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Decision support for target country selection of future generation sovereign wealth funds: hedging the country industry risk

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Abstract

This paper addresses the challenging problem of selecting target country for future Sovereign Wealth Funds' (SWFs) asset allocation to hedge the industry risk, which is rarely studied in the field. The target country selection includes which country and how much to invest to obtain the return objective and minimize the risk of these funds. In terms of the industrial perspective, the home country as the investor should consider SWF as part of its budget to make decision in long term. In order to control the risk, this paper measures the similarity between the home and the recipient country of SWF investment. The industrial risk of SWFs' recipient country is also taken into consideration which is measured by concentration ratio. Based on an analytical process of target country selection, the paper finds that Kazakhstan, India, Australia, Greece, Spain, United States, Austria, Portugal, Peru, Netherlands are the top 10 countries that China should consider as its investment priorities.

sovereign wealth funds; future generation; industrial structure; strategic asset allocation

1. Introduction

The discussions of SWF project research group from Research Centre on Fictitious Economy and Data Science, CAS improve this paper a lot. This paper benefits from the discussion with Yanping Zhao. Yujing Ze provided a lot of useful information about data collection. The authors are solely responsible for any errors.

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Sovereign Wealth Funds (SWFs) have attracted numerous public attentions due to their recent emergence as an important investor vehicle. Beginning with the inception of the Kuwait Investment Authority, which is the first SWF, the growth of SWFs was driven by oil and commodity revenues, but recently the large foreign exchange reserve of Asian countries such as China, Singapore have also contributed to the increase in SWFs.

According to the definition of the International Monetary Fund (IMF), international reserves are external assets that are controlled by and readily available to finance ministries and central banks for direct financing of international payment imbalances. Countries typically keep reserves on hand to cushion an export shortfall or to intervene to defend the currency in a financial crisis. Reserves are by definition invested in highly liquid and marketable securities, which usually means highly rated industrialized-country government bonds. The excess reserves lead to SWFs.

The definition of the U.S. Department of the Treasury, sovereign wealth funds is a "government investment vehicle which is funded by foreign exchange assets, and which manages those assets separately from the official reserves of the monetary authorities."[1]

In the Santiago Principles made by the International Working Group of Sovereign Wealth Funds (IWG), SWFs are defined as special purpose investment funds or arrangements, owned by the general government. Created by the general government for macroeconomic purposes, SWFs hold, manage, or administer assets to achieve financial objectives, and employ a set of investment strategies which include investing in foreign financial assets. The SWFs are commonly established out of the balance of payments, official foreign currency operations, the proceeds of privatizations, fiscal surpluses, and/or receipts resulting from commodity exports. Foreign currency reserve assets held by monetary authorities for the traditional balance of payments or monetary policy purposes, operations of state-owned enterprises in the traditional sense, government-employee pension funds, or assets managed for the benefit of individuals are excluded from SWFs. "To the extent governments have traditionally held investment assets; it was to protect domestic currencies and banks from crisis," writes the *Economist*[3].

Although there is no widely accepted definition of SWFs to date, the features of the SWF have been discussed by several researches. Moshirian, Fariborz regard that SWFs are state-owned and have no explicit liabilities, and have a substantial exposure to foreign investments[2]. Bernd Scherer defines SWF as sovereign investment vehicles with high foreign asset exposure, non-standard liabilities and long time horizon[3] . State-owned, no explicit liabilities and foreign asset exposure are the three essential features. Jen (2007), a researcher at Morgan Stanley Research Global identifies from the following rules: (a) it is sovereign; (b) it has high foreign currency exposure; (c) it has no explicit liabilities (in contrast to a national state pension); (d) it has high risk tolerance; and (e) it has a long investment horizon[4].

From the perspective of objectives of the funds, which vary from shielding the domestic economy from fluctuations in commodity prices and improving the return on foreign exchange reserves to accumulating wealth for future generations, the International Monetary Fund work agenda on SWFs [5] classified SWFs into five types: (i) stabilization funds, where the primary objective is to insulate the budget and the economy against commodity (usually oil) price swings; (ii) savings funds for future generations, which aim to convert non-renewable assets into a more diversified portfolio of assets and mitigate the effects of Dutch disease; (iii) reserve investment corporations, whose assets are often still counted as reserve assets, and are established to increase the return on reserves; (iv) development funds, which typically help fund socio-economic projects or promote industrial policies that might raise a country's potential output growth; and (v) contingent pension reserve funds, which provide (from sources other than individual pension contributions) for contingent unspecified pension liabilities on the government's balance sheet[5].

It is the unbalanced exploitation of endowed resource like natural resource and population bonus that leads to the inception of future SWFs. In our opinion, essentially, it is the unbalanced industry structure that caused the unbalanced revenue income between generations. Considering future liabilities, one of the most important issues governments are facing is how to keep welfare between generations. So a lot of resource and foreign exchange surplus countries set up future SWFs to invest globally to balance the income between generations. A lot of future SWFs are launched to prevent potential damage of the running out of the unexploited resources. In this paper, we split the SWFs into two classifications which are future SWFs and non-future SWFs. In this paper, we classify the SWFs into present SWFs and future SWFs. Present SWFs aim at the present purpose and future SWFs are raised for

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[3] http://www.economist.com/finance/displaystory.cfm?story_id=9230598

the future reason [5]. The investment horizon of the funds is different, so the investment strategy and principle should also be different. The future funds with long time horizon are the objects we study in this paper.

This research is also motivated by the amount of the future SWFs. Among the five categories of SWFs designed by IMF, at least two of them are the future SWFs which are savings funds and contingent pension reserve funds. The main objective of these funds is to support the welfare of the future generation. According to the criterion, the Sovereign Pension Reserve Funds also are members of the study family. We analyzed the pension classification details of Truman[6] and A. Blundell-Wignall[7]. The pension funds are classified as SWFs if any one of them classifies the pension fund as SWFs. We classify all of the SPRFs which are regarded as SWFs as future SWFs in this research. Based on the data of SWF Institute, we analyze the objective of the general SWFs and classify the SWFs into five types according to the definition of IMF. If the fund is savings funds, or pension reserve funds, we take the fund as future SWFs. Hence parts of the general SWFs and all of the SPRFs are the study object of this paper. According to the previous criteria, 2203 billons out of all of the 3652 billion are future SWFs.

Some of the future SWFs are sourced from natural resources such as Kuwait Investment Authority, some are supported by non-community such as China Investment Cooperation. For the oil based future SWFs, there may be one day all of the natural sources ran out. For the non-community based future SWFs, the country may transfer from demography bonus to demography debt. In order to avoid these issues, it is very important for these countries to invest properly for the next generations' welfare. There are some researches related to the oil based future SWFs[3]; however, to the best our knowledge, there are rare researches related to non community based future SWFs.

In our view, futures SWFs are part of the country's asset. Helmut Reisen defined country's national total capital as the sum of net financial assets, the physical capital stock (e.g. real estate, machines, and plantations), the unused (clean) environment, human capital and unexploited natural resources[8]. We divided the national capital into two parts: the exploited capital and unexploited resources. The exploited resources include the financial assets, real estate, machines, plantations and other forms of wealth; the unexploited resources include the human capital, other unused natural resources. The unbalanced use of the resource makes it quite necessary to hedge the risk of the unbalanced flow among different generations.

This paper is a research to find out how risk stemming from non-financial assets or the industry structure can be hedged, at least partially, through financial assets for non community based future SWFs. In other words, we discuss the asset allocation with non-tradable wealth using tradable wealth. The country with non community based future SWFs should invest the exploited resource in the right way to hedge the future potential debt.

Because of the drawback of the existing coefficients which will be demonstrated in the second Section, we design a new type similarity coefficient named ratio based similarity coefficient to reflect the structure of the industry. In this paper, we study the purpose of the inception of SWFs, the investment strategy of SWFs, and the decision process of choosing target countries to invest for future SWFs which are launched for the next generations. In this field, there is rare study to set up an investment principle for the future generation SWFs at present.

The paper is organized as follows. The target country selection process is proposed in Section 2. Section 3 reviews the current researches related to similarity measurement which will be used in our paper. Section 4 introduces our newly designed industry similarity measurement coefficient. Section 5 presents an empirical analysis of target country selection for future SWFs. The conclusion is made in Section 6.

2. Decision process

Decision making is a hot topic in financial fields[9, 10].One of the features of SWFs is fully foreign asset explored, so the first problem the future SWFs facing is which country to invest. Taking SWFs as part of the public budge, in order to hedge unbalanced inflow which is derived from the structure of the country for future SWFs, SWFs should invest in the countries with different industry structure. As mentioned the object of this study is future SWFs, which are also named next generation SWFs. Our idea is quite simple. The future SWFs whose sources are mainly oil should not invest into the countries which also rely on oil. The home country of SWFs which relies on manufacturing should not invest largely into a manufacturing country. The country with closed industry structure should not be the main investment target countries. This idea is quite similar with pension funds; however there is a lot of difference between SWF with mission to balance the demography bonus and the pension bonus. This idea is also supported by econometrics analysis. Through econometrics analysis, Chhaochharia and Laeven get that sovereign wealth funds tend to invest in countries with similar culture and the SWFs' purchase of stock has positive impact on the share prices [9].

The investment decision includes which country to invest and how much to invest. The decision determines the welfare of the future generation of the SWFs' home country[11]. Based on the above similarity and concentration coefficient we designed, in this section, we will discuss the process of investment decision making and recommend candidate target countries to invest taking China as an example.

Our decision process can be spitted into two parts. The first section is about choosing the countries to invest based on the industrial difference and concentration to control the risk and the second part is to decide how much to invest to the target countries to minimize the risk of the funds. The process has taken the country risk into consideration[12]. According to the above requirement, we list the decision process as follows.

Steps to choose country to investment:

Step1: *Select countries from a large amount of candidate countries by the GDP volume and predicted increase rate.*

Step2: *Set the concentration rule and threshold; exclude the countries with high concentration risk;*

Step3: *List the countries with little similarity; delete the countries too similar to the home country;*

Step4: *Resort the countries with the GDP increase rate descending;*

Step5: *Allocate the asset of the funds according to the GDP share in the left countries.*

The decision process is also displayed in Fig 1.

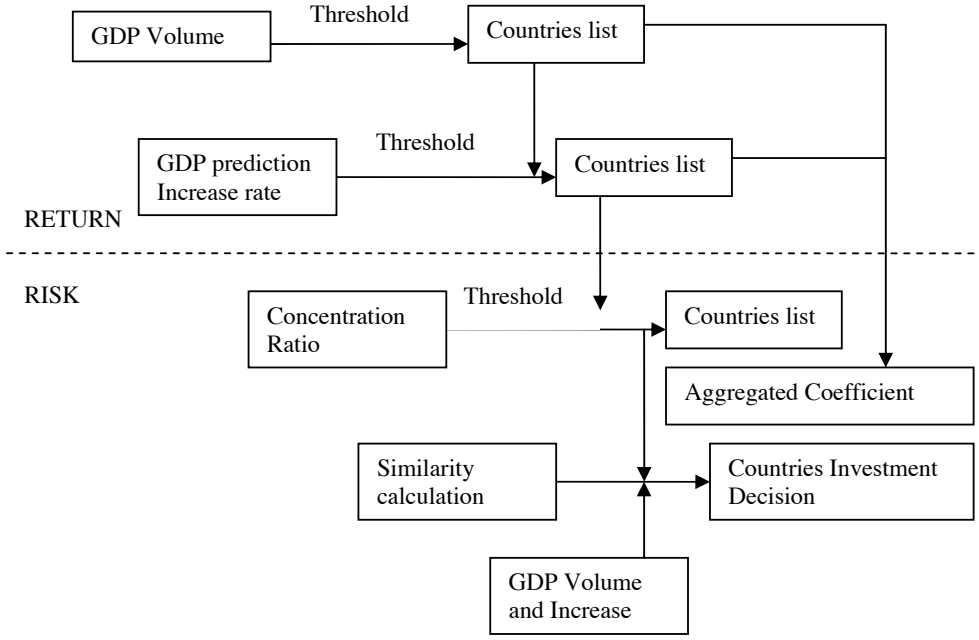

Fig. 1. Decision process for target countries selection

Now that we want to invest into the most dissimilar countries, the similarity calculation is a key question to answer. In the following two sections, we will review the existing researches and propose our similarity measurement coefficient.

3. Ratio based similarity measure

Because of the drawback of the existing coefficients demonstrated in the above statement, we design a new type similarity coefficient named ratio based similarity coefficient to reflect the structure of the industry. Let's take the patterns displayed in Fig 1 for example; the two patterns of A are more different than the two patterns of B. The ratio of the near neighbour can reflect the degree and the direction of the change. Given there are N points, and

everyone is divided by the next neighbour, there will be N-1 results. If the divided value is larger than 1, that means the neighbour goes up, else the neighbour goes down. Then we can calculate the similarity of the patterns based on the results.

The application of our research is to measure the affinity or similarity of the countries' industries. If there are N industries in country i and the industries are labelled by 1, 2, and 3…N in turn, the industry structure of the country can be calculated from the following formula.

$$R_{in} = \frac{s_{in}}{s_{in+1}} \quad n = 1.....N \qquad (1)$$

Where s_{in} is the share of industry n of the GDP of country i and s_{in+1} is the share of industry $n+1$ of the GDP of country i, R_{in} denotes the No. n structure ratio value of country i.

Table 3 shows the calculation process of the above ratio. R_1(X1), R_2(X2), R_1 (Y1), R_2 (Y2) in table 3 are the ratio to reflect the structure of example data. All of the values are calculated according to formula 6.

Formula 7 is ratio absolute similarity coefficient (RASC) designed to reflect the similarity of the pattern structure. Different with other coefficients, the small the result is, the more similar the structure of the pattern is. If the industries are the two countries are exactly the same, i.e. $R_{in} = R_{jn}$, the value of the RASC should be 0.

$$\mathrm{RASC}_{ij} = \frac{\sum_{n=1}^{N-1} \left| R_{in} - R_{jn} \right|}{N-1} \qquad (2)$$

Where R_{in} is the No. n ratio of country i got according to the formula 6; R_{jn} is the No. n ratio of country j got according to the formula 6. There are N industries in all.

The RASC of the example data is listed in table 3. The RASC of two X patterns is 0.49 and that of two Y patterns is 0.45 which means the X patterns are more similar with each other than that of Y patterns.

Table 1. The calculation process of ratio, RASC and RSSC of X and Y array

X Patterns	R_1(X1)	0.80	0.71	1.40	0.63	2.67
	R_2(X2)	0.67	0.75	0.67	1.50	2.00
	$\lvert R_1(X1) - R_2(X2) \rvert$	0.13	0.04	0.73	0.88	0.67
	$\mathrm{RASC}_{12(X)}$			0.49		
	$(R_1(X1) - R_2(X2))^2$	0.02	0.00	0.54	0.77	0.44
	$\mathrm{RSSC}_{12(X)}$			0.22		
Y Patterns	R_1(Y1)	1.25	0.80	1.67	0.43	0.88
	R_2(Y2)	3.00	0.67	1.50	0.50	1.00
	$\lvert R_1(Y1) - R_2(Y2) \rvert$	1.75	0.13	0.17	0.07	0.13
	$\mathrm{RASC}_{12(Y)}$			0.45		
	$(R_1(Y1) - R_2(Y2))^2$	3.06	0.02	0.03	0.01	0.02
	$\mathrm{RSSC}_{12(Y)}$			0.29		

Ratio square similarity coefficient (RSSC) is also proposed in our research. The detailed formula is displayed as follows.

$$\mathrm{RSSC}_{ij} = \frac{\sqrt{\sum_{n=1}^{N-1}(R_{in} - R_{jn})^2}}{N-1} \qquad (3)$$

Where R_{in} is the No. n ratio of country i got according to the formula 6; R_{jn} is the No. n ratio of country j got according to the formula 6. There are N industries in all. Similar with RASC, the smaller the value is, the closer the industry is with each other. We also calculate the RSSC of the example data, the $\mathrm{RSSC}_{12(X)}$ is 0.22 and $\mathrm{RSSC}_{12(Y)}$ is 0.29. This means the patterns of Y are closer than the patterns of X which is not consistent with the result of RASC. We examine the original data again, and find that these difference results from the outliers which are the first two points of Y. From Fig 1, we can see the first two points of Y_2 drop far faster than the first two points of Y_1. This causes the square value quite large which is 3.06 and influences the final value of RSSC.

Of course, there are several drawbacks of this coefficient. Firstly, R_{in} may not exist because the denominator is 0; secondly, the value of the RASC and RSSC may not be consistent. In our opinion, the RASC is better than RSSC to measure the similarity because the square of RSSC exaggerates the distance of industries. To some extent, the square misleads the calculation. Hence, RASC is preferred to measure the similarity of the industry structure. In spite of the above drawback, these two coefficients can differ the distance which is ignored by the traditional correlation coefficient.

4. Empirical study

Here, we will take China as the example to study which countries the China's future SWF should invest. First of all, we will eliminate the countries with small GDP volume. Then, the industrial concentration will also be used. If one sector takes more than a fixed threshold, we will take the economy area as high concentration risk and exclude the countries. Thirdly, we will calculate all similarity coefficients we design between China and the rest chosen economy areas. After the candidates are chosen, we will take the predicted GDP growth rate into consideration. The final investment decision includes how much to invest is made based on the share of GDP and other factors. In this case, we will just finish the first two steps to choose the candidate target investment countries.

From the website of United Nations[4], we get the GDP share of 7 industry categories of 210 countries. According to the classification of IMF, the GDP share is broken down into seven parts which include Agriculture, hunting, forestry, fishing, Mining, utilities, Manufacturing, Construction, Wholesale, retail trade, restaurants and hotels, Transport, storage and communication, Other activities. Ratio based similarity measure requires the value of all the variables cannot be 0. Because the value of Wholesale, retail trade, restaurants and hotels and Transport, storage and communication of Democratic People's Republic of Korea are 0, we delete the data of DPRK.

The Manufacturing share of Guinea-Bissau, Kosovo is unavailable, so the data of these two countries is deleted. The Mining share of Nauru is minus, so the data of Nauru is deleted. The mining share of Belarus, Lebanon, Russian Federation, Tajikistan, Turkmenistan, and Uzbekistan is unavailable, so we assume the mining share of these countries is equal to manufacturing. After pre-process, the dataset consists of 206 countries and 7 industries.

If the economy volume of the candidate country is too small, the home country will be unwilling to invest because it costs too much to access the information of the country. In order to pinpoint the countries that the SWFs are willing to invest, we exclude the countries with small GDP volume. In this case, we select the top 50 GDP countries as rough candidate set to calculate the similarity.

In this case, we set the threshold of concentration 40%. If one sector (except other sector) of a country is larger than 40%, the industry of country is regarded as too concentrated. The threshold of Mining sector is set to 35% for the country cannot rely on mining too much. According to the concentration rule, Nigeria, Algeria, Kuwait, Saudi Arabia, Thailand, United Arab Emirates, Norway, Chile, Iran, Malaysia, Indonesia are deleted because their industries are too concentrated.

According to the formula 1 and formula 2, we calculate the RASC and RSSC between China and left 39 countries with concentration threshold. There exists minor difference between RASC and RSSC. As we introduced in Section 3, RASC is recommended. Hence, the results displayed in table 2 are sorted by RASC.

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[4] The data can be accessed here: http://unstats.un.org/unsd/snaama/downloads/Shares-countries.xls

Table 2. the RASC and RSSC between China and 39 countries

Country	Agriculture (%)	Mining (%)	Manufacturing (%)	Construction (%)	Wholesale (%)	Transport (%)	Other (%)	RASC	RSSC
Kazakhstan	6.33	17.63	12.42	8.99	13.24	11.94	29.45	1.21	0.99
India	18.31	4.83	16.02	6.74	16.57	8.81	28.73	1.17	0.89
Australia	2.87	9.28	11.40	7.15	13.56	7.74	48.00	1.13	0.93
Greece	4.26	2.60	12.45	7.87	22.39	8.35	42.07	1.08	0.94
Spain	3.22	2.21	16.21	11.46	18.14	6.92	41.84	1.04	0.97
United States	1.04	3.82	13.25	4.78	15.17	5.92	56.01	1.03	0.74
Austria	1.71	2.91	19.56	7.64	17.35	6.77	44.06	1.00	0.76
Portugal	2.94	3.14	14.76	6.83	17.46	6.94	47.93	1.00	0.82
Peru	7.06	12.58	16.33	6.03	17.88	8.35	31.76	0.98	0.72
Netherlands	2.18	4.68	13.84	5.47	14.84	7.25	51.76	0.95	0.75
Poland	4.61	6.27	18.64	6.10	20.28	7.24	36.86	0.94	0.69
Canada	2.16	9.44	16.50	5.51	13.82	7.03	45.54	0.93	0.68
France	2.25	1.94	12.99	5.88	12.72	6.36	57.86	0.87	0.79
Switzerland	1.21	2.46	19.15	5.61	15.64	6.47	49.46	0.87	0.61
Denmark	1.75	5.22	14.46	5.49	13.14	8.77	51.17	0.85	0.72
Pakistan	20.15	5.47	19.08	2.46	18.21	12.81	21.82	0.83	0.58
Ireland	2.02	1.63	24.84	9.39	11.87	5.34	44.90	0.82	0.71
New Zealand	6.51	3.89	14.53	5.18	15.67	7.48	46.75	0.79	0.68
Japan	1.47	2.40	20.43	6.19	13.14	6.54	49.83	0.78	0.59
Italy	2.25	2.39	18.39	5.95	15.55	7.67	47.81	0.77	0.62
Belgium	0.99	2.23	17.16	4.88	14.67	8.36	51.70	0.75	0.56
Colombia	11.70	10.87	15.89	6.35	10.96	8.01	36.22	0.75	0.72
Romania	10.63	4.27	23.44	7.50	13.38	11.02	29.77	0.75	0.63
Brazil	6.05	5.98	18.33	5.34	17.92	8.55	37.84	0.71	0.56
Israel	1.93	2.02	14.81	4.94	11.38	7.88	57.04	0.68	0.62
Mexico	3.80	2.83	17.75	5.44	20.78	10.36	39.03	0.68	0.58
Philippines	14.33	4.75	22.70	4.15	15.71	7.38	30.96	0.58	0.39
Sweden	1.48	3.32	19.69	4.51	12.38	7.82	50.79	0.57	0.40
Czech Republic	2.91	5.09	26.47	6.52	14.69	10.37	33.94	0.55	0.44
Egypt	14.63	14.47	16.83	3.81	13.67	9.38	27.21	0.55	0.37
Turkey	10.40	4.62	21.17	4.57	20.86	14.69	23.69	0.54	0.35
Russian Federation	5.15	15.91	31.82	5.71	20.64	9.80	26.88	0.52	0.30
South Africa	3.01	9.98	18.51	2.65	14.01	9.43	42.42	0.50	0.31
Singapore	0.06	1.78	26.39	3.88	18.97	13.99	34.93	0.49	0.33
Germany	0.93	2.57	22.55	4.05	11.98	5.78	52.15	0.48	0.29
Finland	2.82	2.56	23.44	5.81	12.06	10.49	42.81	0.48	0.42
Hungary	4.38	3.03	22.33	4.82	12.88	7.70	44.85	0.39	0.30
Ukraine	9.11	8.40	21.94	4.50	14.42	11.73	29.90	0.38	0.26
Argentina	9.57	7.57	23.02	4.66	14.11	8.81	32.26	0.33	0.25
China	12.17	8.69	33.92	5.59	8.20	6.17	25.26	--	--

From table 2, we can get Kazakhstan, India, Australia, Greece, Spain, United States, Austria, Portugal, Peru, Netherlands are the top 10 countries that China should pay more attention to during the process of investment. The industry structures of these countries are quite different from the structure of China. Manufacturing which shares 33.92% takes the largest part of China's GDP. The largest industry of all the top 10 candidates target countries is Other sector.

The investment in these countries will help to hedge the industry risk of China. The SWF of China and other state owned should choose the industries of these countries to control the state risk and deal with the aging problem Chinese governments facing considering future pension liabilities in the future.

5. Conclusions

This paper has proposed a target country selection process for future SWFs investment from the perspective of industry. The result of this paper is suggestion of investment candidates of target countries and decision criteria. The basic idea is that future SWFs should invest into the countries which are quite dissimilar with the home country in industry if home countries of future SWFs want to smooth revenues between generations and maximize long-term welfare.

The country choice includes which country and how much to invest to obtain the objective of the funds and minimize the risk of the funds. In this paper, we have tried to answer the first problem i.e. how to select the country to invest for next generation SWFs asset allocation. We answered this question from the industrial perspective of a country and took the future SWF as part of the budget of the country to make decision in long term.

In order to control the risk, we have measured the industry similarity between the home and the recipient country of SWFs investment. Due to the shortcoming of the traditional correlation coefficient, we have designed new coefficients including ratio absolute similarity coefficient, ratio square similarity coefficient, weight absolute similarity coefficient. The industrial risk of the SWFs target country is also taken into consideration which is measured by concentration ratio.

In order to show the decision process, we have taken China as an example to demonstrate the application of the designed coefficient. Kazakhstan, India, Australia, Greece, Spain, United States, Austria, Portugal, Peru, Netherlands are the top 10 countries that China should pay more attention to during the process of investment. This result to some extend reflects the industrial structure difference between China and these countries.

The future work includes the predicted GDP growth rate should be taken into consideration after the candidates are chosen. The final investment decision includes how much to invest should be made based on the share of GDP and other factors.

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