each borrower sets goals. One has to “tune in” the budget and appease disgruntled citizens. Another intends to invest the money received in the development of the economy. In general, almost all participants in international relations resort to loans. But lending is voluntary. And if the government can not repay the debt to its lender, no one wants to give him a "second chance". After all, country leaders are seldom guided by altruistic motives.

However, the principles of lending at the highest level are somewhat different from the principles of consumer lending. So the "fine" state will still be lent. But the conditions will be more stringent: the lender wants to protect himself from the possibility of non-repayment of money, and will take into account all the risks.

2. The process of depreciation of the National Currency is taking place.

Money is a universal means of payment. They can be transformed into anything and everything, and their power is almost limitless. As long as there is no default. When the state becomes entangled in its debts and loses respect, its economy becomes unstable. As a result, the value of the local currency decreases, and often sharply.

Money is the most liquid commodity. Money is successfully used as a means of calculation if the economy of the state is all right. If it has gold and foreign exchange reserves, advanced production and natural resources, the local currency has weight. Improving the economic condition of the country, its comprehensive development contribute to the stable growth rate. But as soon as the state runs out of money and announces that it is unable to repay the loan, the national currency becomes cheaper. In fact, money (banknotes) is an obligation of the state, and the state in the conditions of default no longer guarantees anything to anyone and does not fulfill its obligations.

The default leads to a fall in real incomes of citizens. And the more the state depends on imports, the more noticeable the fall.

3. Local production slows down and then stops.

Nowadays, no state exists in a vacuum, that is, it does not provide for itself. Contacts with the outside world are inevitable. And in case of default, all these contacts are very expensive. With regard to the activities of enterprises, international agreements concerning the supply of raw materials, commodities, components, have been in force for several years. Payment for deliveries is made in one of the world currencies. And if the local course, as already mentioned, falls, then the companies start to work at a disadvantage. It may not last long: the employees of these enterprises go in search of other sources of income, the productivity of factories and factories declines, and eventually they close.

4. Default strikes the national banking system.

The situation of banks depends directly on the economic situation of the state in which they are located. After a default, foreign players leave the market and the banks' operations become unprofitable. They can no longer count on outside financial support. In addition, citizens urgently withdraw their deposits. Finally, savings in national currency are starting to get cheaper. Banks stop providing services: they do not lend, they do not open accounts. Banks need to survive somehow, and they are "lowered" to freezing the accounts of companies of legal entities and individuals. There is no need to talk about any turnover in this situation. It practically stops.

5. Political instability arises.

Not surprisingly, other actors in international relations cease to trust the defaulting government and refuse to cooperate with it. And the citizens themselves blame their leaders for all their sins. The position of the leadership of the country becomes uncertain. It must find a solution to the problem in time and try to put it into practice, otherwise inevitable protests and even attempts to change power. In particularly severe cases, a default can be a cause of civil war.

1.3.2 Positive impact

It would seem that the insolvency of the state leads only to dissatisfaction with citizens and business problems. However, in some ways the default is even useful:

1. The State shall be exempt from payments on loans.

Most often, the country finds itself drawn into chaos because its leaders have overestimated their capabilities. The government takes out loans and then does not know how to repay them. The money for the repayment of the

body of the loan and the interest on it are taken from the federal budget. Because of this, some areas lack funding. But when a default occurs, the state declares bankruptcy and ceases to pay its debts. As a result, he has free money (those intended for repayment of loans), and they can be directed to support those areas that have received almost nothing before. There is a chance to partially remedy the current economic situation in the country. And then - to resume the payment of loans.

2. Default encourages increased competition.

As imports decline during this period, businesses have to tap into previously hidden or untapped opportunities in their own country. There is a resurgence of those industries that were previously uncompetitive (again, through imports). Businesses have to make every effort to survive. It succeeds only the strongest, experienced, in demand. There is nothing superfluous in the economy. This is a real natural selection.

3. Default contributes to the necessary restructuring of the national economy.

It has already been said that all companies are in isolation. Supplies are restricted from abroad, markets are shrinking. Businesses have to refocus on internal resources and internal markets. Until the default comes, it is almost unrealistic to implement such a global economic reform: entrepreneurs simply lack the motivation to reconsider their capabilities and needs. The default provides this motivation.

4. Fake companies go into oblivion.

The default is a turning point. Many players have to leave the market. But those spheres of business, on which the existence of the state depends, have the opportunity to develop. The phenomena of a "blasted economy" eventually go null and void, as counterfeit firms cannot operate in such

difficult conditions. At default business, figuratively speaking, shows the true face. And the organizations that used to rock the market and undermine the economy are disappearing by themselves.

5. Paradoxically, the fact is that the state can partially eliminate external debt.

When the borrower reports a default, the lender finds that he has little choice - either to part with the thought of repaying his money for many years, or to try to force the debtor to pay back a little. In some cases, the amount of loan that the borrower will have to pay back does not compare to the interest amount. Then the collapsed state has a way out: ask the lender to write off the interest or reduce the amount of debt. And the lender, who is afraid of losing everything, has to agree to it. But if it were not for the default, the borrower and lender would hardly have started negotiations and tried to find solutions to their problems.

1.4. Literature review

In the economic literature, a sovereign default is considered to be a situation in which the state (or its government) does not fulfill them in full or in part, its obligations to creditors (lenders) to repay debts and (or) interest on them. The basis of a sovereign default may be both sovereign insolvency and cancellation of external debt. Sovereign insolvency means the objective inability of a state or its government to service and / or repay its external debt within the time limits set by the treaties due to the country's indebtedness increasing to a level unacceptable for the economy and thus requiring a certain reduction in debt loading or restructuring [5].

Foreign debt cancellation is a situation in which the borrowing country refuses (in whole or in part) to meet its obligations, as well as adopts other

legislative measures with equivalent effect, ie a strategic decision declares a default, which should be understood as the absolute meaning of the term.

The de facto default can also be attributed to the situation in which the state, without being able to pay its domestic debt, "inflates" it, resulting in lenders (lenders) receiving less real income. A typical example of such a situation is the Argentine practice, when in order to reduce the cost of servicing government bonds indexed by the Government of Argentina, the national statistical agency INDEC published low inflation figures [7].

It should be borne in mind that due to the inaccessibility and limited reliability of data on domestic debt, as well as the difficulty of recognizing the facts of internal defaults, economic literature and theoretical and empirical studies are mainly devoted to the problem of defaults on foreign debt, which is quite natural. Public internal debt, despite its high level (on average about 60% of the total debt of the state) and its possible growth, unlike external one, does not pose a significant, critical threat to national economic security: in the event of problems, its fate is resolved domestically and avoids pressure from other countries and international financial institutions.

In world practice, the failure of governments to fulfill their external debt obligations is not uncommon (Figure 1.1). From 1800 to 2009 Reichart and Rogoff (authors of "This Time Will Be Different. Eight Centuries of Financial Reason", which was published in 2011) [4] note 250 episodes of external debt defaults. The record for the largest default is Argentina (in 2001 it declared a default of more than $ 95 billion).

Some sovereign defaults are accompanied by a formal statement of the state's inability to make payments in the form of law or regulation. In other cases, the so-called "default countries" simply stop paying the debt without any official statement or confirmation. At the same time, it is pertinent to mention that, in reality, most defaults are partial rather than complete, though sometimes after lengthy negotiations and many scruples.

The main factors in the onset of sovereign defaults are the academic literature that directly calls external debt and aberration (ie, error) in business cycles. The latter refers to a situation where access to external debt markets is significantly simplified during the economic boom, contributing to the surplus of foreign capital inflows. It was noted that large capital inflows put the country at serious risk of a debt crisis, and with their sharp outflow, more and more countries are in default.

Economists also believe that global economic factors (including commodity prices and bank interest rates in financial center countries) and global conflicts play an important role in triggering public debt crises. In addition, it has been observed that defaults are very sensitive to the global cycle of capital flows - with their sharp contraction more and more countries fall into default. Accordingly, it has been discovered that large inflows of capital put the country at serious risk of a debt crisis in the event of their sudden outflow [10].

At the same time, scientific and applied research into the debt load of the international sovereign sector does not suggest an unambiguous interpretation of a set of indicators and their levels that could reliably signal the country's default conditions.

According to Gilles Dufrennet and Anna-Charlotte Paret, whom they outlined in their work Sovereign default in Emerging Market Countries [9], the most vulnerable to default are countries that have at least 1 default over the previous 5 years. The same authors include countries with a rather fragile macroeconomic environment, ie in which there are:

– a significant decrease in the national currency - devaluation of more than 43% (year-on-year change);

– deep decline in production – real *GDP* growth below 3.4%;

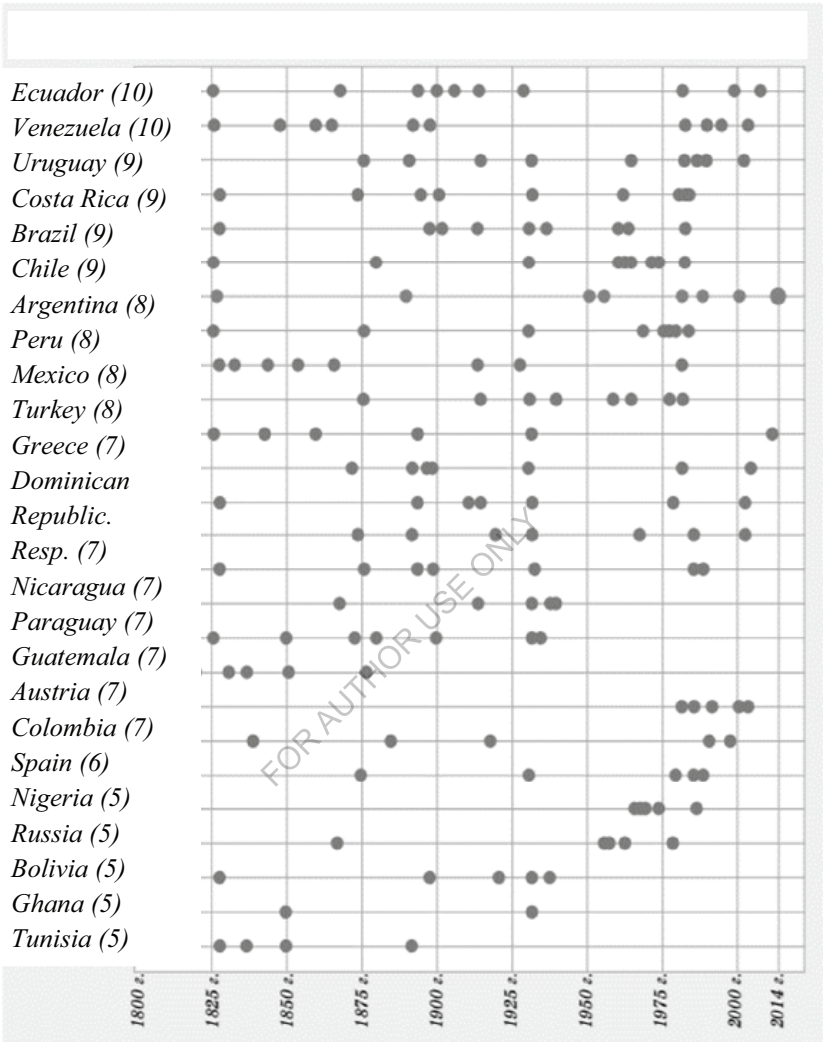

Figure 1.1 - History of external sovereign defaults from 1800 to 2014 [9]

.

– Excess budget deficit by 10.4% of *GDP*;

– exceedance of the debt to debt ratio by 11.3%, and the fact that:

– External government debt is over 59% of sovereign debt;

– coverage of total short-term debt by gross international reserves below 97%;

– total external debt exceeds total exports by 337%, etc.

According to their research, they have developed the "Four Major Sources of Vulnerability" to conduct country-by-country vulnerability research from 1980 to 2013.

There are four main sources of vulnerability [9]:

1) The first source of vulnerability is debt service as a share of fiscal revenue

The model distinguishes between three modes: one is characterized by low debt service vulnerability (less than 9% of budget revenues), high debt service vulnerability mode (where the latter is more than 14% of budget revenues), and intermediate level.

Figure 1.2 shows the results obtained by Duphrenot and Paret when checking countries for the first vulnerability indicator. The table shows the observational regimes for each country and each year. Green cells correspond to observations related to the less vulnerable mode, respectively, red to the most vulnerable mode, yellow indicates an intermediate level.

It is important to note that the calculations for 2013 and Ukraine were in the green zone throughout the forecast period, ie in the low debt service vulnerability mode. It is interesting to check whether Ukraine remains in the same mode in the future.

With the help of the World Bank data [15] it is possible to obtain data on the debt service status of Ukraine as a percentage of the share of fiscal revenues:

2010 – 4,394515, 2011 – 5,17430, 2012 – 4,875080,
2013 – 6,460995, 2014 – 8,2559, 2015 – 12,12239,
2016 – 12,93707, 2017 – 11,39065.

As you can see from the data obtained, as Duphrenot and Paret noted, by 2013 Ukraine was arriving in low vulnerability mode, although it had already entered intermediate mode since 2015. The high vulnerability mode is no longer around the corner, as for him the percentage of debt servicing should be only 14%, and in 2015 Ukraine was very close to this indicator.

2) Second Source of Vulnerability - Internal Savings (% of GDP)

For the "internal savings" model, there are three modes (0, 1 and 2) limited by internal savings of 21.7% and 24.6% of GDP.

The (Fig. 1.2) shows the results obtained by Duphrenot and Paret when checking countries for the second vulnerability indicator. The table shows the observational regimes for each country and each year. Green cells correspond to observations related to the less vulnerable mode, respectively, red to the most vulnerable mode, yellow corresponds to the average mode of vulnerability.

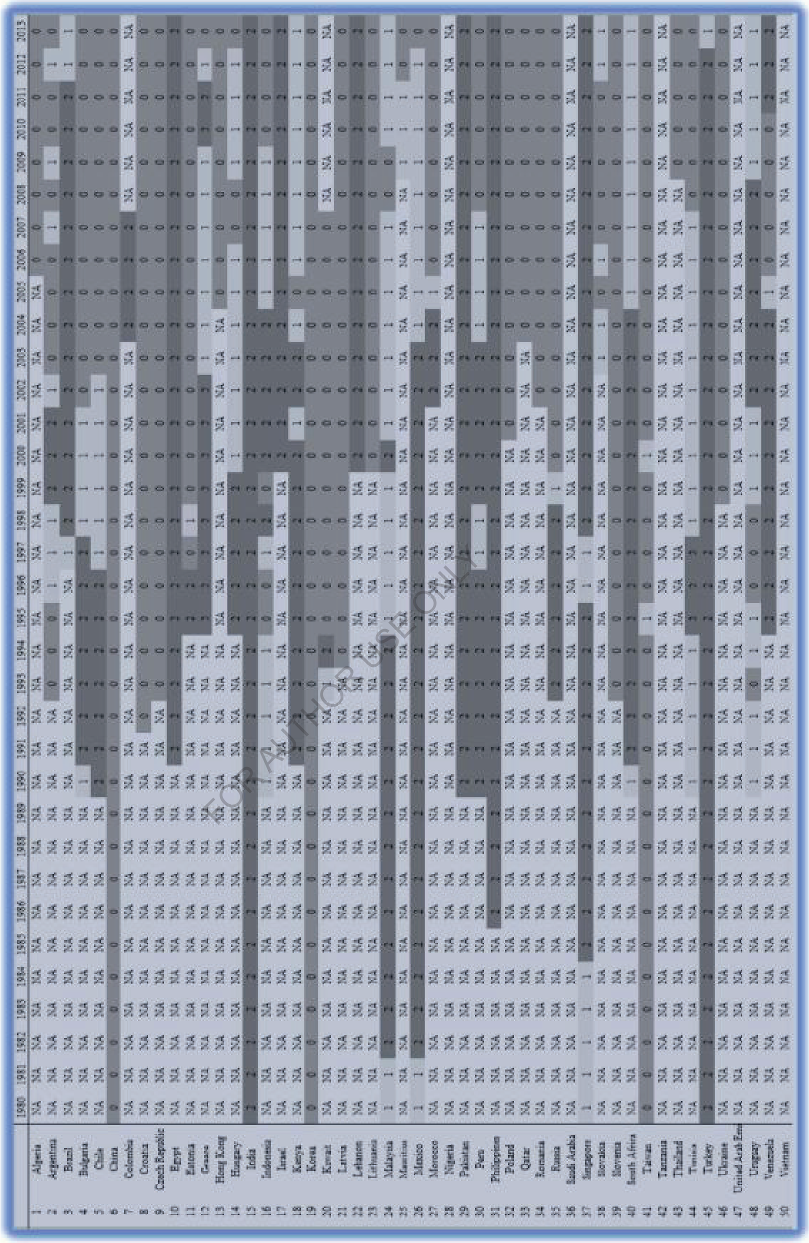

Figure 1.2 - First vulnerability mode - Central government interest payments (% of government revenue) [9]

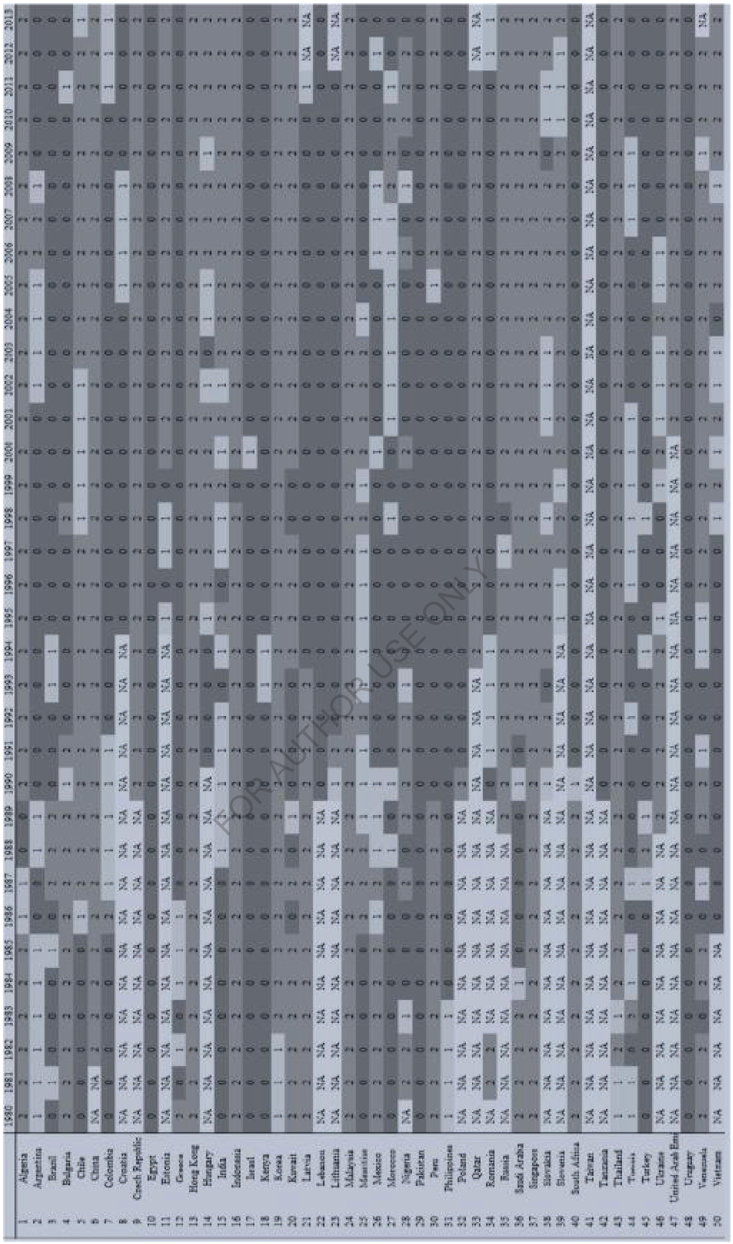

Figure 1.3 - Second vulnerability mode - Internal Savings (% of GDP) [9]

According to their results, it can be seen that from the moment of independence until 1995, Ukraine has been in the "green mode", ie in the low vulnerability mode. From 1995 to 1999, it was already in a state of high vulnerability. From 1999-2006, Ukraine was in a state of low vulnerability, medium, and since 2007 it has not left the “red regime”.

It is necessary to check the more current state of Ukraine according to the second indicator of vulnerability. Is the country in red mode? According to the World Bank [21], data on the share of domestic GDP savings are as follows:

2010 – 16,8401, 2011 – 15,8278, 2012 – 13,0640, 2013 –9,2524, 2014 – 9,8906, 2015 – 13,3221, 2016 – 14,8002, 2017 –12,2577, 2018 – 10,1708.

According to the above results, it can be seen that the country has not been able to rehabilitate the country's second default vulnerability indicator and is now in a high vulnerability to the second indicator of the domestic GDP savings ratio.

3) Third source of vulnerability – Foreign reserves (% of short-term external debt)

For the Foreign Currency Reserves model, two modes (0 and 1) are distinguished by foreign currency reserves of 78.5% of short-term external debt.

The results of this indicator are quite good for Ukraine, but in the period from 2001 to 2003, Ukraine switched to the "red" mode, after which everything was fine by 2012. Since 2012, Ukraine is again in high vulnerability mode on the third indicator:

2010 – 18,69, 2011 – 19,23174, 2012 – 21,731145, 2013 – 11,98582, 2014 – 1,05691, 2015 – 6,81545, 2016 – 7,2010, 2017 – 4,4948, 2018 – 4,6668, 2019 – 2,2300.

It is an interesting fact that in table 1.3 the data do not coincide with the data in Fig. 1.4. This is easily explained in Fig. 1.5 provides a table summarizing all the indicators used in Dufret and Paret's work, and for which period and where the figures were obtained. The data used in the third and fourth vulnerability indicators for Ukraine are missing from official sources and it is not clear what data the authors refer to. That is why the data from the Ministry of Finance of Ukraine [25] [26] were taken to predict the third and fourth vulnerability indicators for Ukraine.

Item	Source	Description => Treatment	Definition	Time period
Sovereign debt in default	Bank of Canada (David T. Beers and Jean-SÃ©bastien Nadeau)	Million US$	Estimates of stocks of government obligations in default, including bonds and other marketable securities, bank loans, and official loans in default, valued in U.S. dollars, for the years 1980 to 2013.	1980-2013 except for MU (85-13), MC, NG, UG, EY, KN, LB, PE, TU, UY, VI (88-13), PO (89-13), TN (13). No default on this period for CH, CZ, EO, HK, HN, IS, KO, LN, MY, QA, SP, SI, SX, TW, UA.
International reserves	World Bank, International Debt Statistics	Total reserves (includes gold), Current Prices, millions USD => % of STED	Total reseves comprise holdings of monetary gold, special drawing rights, reserves of IMF members held by the IMF, and holdings of foreign exchange under the control of monetary authorities. The gold component of these reserves is valued at year-end (December 31) London prices. Data are in current U.S. dollars. Aggregation Method : Sum. Millions USD except for UA, SJ, SP, SI, QA, KW, IS, HK, GR, CT, CZ, EO, HN, SX, PO, KO (US $).	1980-2013 except for CL, NG, VE, UY (80-11), CH (82-13), PO (86-08), LN (92-11), BL UR (92-13), CT (93-08), LV, ES (93-11), EO, CZ (95-13), SX (93-06), SA (94), VI (95-13), SI (56-13), HN (03-13), SP (03-13), IS (06-13). GR, HK, KW, QA, SJ, TW, UA non available.
Total short-term external debt (STED)	World Bank, World Development Indicators	Debt Outstanding, External debt stocks, short-term (DOD), Current Prices, USD	Short-term external debt is defined as debt that has an original maturity of one year or less. Available data permit no distinction between public and private nonguaranteed short-term debt.	1980-2013 except for CL, UY (80-11), CH, HN (82-13), BL (85-13), PO (86-08), VI (87-13), RS, LN (92-11), UR (92-13). LV (93-11), SX (93-06), CT (93-07), SA (94-13). GR, QA, SJ, UA,HK, KW non available.
	Oxford Economics	External debt, short-term, millions USD => % of GDP		1992-2013 except for KO, TW (80-13), EO, CZ (92-13), SI (96-13), SP (03-13), IS (06-13).
External debt (% of Exports)	Oxford Economics	External debt, total, share of exports		1980-2013 except for CH, BL (81-13), ID (83-13), SA (87-13), PK, MC, NG, CG, EY, PE, MU, KN, AA, LB, TU, UY, VI (88-13), PO (89-13), RS (90-13), HN (91-13), LV, EO, UR (92-13), SX, CZ, LN, CT (93-13), IS (95-13), SI (96-13), QA, KW (97-13), UA (99-13), HK (02-13), GR, SP (03-13). TN, SJ non available.

Figure 1.5 — Sources of information for Duphrenot and Paret vulnerability indicators

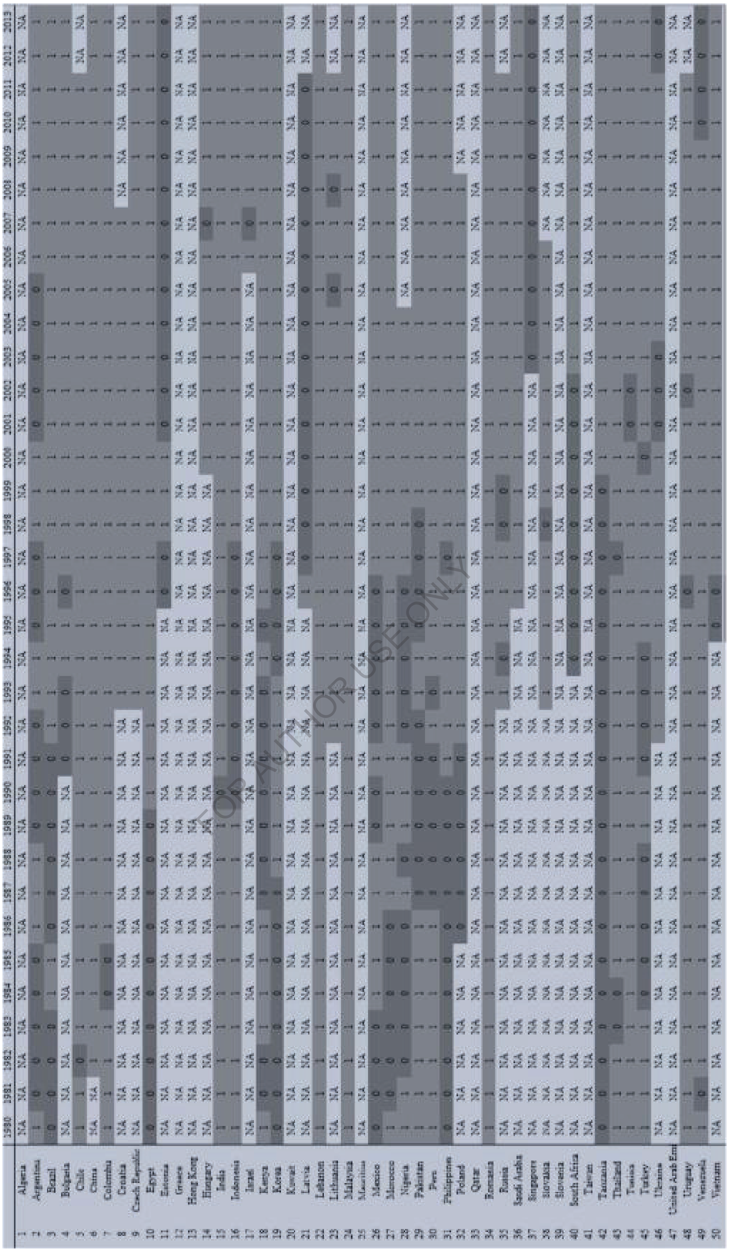

Figure 1.4 – Third vulnerability mode - Foreign reserves (% of short-term external debt) [9]

4) Fourth source of vulnerability -– External debt (% of exports)

For the external debt model, the three modes (0, 1 and 2) are limited by external debt of 126.8% and 258.3% of exports.

According to these modes, the results obtained by Dufrenot and Paret are given in (Fig. 1.5). According to their data, Ukraine is in green all the time until 2013, ie low vulnerability. As you can see from the figures, the third and fourth indicators of vulnerability very rarely come in red or yellow. Usually, this is due to the fact that in economically developed countries, relations with other countries are quite well developed, as indicated by the third indicator, as well as by developed exports (or simply small external debt), as indicated by the fourth indicator according to the Ministry of Finance of Ukraine [26]:

2010 – 49,4158, 2011 – 42,04146, 2012 – 41,3030, 2013 – 41,94622,
2014 – 54,68388, 2015 – 80,98232, 2016 – 86,21396,
2017 – 77,5185, 2018 – 71,09697.

According to these indicators, it can be seen that Ukraine is still in the low vulnerability mode from the fourth country vulnerability to default. Although since 2015, the percentage of external debt from exports has come close to the yellow of the vulnerability.

		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1	Algeria	NA	NA	NA	NA	NA	NA	NA	NA	1	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	Argentina	1	2	2	2	2	2	2	2	2	2	1	2	2	2	1	2	1	2	2	2	2	2	2	2	2	1	0	0	0	0	0	0	0	0
3	Brazil	2	0	2	2	1	1	1	1	1	2	1	1	1	1	1	1	1	1	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0
4	Bulgaria	NA	0	0	0	0	0	0	0	0	0	0	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	Chile	0	1	2	1	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	China	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Colombia	NA	NA	NA	NA	NA	NA	NA	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Croatia	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
9	Czech Republic	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	Egypt	NA	NA	NA	NA	NA	NA	NA	NA	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	Estonia	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Greece	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	3	3	3	3	3	3	3	3	3	3
13	Hong Kong	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
14	Hungary	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	India	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Indonesia	NA	NA	NA	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Israel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	Kenya	NA	NA	NA	NA	NA	NA	NA	NA	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	Korea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	Kuwait	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	Latvia	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0
22	Lebanon	NA	NA	NA	NA	NA	NA	NA	NA	0	0	1	0	1	0	1	0	1	0	1	1	2	2	2	2	2	2	2	2	1	1	1	1	1	1
23	Lithuania	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	Malaysia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	Mauritius	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	Mexico	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	Morocco	NA	NA	NA	NA	NA	NA	NA	NA	2	2	2	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	Nigeria	NA	NA	NA	NA	NA	NA	NA	NA	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	Pakistan	NA	NA	NA	NA	NA	NA	NA	NA	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	0	0	0	0	1	1	1	0	0	0
30	Peru	NA	NA	NA	NA	NA	NA	NA	NA	2	1	2	2	2	2	2	2	2	1	2	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
31	Philippines	0	1	1	2	1	2	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	Poland	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	Qatar	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	Romania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	Russia	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	Saudi Arabia	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	Singapore	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0
38	Slovakia	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	Slovenia	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
40	South Africa	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	Taiwan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	Tanzania	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
43	Thailand	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	Tunisia	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	Turkey	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	Ukraine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47	United Arab Emi	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	Uruguay	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0
49	Venezuela	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	Vietnam	NA	NA	NA	NA	NA	NA	NA	NA	0	2	2	2	2	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 1.5- Fourth vulnerability mode - External debt (% of exports) [9]

1.5 Results of the literature review

According to the material discussed above, the following can be noted, the most vulnerable to default are countries that have experienced at least one default in the last five years. It should be emphasized that in 2015 Ukraine was in a state of technical default [27]. The Cabinet essentially declared a technical default, announcing a temporary suspension of payments on repayment and servicing of public debt. Thus, Ukraine has not paid $ 500 million on Eurobonds. In addition, the Cabinet of Ministers of Ukraine developed a restructuring of the national debt in accordance with Resolution No. 978-p. It is expected that Ukraine will write off 20% of its principal debt, and the maturity of the remaining amount will be delayed by four years - from 2015 - 2023 to 2019-2027. Thus, Ukraine has to start paying off its debt this year, and will it not default again?

Referring to the Gilles Dufrenot and Anna-Charlotte Paret studies, the Sovereign Defaults in Developing Countries identified four major sources of vulnerability, according to which Ukraine has an average vulnerability to the first, second and third default, and, so far, green on the fourth, where the external debt-to-export ratio is involved.

However, already this latest indicator of vulnerability to default for Ukraine can go into high vulnerability mode. Because all the time it has been maintained due to the high export status in the country. According to the Express issue of the State Statistics Service of Ukraine on Foreign Trade of Ukraine in January-August 2019 [28], the export index fell significantly according to the previous results (Fig. 1.6).

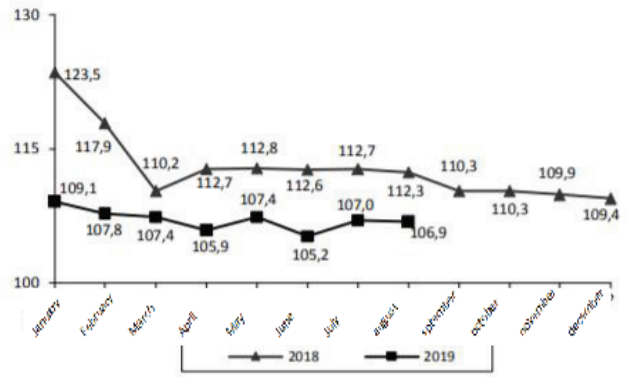

Figure 1.6 – Data of the State Statistics Service of Ukraine on Foreign Trade of Ukraine. Growth (decrease) of exports of goods

According to the Maastricht Convergence Criteria, the ratio of total government debt should not exceed 60% of GDP. Exceeding this criterion becomes not only destructive but also dangerous for the country and its population. Moreover, a number of scholars, based on empirical studies of the question, set the margin of safety well below the Maastricht criterion. Thus, K. Patillo, G. Poerson and L. Ricci have determined that the negative impact of a country's external debt on economic growth occurs on its (debt) levels of 35-40% of GDP.

And K. Reinhard, K. Rogoff and M. Sevastyan determined that the risk of a debt crisis arises already at 15% of gross external debt from GDP [11]. While in Ukraine as of 2018, the level of national debt to the GDP of Ukraine was 60.9% [29].

Meanwhile, Ukrainian oligarch Igor Kolomoisky spoke in favor of Ukraine's default. He said this in an interview with the Financial Times.

"In my opinion, we should treat our creditors like Greece. This is an example for Ukraine," Kolomoisky quotes. In 2015, Greece became the first developed country to fail to pay the International Monetary Fund loan, albeit temporarily.

Kolomoisky thinks there is nothing wrong with the default. "How many times has Argentina defaulted? And what, they restructured it," the oligarch said.

Thus, a default in Ukraine in 2020 may become a sad reality. That is why it is necessary to clearly understand what this will give Ukraine and what the consequences will be.

Chapter 2.
Development of a default forecast model

2.1 Problem statement

As a result of the arguments presented in the first section regarding the approach of the default state for Ukraine, it is necessary to develop predictions of the consequences of this phenomenon for the country. In order to predict the effects of default in Ukraine as effectively as possible, models need to be built that can predict how the data will behave. To obtain such data, you need to develop at least two models for each of the projected metrics. The first is a recession model, it will show how low the figure will fall when simulating a default situation, the second will be a lift model, it should show how quickly the indicator can recover after a default occurs. However, some indicators cannot be clearly described by the fall and rise patterns because each country behaves differently. Each of these indicators will be discussed in more detail in the following subparagraphs.

In order to get a fairly complete picture, forecasting the effects of the default in Ukraine will be carried out for such indicators as: GDP per capita (current US dollar), national currency against the dollar, consumer price index (current US dollar), wages (current US dollar)). These four indicators were chosen because they will be able to demonstrate the quality of life in the country as a result of default.

The models will be created on the basis of four defaulting countries: Argentina, Mexico, the Russian Federation and Uruguay. Of course, these are not the only countries that have defaulted, but these are the ones chosen to create the models. The materials for these countries, on which the models will be developed, are given in the following tables.

Table 2. 1 – Data on Argentina [17], [23], [31], [32]

Argentina (defaulted in 2001)

Years	Exchange rate	Salary Level (Current USD)	Consumer Price Index (2010 = 100%)	GDP per capita (current US dollar)
1990	0,49	3 491 224 489,80	15,38	4 318,77
1991	0,95	5 390 842 105,26	41,78	5 715,50
1992	0,99	5 403 691 004,44	52,18	6 798,03
1993	1,00	5 678 886 217,95	57,71	6 940,35
1994	1,00	6 383 463 151,59	60,12	7 449,48
1995	1,00	6 890 475 239,62	62,15	7 373,43
1996	1,00	6 765 817 091,45	62,25	7 683,57
1997	1,00	7 206 411 024,57	62,58	8 172,66
1998	1,00	6 770 529 470,53	63,16	8 248,76
1999	1,00	7 148 092 670,26	62,42	7 736,37
2000	1,00	7 020 071 899,34	61,83	7 669,27
2001	**1,01**	**6 437 370 036,64**	**61,17**	**7 170,69**
2002	3,41	2 049 280 469,90	77,00	2 579,19
2003	2,96	2 937 100 362,58	87,35	3 330,44
2004	2,97	3 169 563 175,38	91,21	4 251,57
2005	3,01	N / A *	100,00	5 076,88
2006	3,06	N / A *	110,90	5 878,76
2007	3,14	N / A *	120,70	7 193,62
2008	3,43	N / A *	131,06	8 953,36
2009	3,81	N / A *	139,29	8 161,31
2010	3,98	N / A *	154,31	10 276,26
2011	4,29	N / A *	168,91	12 726,91
2012	4,88	N / A *	185,85	12 969,71
2013	6,34	N / A *	Н/Д	12 976,64
2014	8,55	16 936 872 880,36	105,50	12 245,26
2015	11,39	17 220 865 899,71	N / A *	13 698,29
2016	15,84	16 904 588 777,38	N / A *	12 654,35
2017	17,72	N / A *	N / A *	14 398,36

Years	Exchange rate	Salary Level (Current USD)	Consumer Price Index (2010 = 100%)	GDP per capita (current US dollar)
2018	38,84	N / A *	N / A *	N / A *
2019	58,79	N / A *	N / A *	N / A *

* N / A – no data available

Table 2. 2 – Data on Mexico [16], [23], [31], [32]

Mexico (defaulted in 1994)

Years	Exchange rate	Salary Level (Current USD)	Consumer Price Index (2010 = 100%)	GDP per capita (current US dollar)
1985	256,87	8 151 920,02	0,84	2 523,50
1986	611,77	5 307 524,20	1,56	1 704,59
1987	1 378,18	4 982 658,29	3,61	1 832,73
1988	2 273,10	5 984 338,57	7,73	2 212,51
1989	2 461,47	7 110 385,26	9,28	2 645,24
1990	2 812,60	8 341 392,31	11,75	3 060,69
1991	3 018,43	11 732 258,16	14,42	3 596,39
1992	3 094,90	15 228 925,01	16,65	4 088,31
1993	3,12	11 992 637 644,05	18,28	5 526,86
1994	**3,39**	**13 033 973 412,11**	**19,55**	**5 715,41**
1995	6,45	8 065 611 912,52	26,39	3 828,72
1996	7,60	8 910 921 052,63	35,47	4 294,98
1997	7,92	9 380 399 090,68	42,78	5 143,96
1998	9,15	10 417 395 104,90	49,60	5 327,81
1999	9,55	12 874 908 405,74	57,82	5 984,34
2000	9,46	15 335 764 880,01	63,31	6 959,39
2001	9,34	N / A *	67,34	7 341,88

Years	Exchange rate	Salary Level (Current USD)	Consumer Price Index (2010 = 100%)	GDP per capita (current US dollar)
2002	9,66	N / A *	70,73	7 398,80
2003	10,79	N / A *	73,95	6 903,95
2004	11,29	N / A *	77,42	7 310,96
2005	10,89	N / A *	80,50	8 089,41
2006	10,91	N / A *	83,42	8 859,72
2007	10,93	N / A *	86,73	9 412,83
2008	11,14	31 586 034 142,02	91,18	9 765,72
2009	13,50	24 454 430 297,00	96,01	7 792,25
2010	12,62	27 891 011 046,49	100,00	9 016,46
2011	12,43	30 880 188 263,13	103,41	9 912,58
2012	13,15	31 493 692 466,10	107,66	9 940,47
2013	12,76	33 061 864 744,69	111,76	10 400,56
2014	13,30	33 788 935 329,62	116,25	10 582,41
2015	15,87	30 554 298 055,18	119,41	9 298,24
2016	18,66	26 434 446 393,43	122,78	8 450,49
2017	18,93	26 772 095 463,15	130,20	8 910,33
2018	19,24	N / A *	N / A *	N / A *

* N / A – no data available

Table 2. 3 – Data on the Russian Federation [18], [23], [31], [32]

Russian Federation (default in 1998)

Years	Exchange rate	Salary Level (Current USD)	Consumer Price Index (2010 = 100%)	GDP per capita (current US dollar)
1991	55,71	N / A *	N / A *	3 485,06
1992	414,50	Н/Д	0,05	3 095,66
1993	1 247,00	Н/Д	0,52	2 929,46

Years	Exchange rate	Salary Level (Current USD)	Consumer Price Index (2010 = 100%)	GDP per capita (current US dollar)
1994	3 550,00	N / A *	2,13	2 663,39
1995	4 640,00	N / A *	6,33	2 665,78
1996	5 560,00	N / A *	9,36	2 643,93
1997	5 960,00	N / A *	10,74	2 737,57
1998	**20,65**	**6 022 566 585,96**	**13,71**	**1 834,86**
1999	27,00	4 606 148 148,15	25,46	6,73
2000	28,16	7 607 599 431,82	30,76	10,46
2001	30,14	8 211 380 225,61	37,37	5,54
2002	31,78	12 991 089 968,66	43,27	5,23
2003	29,45	18 616 947 926,46	49,18	7,78
2004	27,75	23 460 502 041,54	54,53	7,61
2005	28,78	28 767 257 882,39	61,45	6,78
2006	26,33	39 322 322 272,90	67,39	8,51
2007	24,55	52 081 381 232,13	73,46	8,72
2008	29,38	54 914 160 460,72	83,83	5,29
2009	30,24	65 559 677 558,01	93,59	- 7,85
2010	30,48	67 234 528 446,13	100,00	4,46
2011	32,20	70 020 903 152,87	108,44	5,20
2012	30,37	94 143 754 094,96	113,94	3,48
2013	32,73	99 724 405 118,37	121,64	1,57
2014	56,68	61 031 617 810,26	131,15	- 1,04
2015	72,88	47 993 666 023,64	151,53	- 3,04
2016	60,66	57 406 016 463,09	162,20	- 0,41
2017	57,60	63 087 940 666,87	168,17	1,53
2018	69,47	N / A *	N / A *	N / A *

* N / A – no data available

Table 2.4 – Uruguay Data [20], [23], [31], [32]

Uruguay (defaulted in 2003)

Years	Exchange rate	Salary Level (Current USD)	Consumer Price Index (2010 = 100%)	GDP per capita (current US dollar)
1990	Н/Д*	600 000 000,00	2,13	2 989,99
1991	Н/Д	2 042 857 142,86	4,31	3 577,84
1992	Н/Д	5 045 454 545,45	7,26	4 082,03
1993	Н/Д	10 584 000 000,00	11,19	4 720,38
1994	0,20	21 348 484 848,48	16,20	5 458,09
1995	0,16	34 923 566 878,98	23,05	5 984,14
1996	0,12	63 675 000 000,00	29,58	6 316,29
1997	8,90	1 078 876 404,49	35,44	7 327,96
1998	0,08	133 675 000 000,00	39,27	7 711,08
1999	0,85	14 902 352 941,18	41,49	7 247,40
2000	0,80	13 723 750 000,00	43,47	6 871,90
2001	0,70	25 621 372 191,17	45,37	6 281,38
2002	0,59	30 389 351 180,07	51,70	4 088,77
2003	**0,04**	**566 343 849 885,71**	**61,73**	**3 622,05**
2004	0,03	669 746 094 955,88	67,38	4 117,31
2005	0,40	63 027 147 615,19	70,54	5 220,95
2006	0,04	693 856 879 093,58	75,06	5 877,88
2007	0,04	892 046 234 712,43	81,15	7 009,70
2008	0,05	838 259 903 369,57	87,54	9 062,31
2009	0,04	1 191 109 466 094,48	93,72	9 415,17
2010	0,05	1 096 574 328 551,83	100,00	11 938,21
2011	0,05	1 222 831 443 170,83	108,09	14 166,50
2012	0,05	1 488 317 670 692,93	116,85	15 092,07
2013	0,05	1 723 358 996 117,89	126,87	16 881,21
2014	0,04	2 280 236 111 111,11	138,13	16 737,90
2015	0,04	2 911 165 811 358,70	150,10	15 524,84
2016	0,03	5 979 155 296 895,19	164,57	15 298,35
2017	0,03	4 297 091 348 825,21	174,80	16 245,60

Years	Exchange rate	Salary Level (Current USD)	Consumer Price Index (2010 = 100%)	GDP per capita (current US dollar)
2018	N / A *	N / A *	N / A *	N / A *

* N / A – no data available

Table 2.5 – Data on Ukraine [19], [23], [31], [32]

Ukraine

Years	Exchange rate	Salary Level (Current USD)	Consumer Price Index (2010 = 100%)	GDP per capita (current US dollar)
1991	Н/Д*	N / A *	N / A *	1 489,69
1992	Н/Д	N / A *	N / A *	1 417,87
1993	Н/Д	N / A *	N / A *	1 258,14
1994	Н/Д	N / A *	N / A *	1 012,11
1995	Н/Д	N / A *	N / A *	935,97
1996	Н/Д	N / A *	N / A *	872,71
1997	Н/Д	N / A *	N / A *	991,23
1998	**3,85**	N / A *	**22,15**	**835,26**
1999	5,20	876 423 076,92	27,18	635,77
2000	5,40	1 261 222 222,22	34,84	635,71
2001	5,30	1 757 037 735,85	39,01	779,98
2002	5,33	2 097 332 389,35	39,31	878,62
2003	5,35	2 603 207 225,05	41,34	1 047,50
2004	5,30	3 374 094 339,62	45,08	1 366,02
2005	5,05	4 046 214 823,62	51,20	1 826,93
2006	5,05	5 182 736 091,86	55,84	2 300,77
2007	5,05	6 809 395 441,03	63,01	3 065,61
2008	5,90	7 815 932 203,39	78,90	3 887,24
2009	8,00	5 998 625 000,00	91,43	2 543,00
2010	7,97	6 821 004 394,22	100,00	2 965,14
2011	8,00	7 234 771 732,33	107,96	3 569,76

Years	Exchange rate	Salary Level (Current USD)	Consumer Price Index (2010 = 100%)	GDP per capita (current US dollar)
2012	8,04	7 894 488 059,70	108,57	3 855,42
2013	8,61	7 930 256 297,33	108,31	4 029,72
2014	15,77	4 628 549 686,09	121,39	3 104,66
2015	**24,00**	**3 483 070 833,33**	**180,50**	**2 124,66**
2016	26,99	4 040 640 978,14	205,61	2 187,73
2017	28,14	4 986 941 531,90	235,30	2 639,82
2018	27,92	Н/Д	Н/Д	3 095,20

* N / A – no data available

Given that the model will depend on time, it is necessary to carry out correlation analysis to identify the level of correlation between the coefficients and the passage of time. Thanks to Microsoft Excel Data Analysis features, which can be obtained by installing additional analysis data package, correlation analysis of GDP per capita (current US dollar), national currency against the dollar, consumer price index (current US dollar), level of payment was made labor (current US dollar) depending on time. Such an analysis will prove that countries are well suited to take them to develop a model of forecasting the impact of Ukraine's default in 2020. The data tables on the basis of which the correlation analysis was made are given above.

Table 2.6 - Correlation analysis for Argentina in the period 1990-2019.

	Years
Exchange rate	0,693
The level of remuneration	0,607
Consumer Price Index	0,513
GDP per capita	0,675

According to the correlation analysis of Argentina, one can see the correlation between GDP per capita (current US dollar), national currency to dollar, consumer price index (current US dollar), wages (current US dollar) from time to time . Almost all metrics have more than 0.6 links except the Consumer Price Index. The more the index of correlation analysis approaches unit by unit, the better the relationship. When the indicator is negative, it indicates feedback and the closer it is to one, the better. The relationship between the Consumer Price Index and the passage of time is 0.51. The fact that more than 50% already indicates that there is a link, but the fact that such a low can be explained by the fact that since 2015 in Argentina there is no data on the Consumer Price Index. That is why, due to the reduction in data sampling, the communication level has decreased slightly, but it still exists.

Table 2.8 – Correlation analysis for Mexico in 1985 -2018

	Years
Exchange rate	-0,658
The level of remuneration	0,980
Consumer Price Index	0,994
GDP per capita	0,497

Correlation analysis for Mexico indicates a stronger relationship than Argentina. The exchange rate is negative, but still sufficiently usable. The GDP per capita, as in Argentina, is a little less than all other indicators, but it can be tolerated based on the mathematical rules of rounding numbers.

Table 2.9 – Correlation analysis for the Russian Federation in the period 1991 - 2018

	Years
Exchange rate	0,767
The level of remuneration	0,984
Consumer Price Index	0,991
GDP per capita	-0,661

TC correlation analysis for the Russian Federation shows very good results. All metrics exceed the 0.65 level of modulo communication. The indicators of the level of remuneration and consumer price index are almost entirely dependent on the passage of time in the Russian Federation.

Table 2.10 – Correlation analysis for Uruguay for the period 1990-2018

	Years
Exchange rate	-0,498
The level of remuneration	0,876
Consumer Price Index	0,980
GDP per capita	0,618

In 1993, after the next period of inflation, the Uruguayan government reformed, after which the “peso uruguayo” (code: UYU) replaced the new peso and changed at a rate of 1: 1000. It is for this reason that data up to 1993 is not calculated, which reduces the range of data to identify. Nevertheless,

based on the mathematical rules of rounding the numbers, the data can still be taken to calculate the model of default consequences for Ukraine in 2020.

Table 2.11 – Correlation analysis for Ukraine in the period 1991-2018.

	Years
Exchange rate	0,823
The level of remuneration	0,948
Consumer Price Index	0,924
GDP per capita	0,740

In Ukraine, the correlation between GDP per capita (current US dollar), national currency to dollar, consumer price index (current US dollar), wages (current US dollar) and over time shows very good communication results , which is why these four indicators were selected for forecasting.

Based on the correlation analysis, it becomes clear why the countries themselves were selected: Argentina, Mexico, the Russian Federation and Uruguay in order to build their GDP per capita behavior model (current US dollar), the national currency against the dollar, consumer price index (current US dollar), wage level (current US dollar)

2.2 GDP per capita behavior patterns

To start building GDP per capita behaviors in Ukraine in 2020, it is necessary to study the default behavior in countries such as Argentina, Mexico, the Russian Federation and Uruguay during the default (Figures 2.1 - 2.4). [31]

Argentina experienced a default in 2001 and, with the exception of Greece, the country experienced the strongest default in the 21st century. Back in 2001, GDP per capita was $ 7,170.6, and as early as 2002, $ 2,579 6 years (Fig. 2.1).

Figure 2.1 – GDP per capita behavior in Argentina

The default in Mexico came in 1993. To date, the country's GDP per capita has been increasing year by year. In 1993 it was $ 5,715, and in 1994 it dropped to $ 3,828. The decline lasted only 1 year and since 1995 the figure has increased. Mexico's GDP per capita took 5 years to recover. During all this time, the index has experienced only growth (Fig. 2.2).

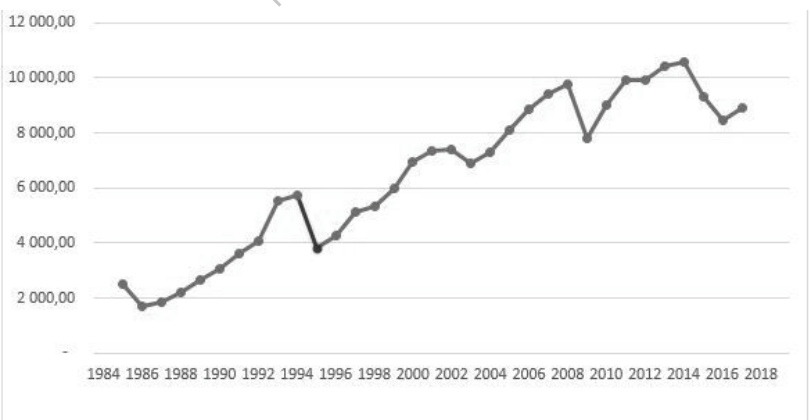

Figure 2.2 – GDP per capita behavior in Mexico

The Russian Federation defaulted in 1998, but its GDP per capita figure began to decline two years earlier. The fact is that in the late 1990s, just in 1997-1998, the economic crisis in the countries of South and East Asia exploded. Almost all Asian countries were affected, including the Russian Federation, for which the crisis has defaulted. In the period

From 1998-1999, the GDP per capita indicator fell from $ 1,834 to $ 1,330. After a year of decline, GDP per capita has started to rise. Its period of growth continued until 2008, until the economic situation in the country faltered again. The recovery of GDP per capita in the Russian Federation took 5 years, which can be seen from (Fig.2.3).

As regards Uruguay, the country defaulted in 2003 as a result of the crisis that began in 2001. This is why GDP per capita began to decline in 2001. The default was officially announced in early 2003, but its presence in the country was felt as early as 2002. As a result, GDP per capita declined from 2002 to 2003 from $ 4,008 to $ 3,622.

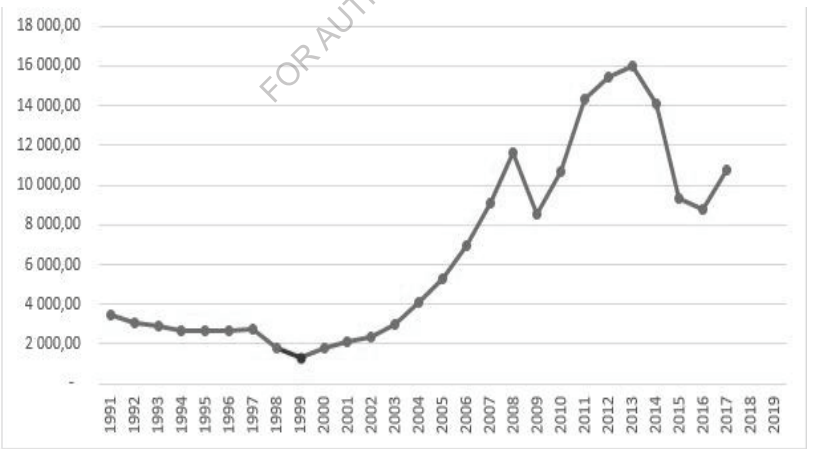

Figure 2.3 – GDP per capita behavior in the Russian Federation

Figure 2.4 – GDP per capita behavior in Uruguay

After the default and year of recession, GDP per capita began to recover, with a year-long decline in the country.

From the graphs, it can be seen that the GDP per capita process only took a year, after which it began to increase in each country.

Without further information, we will assume that the downturn occurred in an exponential form, which is why model (2.1) was chosen for the downturn forecast:

$$Y_t = A_1 \ e^{-\lambda_1 t} \tag{2.1}$$

where A is the relative amplitude of the change in the indicator, t is the time at which the forecast is made, since for all indicators the data is collected by year, it is equal to one, λ – the coefficient of the formula:

$$\lambda_i = \frac{1}{T_i} \tag{2.2}$$

where T_i – a period of continued decline or rise in years.

The analysis of the graphical form of the graph of GDP per capita rise shows that it also has an exponential view. The general appearance of the lifting model is of the form

$$Y_t = A_2(1 - e^{-\lambda_2 t}) \quad (2.3)$$

In each of the countries experiencing default, GDP per capita has fallen no more than a year, so for Ukraine the recession model will continue for one year. For declining and lifting models, you must calculate the relative magnitude of the fall amplitude for each country and find the average amplitude for future use.

The calculation will be made by the formula:

$$The\ relative\ amplitude = \frac{T_0}{T_1} \quad (2.4)$$

where T_0 – is the *GDP* per capita default, T_1– this is an indicator of GDP per capita after default. The calculations in Table 2.12 are a calculation of the relative magnitude of GDP per capita decline across countries.

Table 2.12 –Relative amplitude of GDP per capita (current US dollar) by country

Argentina	2,9735166
Mexico	1,4435280
R.F.	2,0571489
Uruguay	1,1288541
Average value	**1,9007619**

Due to the fact that the GDP per capita in all countries is based on the current exchange rate of the national currency against the US dollar, the relative amplitude indicator can be considered as objective. Now with the

help of Microsoft Excel "Regression" it is necessary to make regression analysis of GDP per capita by years (Table 2.13).

Table 2.13 – Regression analysis

Regression statistics	
Multiple R	0,740
R-squared	0,547
Normalized R-squared	0,529
Standard error	765,054
Observations	27

	Odds	*Standard error*	*t-statistic*	*P-value*
Y intersection	-206300,412	37882,287	-5,446	0,0000118
Variable x 1	103,910	18,903	5,497	0,0000104

	Lower 95%	*Top 95%*
Y intersection	-284320,44	-128280,381
Variable x 1	64,978	142,842

According to the above results, attention should be paid to the "R-square" indicator, which indicates the level of approximation. It is high enough to use the coefficients calculated from the analysis. This value of the level of approximation can be partly explained by a rather small sample, since independence was obtained in 1991 by Ukraine, which provides us with data for only 27 years (full years are estimated, 2019 is not counted).

Regression analysis has found the coefficients that will be substituted into formula 2.5 to predict the behavior of GDP per capita specifically for Ukraine.

$$y_i = a + bx, \tag{2.5}$$

where y_i – is the estimated forecast of the behavior of the indicator i; a and b are the coefficients found by regression analysis for exponent i;

x – is the number of the year for which i is predicted (the indicator depends on y).

Thus, to predict *GDP* per capita, it is necessary to find the coefficients by which GDP per capita behavior will be calculated for Ukraine, and then multiply this by the recession (2.1) or fall (2.3) model to adjust the GDP per capita behavior. population to default. Because, even with all the arguments given for approaching a default, there are still a great number of economic phenomena that need to occur for its official occurrence. Because these phenomena have not yet fully occurred in Ukraine, it is necessary to combine the model of behavior of the calculated indicator and the model of behavior of this indicator in the default state.

Based on all the above arguments and having coefficients, we can substitute this data to form a real-world view of the recession model (2.6). For ease of perception, two different models were bracketed.

$$y = (-206300,412 + 103,91x)(1.9e^{-\lambda t}). \quad (2.6)$$

With regard to the second model, it is first necessary to calculate how quickly the *GDP* per capita can recover after such a fall.

Table 2.14 shows how long each country has taken to raise GDP per capita to default or even higher, as GDP per capita is obtained at an annual interval. Thus, the *GDP* per capita recovery period has been found and the forecast for Ukraine will be adjusted to this average.

Table 2.14 – Over the past hour, an indicator of GDP per capita has been updated (years)

Argentina	6
Mexico	4
R.F.	5
Uruguay	1
Average value	4

For the model of statistics, the indicator of annual amplitude of the indicator of GDP per capita of the population by skin rock is likely to make a prediction (table 2.15)

Table 2.15 – Higher change in the annual amplitude of GDP per capita in the country

Number per period, default	Argentina	Mexico	R.F.	Uruguay	Average value	Standard deviation
0	2,9735166	1,443528	2,057148	1,1288541	1,90076	0,703592
1	0,774430852	0,891440223	0,751164	0,7886128	0,80141	0,05367
2	0,783342059	0,834955569	0,843474	0,8882377	0,83750	0,037248
3	0,837437785	0,965492254	0,883417	0,838535	0,88122	0,052071
4	0,863597586	0,890292154	0,799136	0,7734998	0,83163	0,047165
5	0,81722	0,85989	0,72522	0,96252	0,84121	0,085286

Thus, a general view of the GDP per capita forecasting model, that is, a model of the GDP per capita overall forecast adjusted for the default model of recovery, is given in of formula (2.7).

$$y_i = (-206300{,}412 + 103{,}910x_i)\left(1 - A_i e^{-\lambda_i t}\right). \qquad (2.7)$$

The data obtained with the help of the created models of GDP per capita forecast by default are immediately reflected in Fig. 2.5, which also provides data from previous years for comparison.

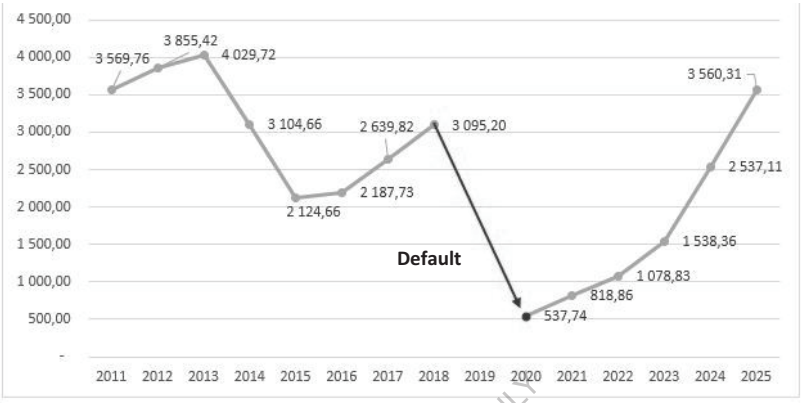

Fig. 2.5 – GDP per capita behavior model of Ukraine's default in 2020

As can be seen from the graph, the GDP per capita is projected to recover in approximately 4.5 years, from 2021-2025. GDP per capita figures for 2019 are not yet calculated, so they are not on the chart.

Due to the fact that the regression analysis gave an indicator of the level of approximation of 54.7%, the obtained values will be reliable only by 54.7%, so it is necessary to calculate the upper and lower bounds of forecasting.

Using the root mean square deviation (SLE), you can get a "prediction band corridor". SLE - must be calculated for the fall period and the rise period, and since the fall period is equal to 1 year, the SLE, and accordingly the forecast range corridor, will appear during the rise period. The formulas for calculating □ in the upper (2.8) and lower (2.9) limits are given below. To calculate the upper and lower bounds of the GDP per capita corridor, it is necessary to substitute formulas (2.8) or (2.9) into formulas (2.6) and (2.7), respectively.

$$\lambda+= \frac{1}{T\text{cp}+\sigma_{t_i}} \quad (2.8)$$

$$\lambda-= \frac{1}{T\text{cp}-\sigma_{t_i}} \quad (2.9)$$

The values of the root mean square deviation are given in Table 2.9. Substituting the values of formulas (2.7) and (2.8) in model (2.6) and (2.7), one can calculate the corridor of the forecasting range, but this will be the calculation of the forecast corridor only for the default model. Due to the fact that GDP per capita behavior is predicted by using integrated GDP per capita behavior models for Ukraine and GDP per capita defaults, the GDP per capita behavior model for Ukraine needs to be adjusted. Table 2.7 shows the results of the regression analysis, where it can be seen that the found coefficients can describe only 54.7% of the total variation of values, while at the same time Table 2.7 shows the coefficients for calculating the upper and lower bounds of the data corridor.

Thus, the general view of the model for predicting the lower boundary of the corridor of the forecasting range will look for the recession model (2.10) and the lift model (2.11).

$$y = (-284320,44 + 64,978x)(1.9e^{-\frac{1}{T_{av}-\sigma_{t_i}}t}), \quad (2.10)$$

$$y = (-284320,44 + 64,978x)(1 - A_i e^{-\frac{1}{T_{av}-\sigma_{t_i}}t}). \quad (2.11)$$

The general view of the model for forecasting the upper boundary of the corridor of the forecasting range will look for the recession model (2.12) and the lift model (2.13).

$$y = (-284320,44 + 64,978x)(1.9e^{-\frac{1}{T_{av}+\sigma_{l_i}}t}), \qquad (2.12)$$

$$y = (-284320,44 + 64,978x)(1 - A_i e^{-\frac{1}{T_{av}+\sigma_{l_i}}t}). \qquad (2.13)$$

The results of the calculations of the optimistic and pessimistic forecasts obtained using formulas (2.10) – (2.13) are shown in Fig. 2.6.

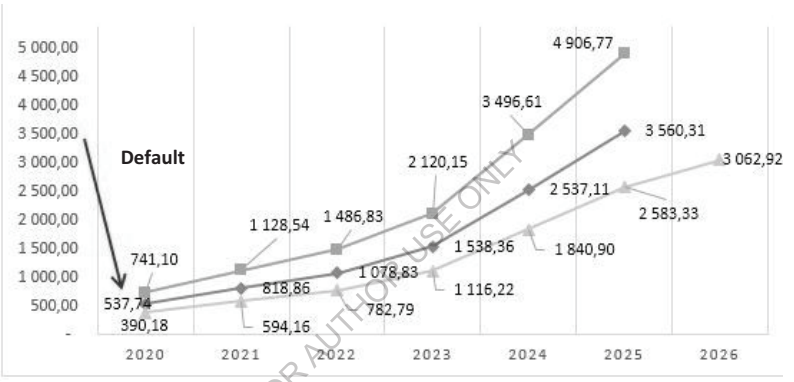

Fig. 2.6 – Corridor of GDP per capita behavior forecasting range due to default in Ukraine in 2020

The main criterion for predicting the *GDP* per capita behavior model due to the default in Ukraine in 2020 was:

1) predict the fall in GDP per capita

2) to predict the speed of its recovery to the value that was before the onset of default in Ukraine.

Thus, it can be argued that as a result of the default in 2020 in Ukraine the GDP per capita will fall by 82.63%. The last known GDP per capita value for 2018 is 3 095.2 (USD) and the projected value for 2020 is 537.74 (USD). Starting next year, in 2021, GDP per capita will begin to rise and, according

to the model developed, will be able to recover from its position in 2018 in about 4.5 years. Due to the fact that in 2025 the GDP per capita value will be 3 560.63 (USD), which even exceeds the value in 2018. With a probability of 46%, the renewal period can be reduced to 3.5 years or extended to 6 years. According to the corridor of the forecasting range, in which the upper limit can be called optimistic forecast and the lower, respectively, pessimistic forecast.

2.3 Consumer Price Index Behavior Models

In order to start building the behavior of the Consumer Price Index in Ukraine in 2020, it is necessary to study the default behavior in countries such as Argentina, Mexico, the Russian Federation and Uruguay during the default (Fig. 2.7 – 2.10). The Consumer Price Index for all countries was taken from the World Bank database [23], where 100 were selected as the price level in 2010 and all subsequent calculations were made according to 2010. By its nature, the Consumer Price Index is constantly growing, which is illustrated in the following pages.

As can be seen from Fig. 2.7 In Argentina, until 2001, that is, before the onset of default, the Consumer Price Index was almost at the same level. Then he quickly went uphill.

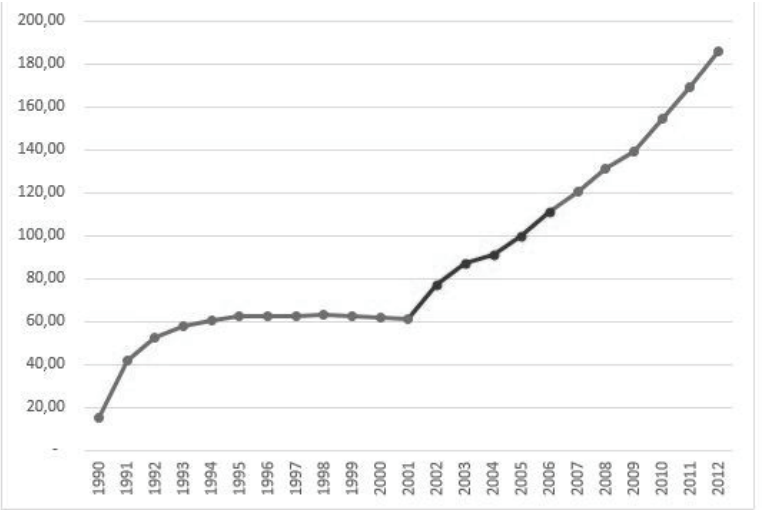

Figure 2.7 – Consumer Price Index Behavior in Argentina (100% Accepted 2010)

In Mexico, the consumer price index before the onset of default tended to rise, but, like in Argentina, the rate of price increase increased after the default. (Fig. 2.8)

In the Russian Federation, until the onset of default, the Consumer Price Index has remained at approximately the same level for the last 4 years, after which rapid growth has taken place. After that, the dynamics of growth persists to this day.

Uruguay, in its turn, has not experienced a rapid rise in the price index as Mexico and Argentina, but compared to previous years, a jump can be seen.

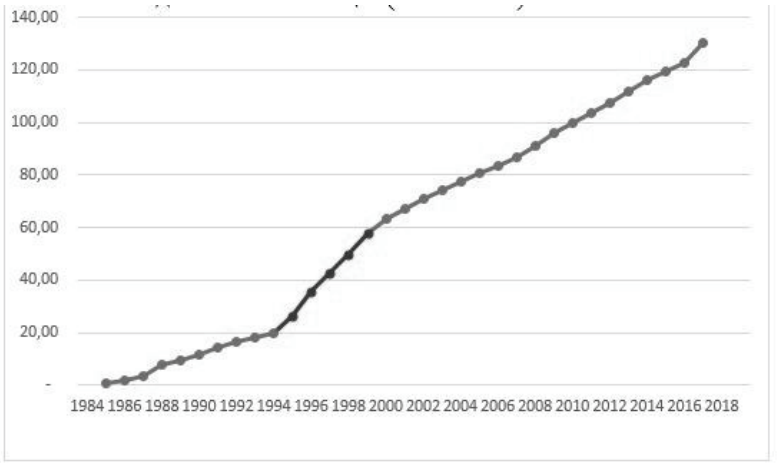

Figure 2.8 – Consumer Price Index Behavior in Mexico (100% Accepted for 2010)

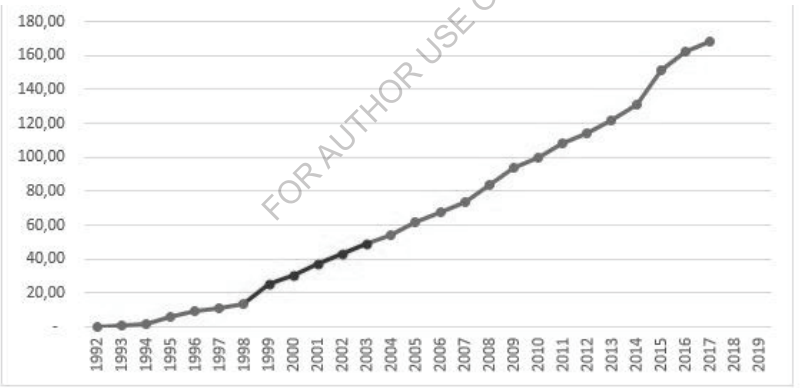

Figure 2.9 – Consumer Price Index Behavior in the Russian Federation (100% Accepted for 2010)

To date, the World Bank database has calculated CPIs for 2017 across all countries, which will not prevent it from forecasting its behavior for Ukraine as a result of default in 2020, as its behavior model will be calculated based on behavior in other countries for the period of default.

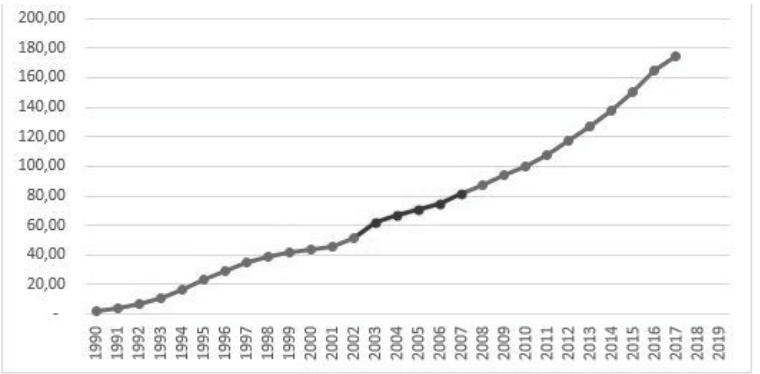

Figure 2.10 – Uruguay Consumer Price Index Behavior (100% Accepted 2010)

The previous section predicted that GDP per capita will recover after a default of less than five years, which is why the Consumer Price Index behavior will be calculated 6 years in advance (the year of default and 5 years after it). It should be noted that, unlike GDP per capita, the Consumer Price Index has a somewhat different nature, due to its dependence on constant economic and inflation growth, the Consumer Price Index (hereinafter CPI) is constantly growing. That is why from the analysis of the graphical form of the graphs of the rise of the CPI indicator it was evident that it also has an exponential appearance. The general appearance of the lifting model is (2.3).

Table 2.16 shows the results of the relative CPI growth amplitude over 6 years: in the year of default and then 5 years later. The table also has a standard deviation indicator that will be used in future calculations of the CPI range corridor. Because forecasting is year by year, and the Consumer Price Index does not have such a clear pattern of GDP per capita, that is, a clear drop in the first year and a further gradual increase, so the CPI forecast corridor will be used for each new year standard deviation this year.

Table 2.16 – Results of relative CPI growth amplitude

Number per period, default	Argentina	Mexico	R.F.	Uruguay	Average value	Standard deviation
0	-0,6595482	1,2732172	2,972418	10,02	3,40158	4,655
1	15,8250288	6,8428139	11,75475	5,65	10,01878	4,686
2	10,3509849	9,073871	5,296086	3,17	6,97179	3,323
3	3,85717014	7,3154957	6,606232	4,51	5,57301	1,650
4	8,79191202	6,8147224	5,899583	6,09	6,89920	1,322
5	10,9011245	8,2261687	5,911474	6,39	7,85770	2,261

Regression analysis for the time-dependent CPI was performed using Microsoft Excel Regression (Table 2.11).

Table 2.16 – Regression analysis of CPI versus time

Regression statistics	
Multiple R	0,921
R-squared	0,848
Normalized R-squared	0,840
Standard error	24,157
Observations	20

	Odds	*Standard error*	*t-statistic*	*P-value*	*Lower 95%*	*Top 95%*
Y intersection	-18794,2	1880,589	-9,993	9,02E-09	-22745,1	-14843,2
Variable x 1	9,405	0,936	10,040	8,39E-09	7,4376	11,373

According to the data in Table 2.16, the R-squared value is 0.84, which indicates a very high level of approximation. Using the coefficients found using regression analysis, one can formulate the final view of the CPI behavior forecast model in the event of a default in 2020

$$y = (-18794{,}2 + 9{,}405x_{\mathrm{i}})\left(1 - A_{\mathrm{i}}e^{-\lambda_{\mathrm{i}}t}\right). \qquad (2.14)$$

The result of the CPI forecast model for Ukraine due to default in 2020 is presented in Fig. 2.11.

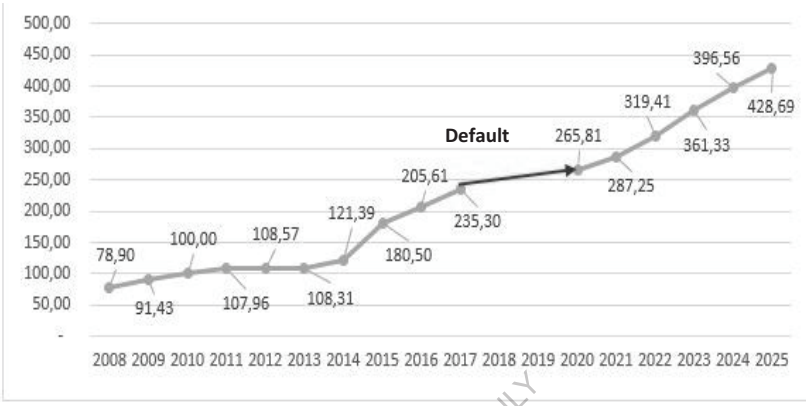

Figure 2.11 – CPI default behavior model due to default in Ukraine in 2020.

As described in the previous section, it is necessary to develop a corridor of the forecasting range, since there is a probability of 85% that the CPI will increase according to the forecast data, as well as to take into account the inverse probability of 15%, which may increase in another scenario (Fig. .2.12).

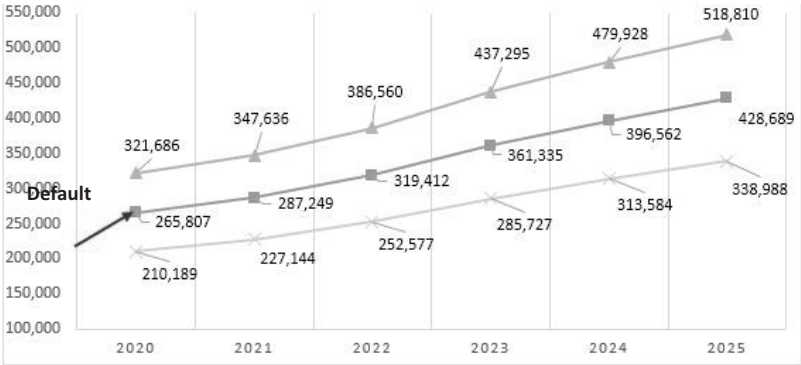

Figure 2.12 – Corridor of the CPI Behavior Predictive Range as a result of Ukraine's default in 2020.

According to the forecast calculations, it can be stated that the behavior of the Consumer Price Index in Ukraine in 2020 due to the default will be:

1) with a realistic forecast, that is, the forecast for the classic model from the moment of default in Ukraine until 2025, the Consumer Price Index will increase 1.8 times, according to its last value in 2017,

2) when the optimistic forecast, according to the forecast below the lower bound of the model of behavior of the Consumer Price Index, predicts that the index will increase by 1.44 times, compared to its last value in 2017,

3) in the case of a pessimistic forecast, according to the forecast beyond the upper bound of the consumer price index behavior model, the index will increase 2.2 times, in line with its last value in 2017.

The probability of a realistic forecast of the Consumer Price Index behavior in Ukraine due to the default in 2020 is 85%.

2.4 Wage Level Behavior Models

Due to the data collected by the World Bank [32], it is possible to obtain complete information according to the wage rate indicator for each country, however, as with the previous indicator of the Consumer Price Index, the data on the Wage Level indicator are given only until 2017 inclusive. As in the previous section, it will not interfere with the construction of the wage rate indicator behavior model, since the model will also be constructed according to data on changes in the default indicator in other countries.

For all countries that will be used to calculate the model, the wage rate indicator is given at the dollar exchange rate in national currency, so the data will be objective.

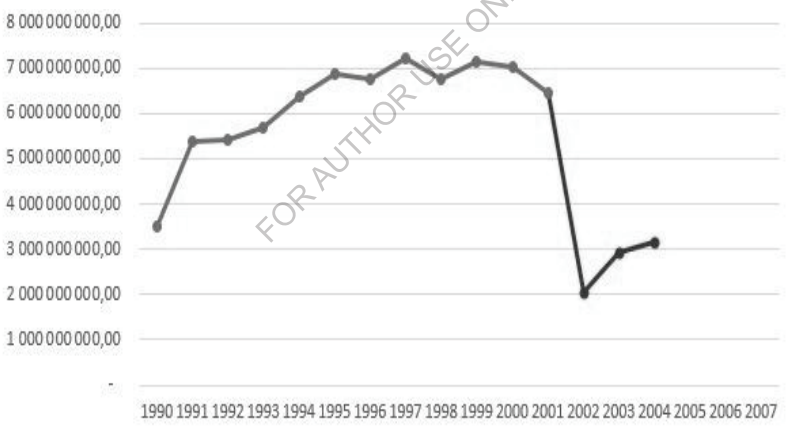

Figure 2.12 – Argentina's wage rate behavior

According to the data, according to the behavior of the level of payment due to default in Argentina, it fell from 6 billion to 2 billion in just a year. After such a fall, the index began to recover. Since 2004, there has been no accurate data on the World Bank's wage rate indicator because of the risk of their uncertainty.

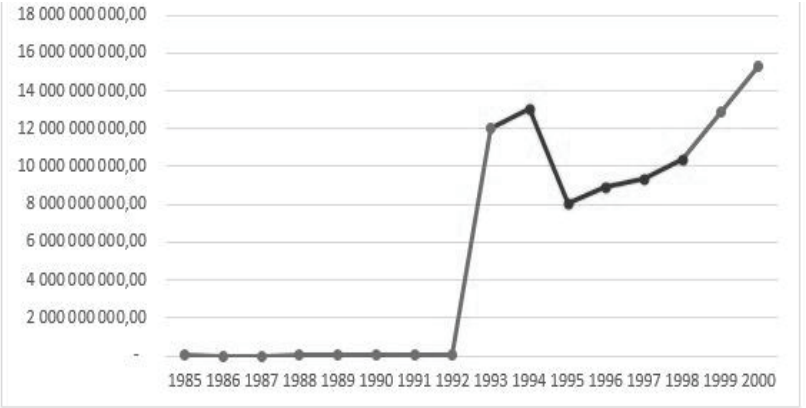

Figure 2.13 – Wage Level Indicator Behavior in Mexico

In Mexico, as in Argentina, one can see a tendency to increase in the level of remuneration. After the onset of default, the level of remuneration continued to rise, but due to a default in 1995 it fell and after that it began to rise again since 1996.

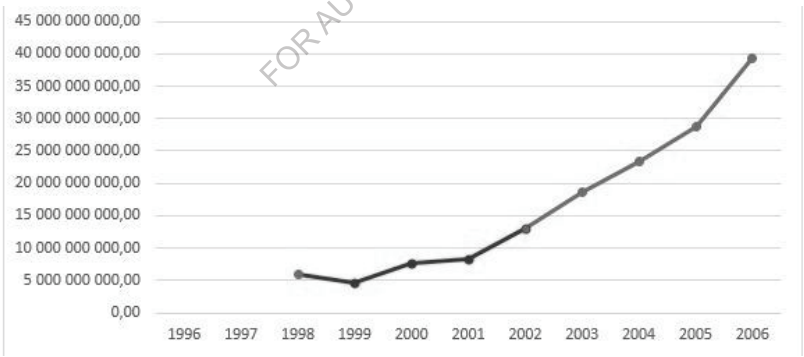

Figure 2.14 – The behavior of the indicator of the level of remuneration in the Russian Federation

Data for the Russian Federation until 1998 are not available and therefore not presented in Fig. 2.14. In the period 1998-1999, one can see the decline caused by the default. The index then began to recover.

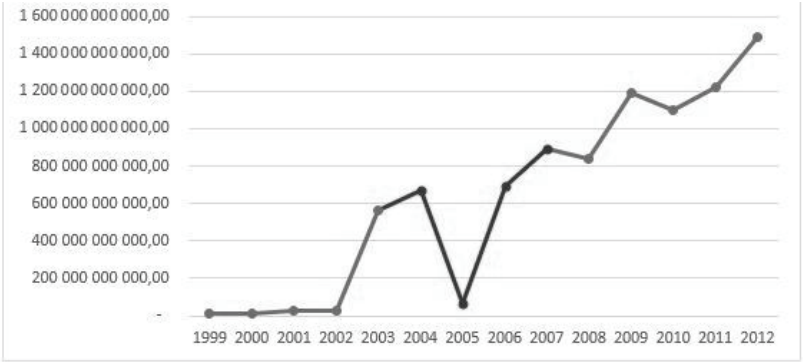

Figure 2.15 – Uruguay wage rate behavior

Uruguay demonstrates a continuing rise in the level of remuneration during the country's default, although it is still experiencing a fall in 2005. Already since 2006, the indicator has started to grow again.

From the analysis of the graphical form of the graphs of the rise of the Wage Level indicator, it was decided to make a forecast of the Wage Level indicator for Ukraine through an exponential lifting model (2.3).

Since the wage rate indicator does not have the same clear behavior as the GDP per capita in the event of a default in the country, it behaves differently across countries. You can see a tendency for a slight rise after the onset of a default, and after a rise - fall and rise again. Such behavior can be caused by economic processes that begin in the country at the time of default. As discussed in the first section, after a default is declared, the country refuses to pay its debts, and therefore the funds that were previously deferred to repay the debt are returned to the country. It is this phenomenon that may explain the rise in the level of remuneration, but it has a short-term effect, which means that, after its effect, a fall. When the effects of default start to wane, the wage rate indicator rises again, indicating a return to a stable situation in the country.

Considering the above facts, the construction of the model of behavior of the level of remuneration will be carried out in years, taking into account

the average indicator of the relative amplitude of the behavior of the level of remuneration in other countries that have experienced default (Table 2.17).

Table 2.17 – Results of the relative amplitude of the wage level behavior

Number per period, default	Argentina	Mexico	R.F.	Uruguay	Average value	Standard deviation
0	1,0905186	0,9201060	-	0,0536588	0,6880944	0,569616441
1	3,1412830	1,6159931	1,3075060	0,8456097	1,7275980	0,994206815
2	0,6977223	0,9051378	0,6054667	10,626311	3,2086595	4,946688773
3	0,9266577	0,9499511	0,9264702	0,0908359	0,7234787	0,421905966
4	-	0,9004553	0,6320778	0,777826	0,7701197	0,40038135
5	-	0,8091238	0,6978098	1,0641642	0,8570326	0,455129792

In each of these countries there was a cycle that passed the indicator of the level of remuneration: a slight rise, fall and recovery to the value it had before default. In Argentina, this cycle lasted about 8 years, in Mexico - 6, in RF. - 2, and in Uruguay - 3. The average value of the cycle in these countries is 4.7 years, which indicates that the indicator of the level of remuneration for Ukraine should be projected 5 years ahead from the moment of default. This is also in line with the per capita GDP and CPI projections, which were maintained for 5 years after the default as well.

Using Microsoft Excel Regression features, regression analysis was performed for the Time-Dependent Wage Indicator (Table 2.18) to find the coefficients to form the forecast model and find the approximation level.

Table 2.18 – Regression analysis of CPI as a function of time

Regression statistics	
Multiple R	0,948119985
R-squared	0,898931506
Normalized R-squared	0,892986301
Standard error	12149755963
Observations	19

	Odds	*Standard error*	*t-statistic*	*P-value*
Y intersection	- 499 958 494 072,15	160 743 016 040,75	- 3,11	0,01
Variable x 1	251 311 945,15	80 051 005,01	3,14	0,01

	Y intersection	Y intersection
Y intersection	- 839 096 613 342,83	- 160 820 374 801,46
Variable x 1	82 419 087,77	420 204 802,53

The quality of approximation is 89%, which indicates a high level of confidence. Using the coefficients found using regression analysis, one can formulate the final view of the model of the behavior of the Wage Indicator in the event of a default in 2020.

$$y = (-499\,958\,494\,072{,}15 + 251\,311\,945{,}15x_{\text{i}})\left(A_{\text{i}}1 - e^{-\lambda_{\text{i}}t}\right). \quad (2.15)$$

The result of the CPI forecast model for Ukraine due to default in 2020 is presented in Fig. 2.16. For convenience, the values obtained were reduced to millions of dollars.

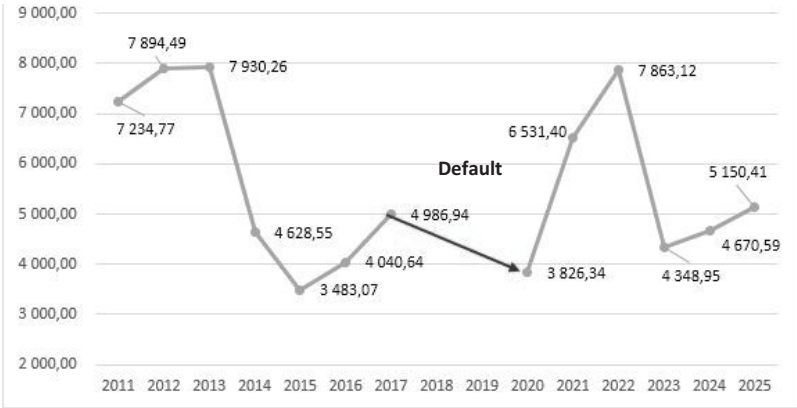

Figure 2.16 – The model of behavior of the Indicator of the level of remuneration due to the default in Ukraine in 2020

As mentioned above, there is a need to create a corridor of forecasting the Wage Score based on SLE and the upper and lower bounds of the regression analysis. Accordingly, performing the same operations as in Section 2.2, one can obtain the corridor of the forecasting range, which is clearly shown in Fig. 2.17. Again, for convenience, all values were reduced to millions of dollars.

According to the results obtained, it can be concluded that the indicator of the level of remuneration due to the onset of default in the country in the first year will fall by 22.5%, compared to the last value of this indicator in 2017 with a probability of 89.8%. When considering the optimistic forecast, the indicator of the level of remuneration after default will increase to 28.7%, while at the consideration of the pessimistic forecast – it will fall to 54.3%. During the lifting phase, the wage rate indicator will increase, with an optimistic forecast up to 2.6 times the indicator in 2017, with a realistic forecast, according to the value in 2017, the indicator will increase 1.5 times according to the pessimistic forecast it will fall by 7%, which, compared to the percentage drop in 2020, can be regarded as almost a recovery of the indicator.

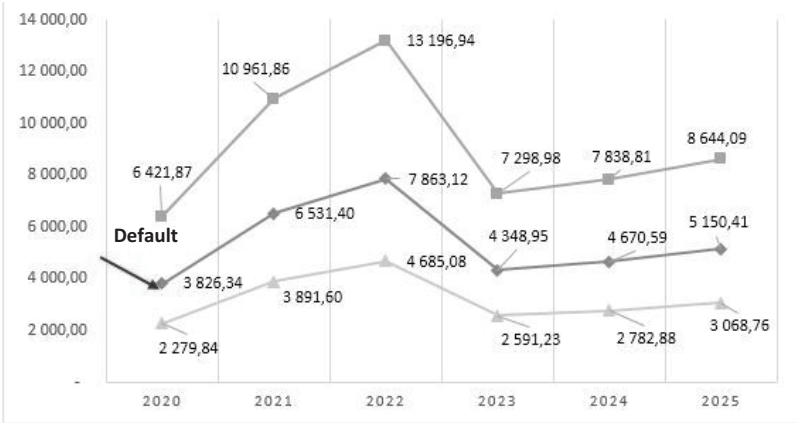

Figure 2.17 – Corridor of the forecast range of the behavior of the Indicator of the level of remuneration due to the default in Ukraine in 2020.

According to the realistic forecast, at the end of the forecasting period, the Wage Level indicator will not only recover from 2017, but even increase by 4%.

To date, the population in Ukraine is 44.6 million, while the number of able-bodied population is 20.037 million Ukrainians [33] and every year this figure falls, but if you calculate the future average salary for this population, you can get the following results (Table 2.19). It should be emphasized that all data is now in dollars.

Table 2.19 – Estimated average wage in Ukraine due to default in 2020

Years	Pay Level Forecast (USD)	Average salary (USD)
2020	3 826 336 699,67	190,9581202
2021	6 531 399 935,71	325,9576853
2022	7 863 122 911,05	392,4189865
2023	4 348 946 333,90	217,0396078
2024	4 670 594 761,63	233,091875
2025	5 150 405 431,12	257,0374267

2.5 Models of behavior of the National currency exchange rate against the dollar

In order to start building the behavior of the national currency to dollar index in Ukraine in 2020, it is necessary to study the default behavior in countries such as Argentina, Mexico, the Russian Federation and Uruguay during the default (Fig. 2.18 – 2.21). [16], [17], [18], [19], [20]. For all countries, the national currency rate against the US dollar was taken as the average of the year.

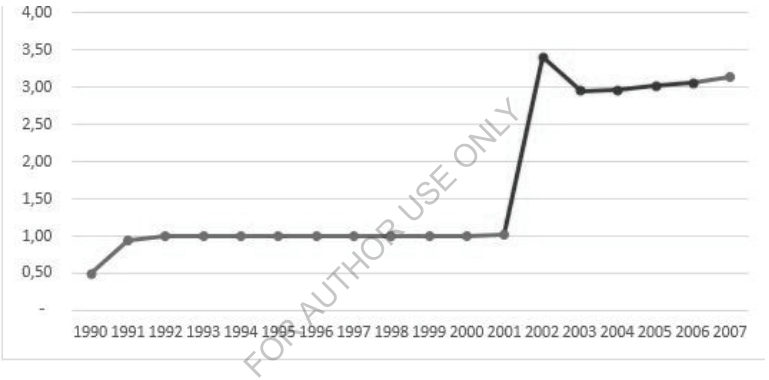

Figure 2.18 – The behavior of the national currency against the US dollar in Argentina

As a result of the default of the Argentine peso, it increased more than twice in one year, after which it decreased slightly the following year, but still retained its upward trend.

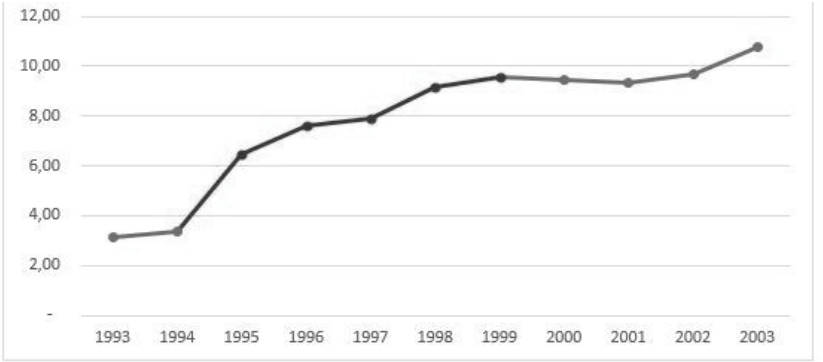

Figure 2.19 – The behavior of the national currency against the US dollar in Mexico

In 1993, Mexico underwent hyperinflation, and from January 1, 1993, the currency was replaced by a new Mexican peso at the rate of 1: 1000. Therefore, data from earlier 1993 are not taken into account. After the default in 1994, the Mexican peso rose from 3.39 to 6.45 in the first year. About twice. In the years that followed, it retained its upward trend, but it was no longer such an endeavor.

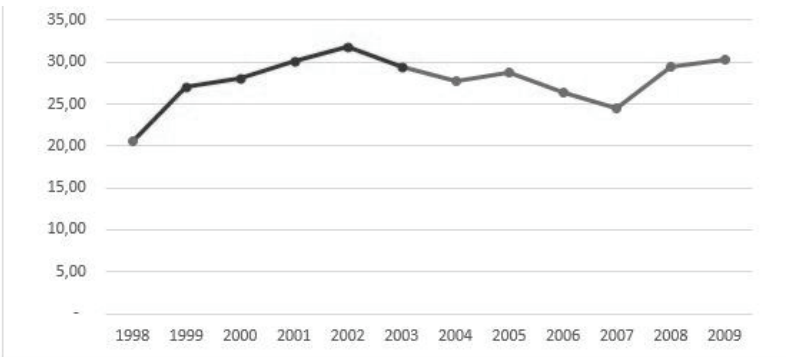

Figure 2.20 – The behavior of the national currency against the US dollar in the Russian Federation

After the collapse of the Soviet Union in 1991, a new ruble was issued, but due to the unstable economy and high inflation in 1998, the Russian Federation was forced to denominate at the rate of 1000: 1. Therefore, the data before 1998 are not taken into account. After defaulting in 1998, the rate rose from 20 to 27 and continued to rise until it reached a maximum of $ 31.78 in 2002.

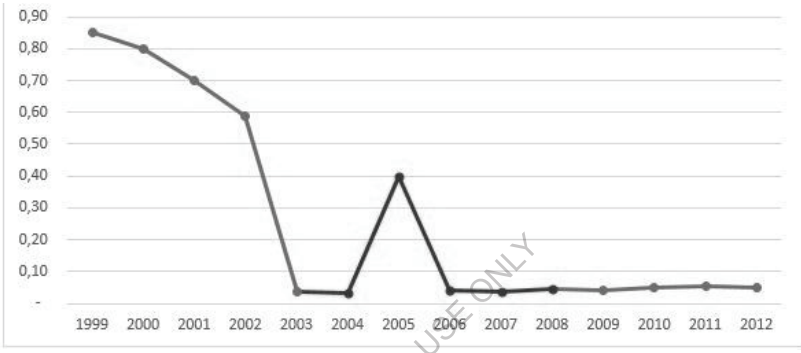

Figure 2.21 – The behavior of the national currency against the US dollar in Uruguay

In Uruguay, the national currency is still roughly in the same range, but after defaulting, the rate will jump to $ 0.4 from $ 0.04 in 2003.

According to the graphical analysis of the data, it was decided that the model for developing the forecast of the hryvnia against the dollar in Ukraine due to default will have an exponential form of the model of lifting the form (2.3).

To begin with, as with all other models, it is necessary to conduct a regression analysis of the indicator of the Currency Exchange depending on time (table 2.15).

Table 2.19 – Regression analysis of the currency rate index as a function of time

Regression statistics	
Multiple R	0,8148
R-squared	0,6639
Normalized R-squared	0,6462
Standard error	5,0488
Observations	21

	Odds	*Standard error*	*t-statistic*	*P-value*	*Lower 95%*	*Top 95%*
Y intersection	-2227,595	365,346	-6,097	0,00001	-2992,27	-1462,91
Variable x 1	1,115	0,18194	6,125	0,00001	0,73	1,49

According to the results obtained, it can be argued that the level of approximation of the currency rate indicator over time is 66.3%, which is quite good. The coefficients obtained can be used to build a model for predicting the behavior of the Hryvnia against the dollar in the country in the event of a default in 2020. To form an accurate model, it is still necessary to obtain the average value of the relative amplitude, each year, to adjust the results obtained in the diversion to the default state.

The data on the relative amplitude of the national currency rate against the dollar by default cranes are shown in Table 2.20. The same table immediately shows the results of the calculation of the root mean square deviation for the calculation of the forecast corridor.

Table 2.20 – Results of the relative amplitude of the behavior of the national currency against the dollar

Number per period, default	Argentina	Mexico	R.F.	Uruguay	Average value	Standard deviation
0	0,99158333	0,9228951	-	16,85714	6,257207	9,179877887
1	0,29659325	0,5250504	0,764815	1,029412	0,653968	0,314950524
2	1,14917314	0,8482895	0,958807	0,085	0,760317	0,467047288
3	0,99697174	0,9598383	0,934307	9,756098	3,161804	4,396271293
4	0,98606503	0,8651661	0,948264	1,108108	0,976901	0,101001746
5	0,98496732	0,9580237	1,079102	0,804348	0,956610	0,114008938

The relative amplitude of the exchange rate behavior of the national currency against the dollar in other countries was developed in the year of default and 5 years later, respectively, as for the previous indicators calculated above. The Russian Federation lacks data on the relative amplitude of the behavior of the national currency against the dollar in the year of default, since in 1998 demonetization was carried out and the rate was adjusted, so the relative amplitude for this period is not reliable. Thus, the model of predicting the behavior of the hryvnia against the dollar will look as indicated in formula (2.16)

$$y = (-2227{,}595 + 1{,}115x_{\text{i}})\left(1 - A_{\text{i}}e^{-\lambda_{\text{i}}t}\right) \quad (2.16)$$

The result of forecasting the behavior of the hryvnia against the dollar for Ukraine as a result of default in 2020 is shown in Fig. 2.22.

As described in the previous sections, it is necessary to develop a corridor of the forecasting range, as there is a probability of 66.4% that the rate of the national currency against the dollar will fluctuate according to the forecast data, and the reverse probability of 33.6% should be taken into account. the indicator may increase in another scenario (Fig. 2.23).

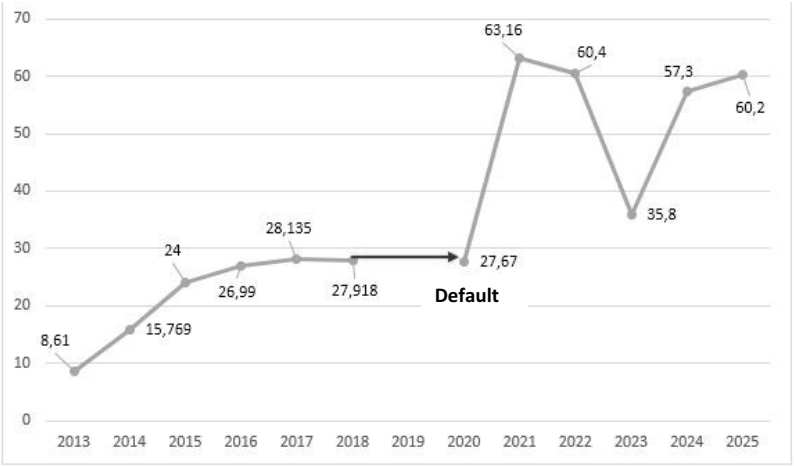

Fig. 2.22 – Hryvnia to dollar exchange rate behavior model due to the default in Ukraine in 2020.

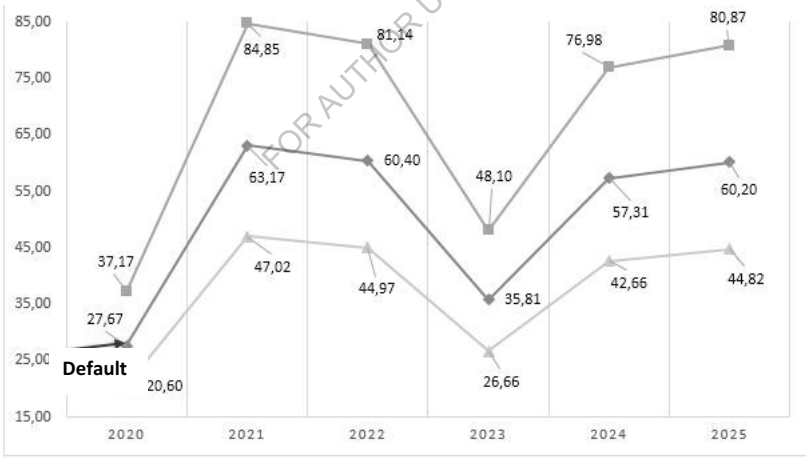

Fig. 2.23 - Corridor of the forecast range of the behavior of the Wage due to default in Ukraine in 2020

According to the results obtained, it can be noted that with a probability of 66.4% in the year of default, 2020, the national currency's exchange rate

against the dollar on the average for the year will hardly change according to the average of this indicator in 2018. A further change in behavior will take place next year, with the rate rising 226% from its last value in 2018. In 2023, the rate will fall slightly, it is during this period, according to forecasts, the indicator of the level of remuneration is also falling. At the end of the forecast period, the rate will remain at 60.2. According to the optimistic forecast, for the whole period considered the course will not rise above the value of 47.02, while according to the pessimistic forecast its value may reach 84.85.

Having obtained the forecast values of the behavior of the national currency against the dollar, you can substitute these values to the forecast of the previous indicator of the level of remuneration and find out at what level the salary in Ukraine will be in the default period. Since the previous values were calculated in dollars, it is now possible to translate them according to the forecast value of the course (Table 2.17)

Table 2.17 – Forecast of the average wage in Ukraine in UAH

Years	Pay Level Forecast (USD)	Average salary (USD)	Average salary (UAH)
2020	3 826 336 699,67	190,9581202	5 284,54
2021	6 531 399 935,71	325,9576853	20 589,18
2022	7 863 122 911,05	392,4189865	23 703,62
2023	4 348 946 333,90	217,0396078	7 771,82
2024	4 670 594 761,63	233,091875	13 357,86
2025	5 150 405 431,12	257,0374267	15 474,14

2.6 The result of the forecast of the consequences of default in Ukraine

As a conclusion, it can be noted that as a result of the default in 2020 in Ukraine GDP per capita will fall by 82.63%. The last known GDP per capita value for 2018 is 3 095.2 (USD) and the projected value for 2020 is 537.74 (USD). Starting next year, in 2021, GDP per capita will begin to rise and, according to the model developed, will be able to recover from its position in 2018 in about 4.5 years. Due to the fact that in 2025 the GDP per capita value will be 3 560.63 (USD), which even exceeds the value in 2018. With a probability of 46%, the renewal period can be reduced to 3.5 years or extended to 6 years. According to the corridor of the forecasting range, in which the upper limit can be called optimistic forecast and the lower, respectively, pessimistic forecast.

According to the above sections, the forecast calculations suggest that the behavior of the Consumer Price Index in Ukraine in 2020 due to default will be as follows:

1) with a realistic forecast, that is, the forecast for the classic model from the moment of default in Ukraine until 2025, the Consumer Price Index will increase 1.8 times, according to its last value in 2017,

2) when the optimistic forecast, according to the forecast below the lower bound of the model of behavior of the Consumer Price Index, predicts that the index will increase by 1.44 times, compared to its last value in 2017,

3) in the case of a pessimistic forecast, according to the forecast beyond the upper bound of the consumer price index behavior model, the index will increase 2.2 times, in line with its last value in 2017.

The probability of a realistic forecast of the Consumer Price Index behavior in Ukraine due to the default in 2020 is 85%.

According to the results obtained, the indicator of the level of remuneration due to the onset of default in the country in the first year will

fall by 22.5%, compared to the last value of this indicator in 2017 with a probability of 89.8%. When considering the optimistic forecast, the indicator of the level of remuneration after default will increase to 28.7%, while at the consideration of the pessimistic forecast - it will fall to 54.3%. During the lifting phase, the wage rate indicator will increase, with an optimistic forecast up to 2.6 times the indicator in 2017, with a realistic forecast, according to the value in 2017, the indicator will increase 1.5 times according to the pessimistic forecast it will fall by 7%, which, compared to the percentage drop in 2020, can be regarded as almost a recovery of the indicator. According to the realistic forecast, at the end of the forecasting period, the Wage Level indicator will not only recover from 2017, but even increase by 4%.

To date, the population in Ukraine is 44.6 million, and every year this figure falls, but if we calculate the future average wage for this population, you can see that in 2020 the average wage will be $ 85.7, while in the next few years it will rise to the value of $ 176.2, after which it will fall to $ 97.4 in 2023. At the end of the forecasting period, the average wage will be $ 115.42.

In terms of forecasting the national currency against the dollar, according to the results obtained, it can be noted that with a probability of 66.4% in the year of default, 2020, the national currency against the dollar in the average for the year will hardly change according to the average of this indicator in 2018. A further change in behavior will take place next year, with the rate rising 226% from its last value in 2018. In 2023, the rate will fall slightly, it is during this period, according to forecasts, the indicator of the level of remuneration is also falling. At the end of the forecast period, the rate will remain at 60.2. According to the optimistic forecast, for the whole period considered the course will not rise above the value of 47.02, while according to the pessimistic forecast its value may reach 84.85.

Having obtained the forecast values of the behavior of the national currency against the dollar, you can substitute these values to the forecast of the previous indicator of the level of remuneration and find out at what level the salary in Ukraine will be in the default period. Thus, in 2020, the average wage will be UAH 2 373, in 2022, when the highest average wage is projected, it will be UAH 10 644 in terms of UAH. After 2022, in 2023, the average wage will fall to UAH 3,489 according to the forecasted rate, after which it will begin to stabilize and in 2025 it will reach UAH 6,948.

From a similar level of the average wage in hryvnia, someone can be happy, but do not forget about the calculations of the Consumer Price Index, which will also grow during this period.

Realities that emerge when comparing the relative amplitude of a change in the Consumer Price Index with the value of a relative amplitude of a change in the level of remuneration (Table 2.18).

Table 2.18 - Comparison of *CPI* Change Rate and Average Wage

The relative amplitude of CPI changes during the default forecasting period	The relative amplitude of changes in the average wage in the period of default forecasting
1,8218899	0,968261936

As can be seen from Table 2.18, the *CPI* will change much faster than the average wage.

For a clearer way of demonstrating how the default of Ukraine in 2020 will affect the lives of Ukrainians, we can show the fuel price chart, some food and consumer baskets for 2017, and use the projected Consumer Price Index to model price levels on this list. of goods in 2020 - 2025 (Table 2.19). For better comparison, a column with average wage levels has been added to the table.

Table 2.19 – Forecast of changes in the price level of listed goods due to default in Ukraine in 2020. [34], [35], [36] compared to the average wage forecast.

Years	Fuel prices (A-95) (UAH / l.)	Bread (UAH / kg)	Poppy products (UAH / kg)	Pork (UAH / kg)	Milk (UAH / l)	Potatoes (UAH / kg)	Consumer basket	**Average salary (UAH)**
2017	*24,59*	*11,87*	*9,77*	*87,75*	*16,56*	*6,08*	*3 248*	*6 638*
2020	27,78	13,41	11,04	99,13	18,71	6,87	3 669	5 284,54
2021	30,02	14,49	11,93	107,12	20,22	7,42	3 965	20 589,18
2022	33,38	16,11	13,26	119,12	22,48	8,25	4 409	23 703,62
2023	37,76	18,23	15,00	134,75	25,43	9,34	4 987	7 771,82
2024	41,44	20,01	16,47	147,89	27,91	10,25	5 474	13 357,86
2025	44,80	21,63	17,80	159,87	30,17	11,08	5 917	15 474,14

2.7 Determining the probability of default

Determining the green, yellow, or red default risk levels for each of the 4 selected factors does not clearly understand the default probability level. Additional calculations are required. We describe these metrics by adding conventions.

The paper [9] indicates that the most vulnerable to default are countries that have admitted at least 1 default in the previous 5 years. (*Ypd* – years from the previous default). The same authors include countries with a rather fragile macroeconomic environment in the zone of high risk of default, that is, in which there are:

– a significant decrease in the national currency - devaluation of more than 43% (year-on-year change) (*Dnc* – devaluation of the national currency);

– deep decline in production - real *GDP* growth below 3.4% (Rgdpg – real GDP growth);

– excess of the budget deficit *(Bdo* – budget deficit overrun) by 10.4% of *GDP*;

– excess debt service ratio (*Edsr* – excess debt service ratio) to budget revenues (*Br* – budget revenues) by 11.3%, and also that:

– external public debt (*Epd* – external public debt) is over 59% of sovereign debt (*Sd* – sovereign debt);

– coverage of total short-term debt (*Tstd* – total short-term debt) by gross international reserves (*Gir* – gross international reserves) below 97%;

– total external debt (*Epd* – external public debt) exceeds total export (*Te* – total exports) by 337%, etc.

There are four main sources of vulnerability:

1) The first source of vulnerability is debt service as a share of fiscal revenue

The model distinguishes between three modes: one characterized by low debt service vulnerability (less than 9% of budget revenues) (*Br* – budget revenues), high debt service vulnerability mode (where the latter is more than 14% of budget revenues), and an intermediate level.

2) Second source of vulnerability (*Is* – Internal savings) in % of *GDP*)

For the "internal savings" model, there are three modes (0, 1 and 2) limited by internal savings of 21.7% and 24.6% of *GDP*.

3) Third source of vulnerability (*Fr* – Foreign reserves) in % of short-term external debt (*Tstd* – total short-term debt).

For the Foreign Currency Reserves model, two modes (0 and 1) are distinguished by foreign currency reserves of 78.5% of short-term external debt.

4) The fourth source of vulnerability - External debt in % of *E* – exports) (*Epd* – external public debt)

For the external debt model, the three modes (0, 1 and 2) are limited by external debt of 126.8% and 258.3% of exports.

Let us summarize all these parameters into one table (Table 2. 20).

Table 2.20 – Summary of default indicators according to [9]

Sources of vulnerability	Indicator	Default risk		
		Low	Middle	Hi
Basic	Debt servicing as a fraction of fiscal revenue (*Epd / Br*)	9%<	>9% & 14%<	>14%
	Internal Savings (*Is / GDP*)	21,7%<	21,7%> & 24,6%<	>24,6%
	Foreign reserves (*Fr / Tstd*)	78,5%<	78,5%>	>78,5%
	External debt (*Epd / E*)	126,8%<	>126,8% & 258,3%<	>258,3%
Extra	Years from previous default (5 - *Ypd*)	< 0	>0 & <4	>4
	Devaluation (*Dnc*)	<43%	>43%	>43%
	Real *GDP* Growth (0.034 - *Rgdpg*)	<0	>0 & <3,3%	>3,3%
	External sovereign debt (*Epd / Sd*)	<59%	>59%	>59%

To determine the default probability for a country, all of these metrics should be combined into a single formula of the form

$$P = \sum_{i=1}^{8} I_i k_i , \qquad (2.17)$$

where, I_i – function of the value of the indicator from the table. 2.20, which takes values from 0 to 1, *ki* – weight factor, and

$$\sum_{i=1}^{8} k_i = 1. \qquad (2.18)$$

Since the authors of [9] identified the first four indicators as the main ones, we define the sum of the weight coefficients for them as 0.8. Then the sum of the weights for the additional indicators will be 0.2. Since there are four indices in two groups, each major indicator has a weighting factor of 0.2 and an additional indicator of 0.05.

A uniform breakdown of the weights between the indicators is made due to the lack of information regarding the relative level of impact of each indicator on the risk of default.

To construct the functions of the values of a metric, we create a table containing, as an argument, the value of the metric and, as a function, the magnitude of the default probability through this metric (Table 2. 21). It sets zero as zero, and 1 as the sum of the largest value and the average range difference.

Table 2.21 – Summary of default indicators

Sources of vulnerability	Indicator	Default risk			
		0,25	0,5	0,75	1
Basic	Debt servicing as a fraction of fiscal revenue (*Epd / Br*)	9%	11,5%	14%	19%
	Internal Savings (*Is / GDP*)	21,7%	23,15%	24,6%	27,5%
	Foreign reserves (*Fr / Tstd*)	25%	50%	78,5%	100%
	External debt (*Epd / E*)	126,8%	192,55%	258,3%	389,8%

Sources of vulnerability	Indicator	Default risk			
		0,25	0,5	0,75	1
Extra	Years from previous default (5 - *Ypd*)	1	2	3	4
	Devaluation (*Dnc*)	10,75%	21,5%	32,25%	43%
	Real *GDP* Growth (0.034 - *Rgdpg*)	0,85%	1,7%	2,55%	3,4%
	External sovereign debt (*Epd / Sd*)	14,75%	29,5%	44,25%	59%

Since linear proportions were used to determine the risk limit, the critical probability values were used to determine the coefficients of the formulas for IIi as linear dependences of the form

$$I_i = a_i + b_i x, \tag{2.19}$$

where, a_i – free member, b_i – angular coefficient, x – the numerical value of the default risk indicator.

The calculation was performed in a spreadsheet of MS Excel processors, the application "Regression".

In the table. 2.22 summarizes the coefficients of these dependencies and the quality index of the approximation (R^2).

Table 2.22 – Numerical values of coefficients of linear models I_i

Sources of vulnerability	Indicator	Odds		
		Free member (a_i)	Angular coefficient (b_i)	Quality of approximation (R^2)
Basic	Debt servicing as a fraction of fiscal revenue (*Epd / Br*)	-0,368571	7,4285714	0,965714286
	Internal Savings (*Is / GDP*)	-2,4793103	12,807881	0,965714286
	Foreign reserves (*Fr / Tstd*)	0,0016635	0,9835683	0,997338351
	External debt (*Epd / E*)	-0,0581531	0,2824551	0,965714286
Extra	Years from previous default (5 - *Ypd*)	0	0,25	1
	Devaluation (*Dnc*)	0	2,3255813	1
	Real *GDP* Growth (0.034 - *Rgdpg*)	0	29,411764	1
	External sovereign debt (*Epd / Sd*)	0	1,6949152	1

As can be seen from the table. 2.22, the quality of the approximation is high, so these coefficients can be added to formula (2.17). Given the weighting coefficients of ki, the calculation of the probability of default will be conducted by the following formula

$$P = -0{,}01129792 + 1{,}485714284\frac{Epd}{Br} + 2{,}56157634\frac{Is}{GDP} +$$
$$+0{,}196713678\frac{Fr}{Tstd} + 0{,}05(5 - Ypd) + 0{,}465116278Dnc +$$
$$+5{,}88235294(0.034 - Rgdpg) + 0{,}33898305\frac{Epd}{Sd} \quad . (2.19)$$

The State Statistics Service of Ukraine and the Ministry of Finance of Ukraine for 2091 were used to calculate the probability of default in Ukraine [28.29].

Substituting the required data into formula (2.19), a value of 0.861245 was obtained. Given that the average value of the quality parameter for the approximation of the formulas R2 = 0.986810151, we can assume that the error of this calculation does not exceed 2%.

Conclusions

The monograph addressed the issue of forecasting financial and economic consequences of default for Ukraine.

In the course of the work, it was analyzed what impact countries might have in default and what might have consequences. What indicators have been analyzed can indicate that the country is nearing default and an analysis has been developed for Ukraine. The urgency of the problem for the country and the degree of its threat were proved.

Models have been developed to predict the behavior of the following indicators: GDP per capita (current US dollar), national currency to dollar, consumer price index (current US dollar), and wages (current US dollar) depending on time. Predicting the behavior of the above indicators was based on the following countries: Argentina, Mexico, the Russian Federation and Uruguay, which declared a time of default. A correlation analysis was also conducted in these countries, proving a good level of correlation of the above indicators in these countries over time, which allowed them to use their data to develop a model of GDP per capita behavior (current US dollar), national currency rate to the dollar, the consumer price index (current US dollar), the level of remuneration (current US dollar) for Ukraine, assuming that the default will come as early as 2020.

Thus, models were developed that predicted GDP per capita behavior (current US dollar), national currency to dollar, consumer price index (current US dollar), wages and salaries (current US dollar) in Ukraine by default in 2020. , showing the financial and economic impact of a default on the country.

The calculation of the probability of default in Ukraine according to 2019 gave a very high level - more than 0.85. This result indicates a near-probable default in the next 2020 year.

It also indicates that the assumption of this offensive that was used at the beginning of the monograph was correct.

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