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Payment System Liquidity Index

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Abstract

ISSP is an index that demonstrates payment system's stability figuring its liquidity (ISLSP) and its operational capability (IOSP). It was formed using two methods, which are statistical normalization and conversion using empirical normalization Min-Max. Basically, this paper intends to evaluate towards variables used in forming ISLSP and basically as a tool to ensure data sensitivity to important events stated. To get ISLSP that is sensitive to RTGS liquidity condition, we use coefficient from each weighted variable through simultaneous regression. We get parameters simbolized β_1, β_2 and β_3 that are used as weight for each variable. Based on observation to these weighted variables, liquidity variables contribute 60%, PUAB contribute 30%, and interconnectedness contribute 10% in forming ISLSP.

Keywords: Payment System's Stability; Economic Crises; Liquidity Index; payment system infrastructure;

1. Introduction

The global financial crises in 2008/2009 have led to much effort to analysis the stability of payment system liquidity of interbank markets. One of the key insight of previous studies is that deep monitoring on Real Time Gross Settlement as one of indicator of liquidity as a part of macroeconomic crises indicator.

Bank Indonesia – Real Time Gross Settlement (BI-RTGS) system is a payment system that `settles high value interbank transactions. To establish an efficient, fast, secure, and reliable payment system, this system has been operated by Bank Indonesia since 2000 and has undergone some enhancements in 2015 to BI-RTGS second generation. In terms of its facility, BI-RTGS second generation has new features to support transaction process efficiency, to mitigate risks, and to gather a more specific transaction information and data.

According to Principles for Financial Market Infrastructure (PFMIs)[2], BI-RTGS second generation is a Systemically Important Payment System (SIPS), so it can be used for domestic and cross-border transactions, but it is vulnerable to systemic risk[3]. Since it captures flow of high value fund from interbank transactions, it can illustrate implicitly or explicitly Indonesia's payment system's liquidity stability.

In 2015, BI creates Payment System Stability Index (ISSP) which consists of two indexes; Payment System Liquidity Index (ISLSP) and Payment System Operational Index (IOSP). ISLSP shows liquidity of RTGS members

[1] The views expresed in this paper do not necessaraly reflect those of Bank Indonesia policy
[2] PFMIs merupakan standar yang diterbitkan oleh BIS-IOSCO sebagai *guidance* dalam penyelenggaraan *financial market infrastructures*
[3] BIS, 2001, *"Core Principles for Systemically Important Payment Systems"*

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while IOSP shows operational stability of RTGS, Script less Securities Settlement System (BI-SSSS) and National Kliring System (SKNBI) members.

Changes in infrastructure and data structure in BI-RTGS second generation affect ISSP indicators created previously. In addition, there were changes in macroeconomics condition and payment system stability in 2015 as a result of domestic and global economic dynamics. Considering these two factors, a revisit to previously established ISSP was necessary. Therefore, we are going to reevaluate ISSP, so its indicators are more suited to represent current and future payment system's condition. The new indicators can be used as an early warning in payment systems. We will focus on liquidity pressure in BI-RTGS with two considerations specified below.

- Payment system (BI-RTGS, BI-SSSS, and SKNBI) infrastructure's capability and performance are no longer monitored by IOSP. According to Decision GBI No. 18/35/2016, these payment systems are critical, so it has to be guaranteed by a more established system based on PDG No. 17/7/2015.
- According to Governor Council Regulation (PDG) about Crisis Management Protocol, evaluation towards main quantitative indicator application from payment system sub-protocol has the possibility of being done periodically or suddenly.

Based on explanation above, this research aim to build an indicator that will be used in forming payment system liquidity measures by construct variabel that ussually use in macroeconomic and payment system such as OM placement, TOR, queue; interconnectedness; and PUAB that consists of frequency and spread of O/N PUAB rate to BI rate.

2. Research Methology

2.1. Place of Research

Basically this research use the statically data which is Indonesian Payment System Data since 2005 until 2016 that it can be download from Bank Indonesia website. ISSP is an index that demonstrates payment system's stability from its liquidity (ISLSP) and its capability (IOSP). It was formed using two methods, which are statistical normalization and conversion using empirical normalization Min-Max.

Formula used in statistical normalization is shown below.

$$Q_t = \sum_{j=1}^{n} \omega_j \frac{x_t{}^j - \bar{x}_{(Base\ Year)}}{\bar{\sigma}_{(Base\ Year)}} \quad (1)$$

Q_t	: composite index
ω_j	: weighted variable
$x_t{}^j$	: value of x at t
$\bar{x}_{(base\ year)}$	: average variable base year
$\bar{\sigma}_{(base\ year)}$	: standard deviation base year

Normalization from each indicator will be combined into an index with a specified weight. The weight is determined by statistics and event analysis. ISSP from these two methods will synchronize perception and index movement.

After that, we will use Min-Max method to compare current payment system with the minimum and maximum payment system stability from period 2005-2010. Below is the formula for Min-Max method.

$$K_t = \sum_{j=1}^{n} \frac{Q_t{}^j - Min(Q_{(Base\ year)})}{Max(Q_{(Base\ Year)}) - Min(Q_{(Base\ Year)})} \quad (2)$$

K_t : conversion composite index
Q_t : composite index
$Min(Q_{(base\ year)})$: minimum value of variable Q^j in base year
$Max(Q_{(base\ year)})$: maximum value of variable Q^j in base year

2.2. ILSP

Indicators used in forming ILSP are liquidity in RTGS, specified transaction, and interconnectedness. Liquidity is seen from Turn Over Ratio (TOR), throughput zone III, queue, unsettled, and demand saving. Specified transaction is determined by Interbank Money Market (PUAB), foreign transaction between banks, foreign transaction with BI, and cash withdrawal. Meanwhile interconnectedness measures connection between banks. Data from 140 banks' daily transaction (who are members of RTGS) is used to form ILSP. Banks are then categorized into Mixed Banks, State Banks, Foreign Banks, National Private Banks, Syariah Banks, UUS, and Local State Banks.

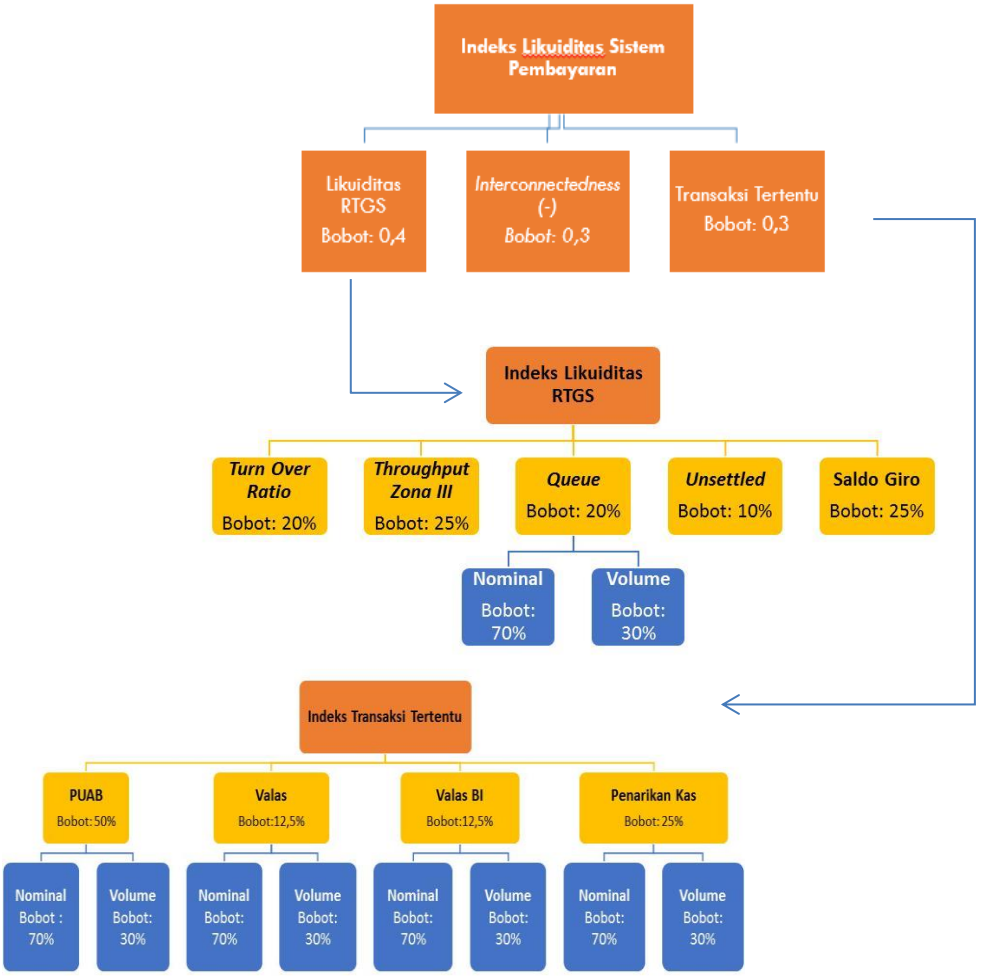

Fig. 1. ILSP

2.3. IOSP

The stability of payment system infrastructure is one of BI's priorities. BI-RTGS, BI-SSSS, and SKNBI are critical applications that have high priority for recovery because of its huge impact and needs for fast and anticipative handling. It can be measured from frequency and period of down system in BI-RTGS, BI-SSSS, and SKNBI. We will use daily transaction data from BI's perspective to form IOSP.

Fig. 2. IOSP

2.4. Determining Weight for Indicators in Index

Turning Point Analysis (TPA) will determine the weight of each indicator. TPA has a better capability in capturing liquidity in Indonesia compared to other methods, such as Principal Component Analysis (PCA) and standard deviation method. One of its advantages is its ability to produce non-linear weight, such as its flexibility to change in accordance with change in data and condition. For example, foreign transaction indicators had only been available since 2010. If the same condition is implemented using other methods, weight of all indicators will be linear, so it becomes the multiplier for previous data.

TPA can produce a modified weight based on scenarios given in the beginning. For example, if weighted throughput zone III is increased by X%, weighted CAR will increase by Y%. Determining weighted indicators is important to combine normalized indicators into a single index ILSP or IOSP. Indicators in ILSP has the highest proportion of 0.4. Interconnectedness and specified transaction has 0.3 each. The numbers are determined by liquidity RTGS from historical data. Based on index graph, the numbers can capture payment system liquidity during mini crisis 2005 and global financial crisis 2008-2009. On the other hand, IOSP is formed by two indicators, which are BI-RTGS/BI-SSSS and SKNBI downtime/availability. Since 80% transactions are done in RTGS, RTGS is weighted 80%. A more detailed process of weighting ILSP and IOSP can be seen below.

2.5. Determining Threshold and Heatmap

Threshold is a parameter used to interpret the results from calculation to place cluster in a specified condition. Meanwhile, heatmap is the color representation of graph of individual variable data[4]. ISSP calculation then translated based on four conditions, which are normal, guarded, elevate, severe.

Table. 1. Threshold ISSP

Indeks	Threshold			
	Normal (green area)	**Guarded** (yellow area)	**Elevate** (orange area)	**Severe** (red area)
ILSP	<0.64	0.64 – 1.03	1.03 – 1,42	>1.42
IOSP	< 2 hours	2-3 hours	3-4 hours	>4 hours

[4] Sumber: Laporan Stabilitas Sistem Keuangan (SSK).

Based on the threshold, we will trace back all indicators from the beginning. Heatmap should be able to demonstrate sources of pressure when payment system liquidity condition is on guarded, elevate, and severe.

3. Result

According toLaine et al (2011), we can categorize global economy phenomenon into three periods: July 1, 2007 – September 14, 2008 as the beginning of financial crisis, September 2008 – June 30, 2009 as the financial crisis, and July 1, 2009 – February 28, 2011 as recovery period. Because of that, we choose 2005 – 2015 as the base year because it includes both normal and crisis periods.

3.1. Choosing Indicators / Demand Saving Balance

According to BIS, demand saving in central banks is a liquidity source in RTGS transactions[5]. Settlement can only be completed if there is enough money (no money no games). As there are higher demand saving balance, there are less pressure to liquidity.

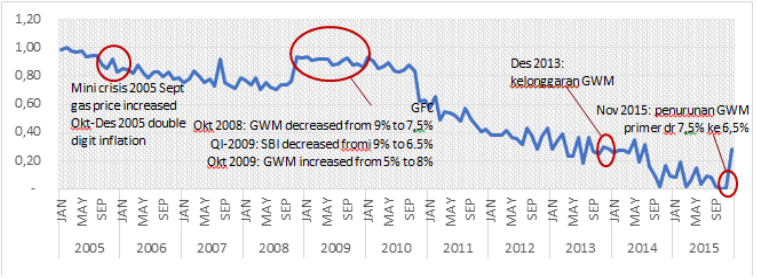

Fig. 3. Demand Saving Movement

Figure 3 shows a decline in demand saving movement, which means there is an increase in saving balance demand. Indicator demand saving is more sensitive in response to BI regulation about Minimum Demand Saving Balance (GWM). The daily beginning balance in RTGS is determined by BI[6], third party balance in bank, and savings. Therefore, we cannot draw a conclusion that an increase/decrease in beginning demand saving balance is solely caused by liquidity pressure. As a result, we cannot use demand saving balance as an indicator for ISLSP.

3.2. Placement of Monetary OperationInstrument (OM)

OM consists of term deposit, marketable securities (SBN), Bank Indonesia Certificate of Deposit (SDBI), and Bank Indonesia Certificate[7]. If there are more banks that put balance to OM, there will be less pressure on liquidity.

Fig. 4. Monetary Operation Placement

[5]*BIS, 1997, "Real Time Gross Settlement System"*

[6]PBI No.18/3/PBI/2016 tanggal 10 Maret 2016 tentang Perubahan Ketiga Atas Peraturan Bank Indonesia Nomor 15/15/PBI/2013 tentang Giro Wajib Minimum Bank Umum Dalam Rupiah Dan valuta Asing Bagi Bank Umum Konvensional.

[7] Pasal 5 PBI No.15/15/PBI/2013 tentang Perubahan Kedua atas PBI No.12/11/PBI/2010 tentang Operasi Moneter

Figure 4 shows that OM is able to capture liquidity pressure during mini crisis 2005, crisis 2008, Greece economy crisis, European crisis, and tapering off the Fed. It also shows the effect of quantitative easing in the U.S. that causes an increase of capital inflow to emerging countries, including Indonesia. Therefore, OM will be used in forming ISLSP.

3.3. Government Transaction Account

Government Transaction Account is shown by outgoing net subtracted by incoming net. As there are more balance on the account, liquidity pressure will be less.

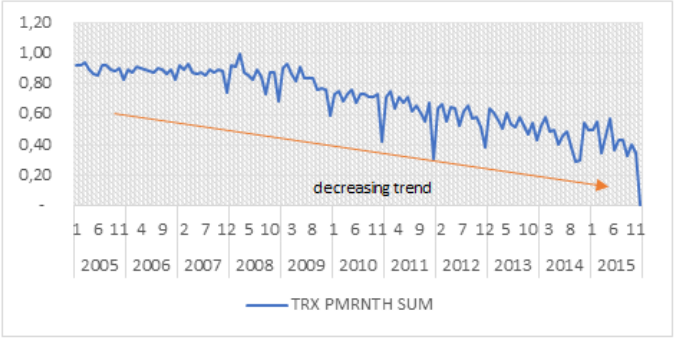

Fig. 5. Government Transaction Account Balance

Figure 5 shows that this indicator cannot capture liquidity pressure during mini crisis 2005 and crisis 2008. Therefore, it will not be included in forming ISLSP.

3.4. Turn Over Ratio (TOR)

TOR is a ratio of bank's required outgoing transaction to bank's daily demand saving balance (Panggabean etal., 2015). A higher TOR indicates a higher liquidity risk. Formula and graph TOR on previous paper is shown below.

$$TOR\ 2015\ version = \frac{outgoingtransaction}{demandsavingbalance} \tag{3}$$

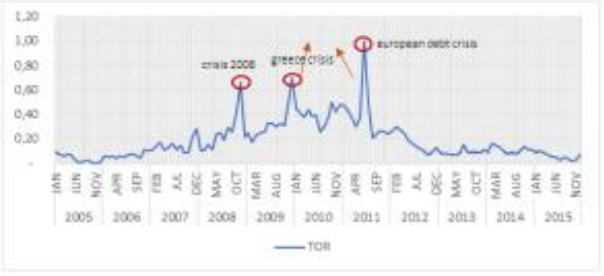

Fig. 6. TOR 2015 version

Figure 6 shows some pressure to the economy. Pressure at the end of 2009 (Greece crisis) and on the second quarter of 2011 is higher than 2008. However, it cannot be explained by economic condition. Therefore, this indicator will be adjusted in this paper by adding OM due at demand saving balance at the beginning of a day. It consists of deposit facility (credited at 8.30) and open market operation (credited anytime during open window). Adding OM has the potential to predict liquidity pressure in the future with the assumption that GWM does not change. Formula and graph TOR after adjustment is shown below.

$$\sum_{i}^{n} TOR\ 2016\ version = \frac{outgoingtransactioni}{demandsavingbalancei + OMi} \tag{4}$$

Fig. 7. TOR 2016 version

Figure 7 can illustrate the effect of BI's regulation that increases GWM Rupiah from 5 percent to 8 percent. It did not appear on graph from previous paper, so this graph can represent the economic condition. Therefore, we will use this indicator.

3.5. Through put Zone III

Through put guide lines are targeted percentage of a transaction in one day during a period of time. It has three zones to prevent balloon transaction at the end of the day as shown below.

Table. 2. Throughput Guidelines

	RTGS (GMT +7)	**RTGS second generation (GMT +7)**	***Guidelines***
Zone I	System open – 10.30	System open – 10.00	30%
Zone II	10.30 – 14.30	10.00 – 14.00	30%
Zone III	14.30 WIB – system closed	14.00 WIB – system closed	40%

Through put calculation is shown below

$$RTGSthroughput^{zoneIII} = \frac{\sum_{t=14.30}^{n} Outgoing\ transaction}{\sum_{t=0}^{n} Outgoingtransaction} \quad (5)$$

$$RTGS\ second\ generationt\ Through\ put^{zoneIII} = \frac{\sum_{t=14.00}^{n} Out\ going\ transaction}{\sum_{t=0}^{n} Out\ going\ transaction}$$

As there are more settlement during zone III, the bigger throughput zone percentage and liquidity pressure will be

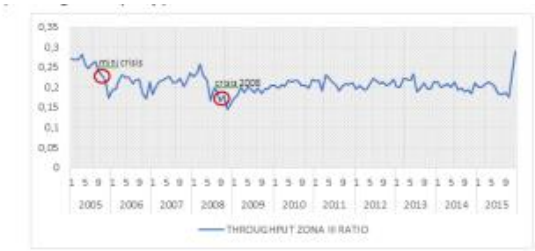

Fig. 8. Through put Zone III

Figure 8 shows that generally BI-RTGS members abide with the guidelines. However, figure 8 cannot show liquidity pressure, such as during mini crisis 2005 and crisis 2008. Also, it does not illustrate clear response to BI's regulation, for example GWM. Since it is dependent and has to be confirmed with other variables (unsettled transaction), we will not use this indicator.

3.6. Queue

Queue transaction system is used when members do not have enough fund when they want to send money (Panggabean et al., 2015). One of the causes is they are still waiting for inbound transaction from other members. If the waiting time gets longer and transaction gets bigger, liquidity pressure will increase. In ISSP paper in 2015, queue could not respond to liquidity pressure in BI-RTGS due to metrics difference.

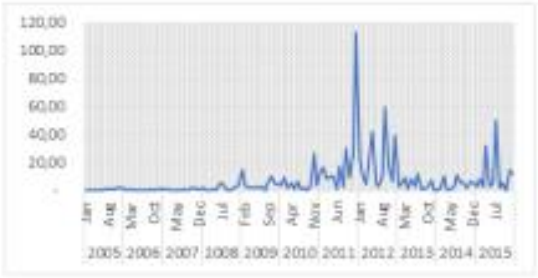

Fig. 9. Queue (2015 version)

In ISLSP 2016, queue formula and graph are shown below

$$\frac{\sum_{i=1}^{n}(payments\ Value_i * settlement\ Time_i)}{\sum_{i=1}^{n} payments\ Value_i} \quad (6)$$

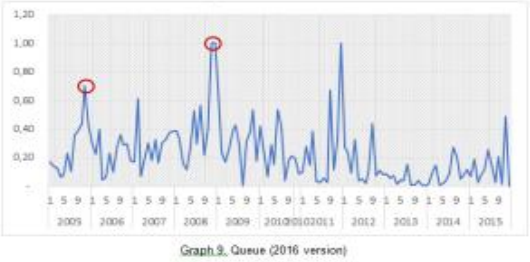

Fig. 10. Queue (2016 version)

Pressure on mini crisis 2005 and crisis 2008 can be shown on graph 9. Therefore, this indicator will be used in forming ISLSP.

3.7. Unsettled Transactions

Unsettled is a transaction that cannot be completed until end of the day due to insufficient fund (Panggabean et al., 2015). As the nominal and frequency of unsettled increases, the pressure to BI-RTGS liquidity will increase as well. Due to limited access to data from 2005-2015, unsettled indicators cannot illustrate liquidity BI-RTGS. However, considering its sudden characteristics, we will monitor this indicator as a supportive quantitative indicator, and not as an indicator.

3.8. Interconnectedness

Interconnectedness shows interbank relationships (Panggabean et al., 2015). In 2016, we use interconnectedness between banks in PUAB excluding interconnectedness between bank and customer. According to research conducted

by central banks of other countries[8], we assume that core banks are connected to all banks, not all periphery banks are connected with other periphery banks, and core banks are connected to mostly periphery banks. Cluster coefficient that illustrates interconnectedness is calculated using formula below.

$$C_t = \frac{m_{nn,i}}{k(k-1)} \quad (7)$$

$m_{nn,i}$: connectedness between all members

k : maximum connectedness possible

If banks are more connected, it will be easier to get loan from other banks. As a result, liquidity pressure in BI-RTGS decreases. However, formula above has a downside because we assume that not all periphery banks are connected with other periphery banks. Improvement to this downside is recommended in future ISLSP revisit.

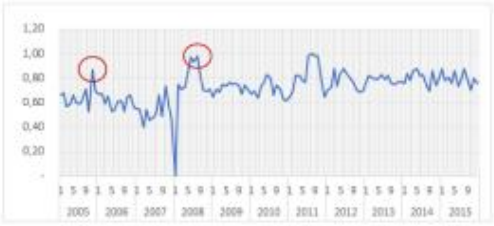

Fig. 11. Interconnectedness

Figure 10 shows an increase during mini crisis 2005 and crisis 2008, so it is being considered as a sensitive indicator to economic pressure.

3.9. Interbank Money Market (PUAB)

To test PUAB's sensitivity, we tested PUAB's frequency, nominal, and overnight (O/N) interest rate to BI's rate.

3.9.1. PUAB's frequency

It shows the quantity of loan transaction between banks to fulfill liquidity needs or to distribute excess in liquidity that happens due to daily liquidity gap. If the frequency increases, liquidity pressure in RTGS will decrease.

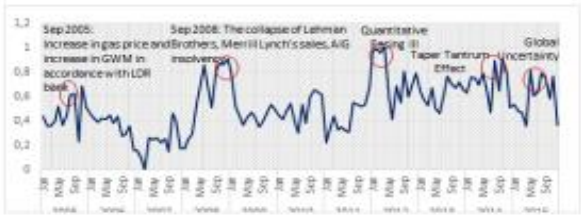

Fig. 12. Frequency PUAB

Figure above can capture pressure during mini crisis 2005, crisis 2008, and quantitative easing III done by The Fed in 2011-2012. There is also a decrease in October 2005 due to BI's regulation about GWM. Since PUAB's frequency graph can capture both domestic and international pressure, we will use it as one of ISLSP's indicators.

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[8]Antara Iain Baek et all(2014), Network Indicators for Monitoring Intraday Liquidity in BOK-Wire, BOK WP No. 2014-01

3.9.2. PUAB's value

It is the amount loaned between banks to cover liquidity or to distribute liquidity excess due to daily liquidity gap. If the amount is high, it indicates that the RTGS liquidity pressure is low.

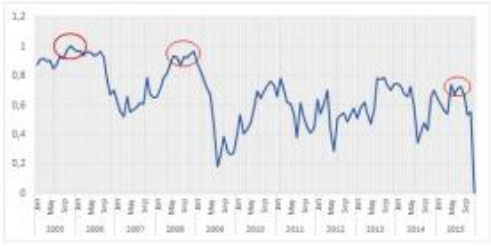

Fig. 13. PUABS's value

Figure 11 illustrates economic pressure to RTGS liquidity during mini crisis 2005 and crisis 2008. Since PUAB transactions are a result of banks' needs to cover daily liquidity gap, it only represents 4% of overall RTGS transactions. Therefore, it will not be used as ISLSP indicators.

3.9.3. Spread of PUAB O/N Interest Rate to BI Rate

It shows bank's cost to get a loan from another bank based on BI rate. A tight liquidity is shown by an increase in PUAB rate and wider spread between selling and buying price[9]. To prevent PUAB rate from widening from BI rate, BI accommodates bank's liquidity needs by monetary operation[10].

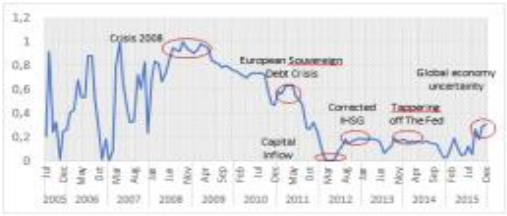

Fig. 14. Spread of PUAB O/N rateto BI Rate

Figure 13 shows high fluctuations in 2005-2008. It is caused by BI's inconsistency in determining threshold of O/N PUAB. After BI restricted PUAB O/N interest to a certain range in 2008, there were enough spread. If the spread becomes wider, pressure to payment system liquidity will increase. Based on event analysis, it will be used as ISLSP indicators.

Both graphs show foreign transaction is insensitive in showing pressure to RTGS liquidity. Therefore, it will not be used in forming ISLSP.

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[9] *Wuryandani, et al., 2014, "Pengelolaan Dana Dan Likuiditas Bank".*

[10] *Sihono, 2010, "Statement Kebijaksanaan Moneter"*

3.9.4. Cash Withdrawal

Cash withdrawal in Indonesia is cyclical, which means there is an increase in frequency and in value that happens every certain period, such as during Ramadhan. Even though it is used as indicator in previous paper (2015), we will reevaluate it.

Fig. 15. Cash Withdrawal Frequency

From doing event anylisis of above graph, cash withdrawal frequency has above average fluctuations during Ramadhan, but it is unable to illustrate internal and external pressure to payment system's liquidity, so it will not be used in forming ISLSP in 2016.

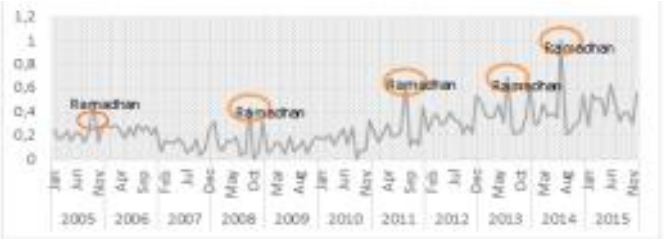

Fig. 16. Cash Withdrawal Value

Cash withdrawal value also experience above average fluctuations during Ramadhan. In addition, it is unable to show liquidity in payment system as a result of internal and external pressure, so it will not be used as ISLSP 2016 indicator.

Based on analysis above, indicators that will be used in forming ISLSP 2016 are liquidity measures, such as OM placement, TOR, queue; interconnectedness; and PUAB that consists of frequency and spread of O/N PUAB rate to BI rate.

3.9.5. ISLSP Construction Model

Generally, ISLSP 2016 is formed using 2005-2015 as base years and using empirical normalization Min-Max method. It is different from ISSP 2015 that used two-time normalization, which are statistical normalization (base year) and empirical normalization Min-Max. Empirical Normalization Min-Max formula is shown below.

$$K_t = \sum_{j=1}^{n} \frac{{Q_t}^j - Min(Q_{(Base\ year)})}{Max\left(Q_{(Base\ Year)}\right) - Min\left(Q_{(Base\ Year)}\right)} \tag{8}$$

K_t : conversion composite index
Q_t : composite index
$Min(Q_{(base\ year)})$: minimum value of Q^j in base year
$Max\left(Q_{(base\ year)}\right)$: maximum value of Q^j in base year

3.10. Forming ISLSP

3.10.1. Determining Weight

Basis in determining each variable's weight is its contribution. If weight is high, its contributions is significant towards the index built. Index used is financial system stability index (ISSK). We will test all six variables chosen above using Eviews with regression model below.

$$\mathrm{Y(ISSK)} = \alpha \ + \beta_1 X1\ (Likuditas) + \ \beta_2 X2\ (PUAB) + \beta_3 X3\ (Interconectiveness) + \ E_t \tag{9}$$

From formula above, we get parameter β_1, β_2 and $\beta_3$that is used as weight of variables that contribute in forming ISLSP in heatmap ISLSP. Liquidity variables have the biggest contribution followed by PUAB and interconnectedness. From the weight regression calculation, we got that liquidity has a weight of 0.6, PUAB 0.3, and interconnectedness 0.1.

3.10.2. Determining Threshold

Threshold is implemented to ease liquidity identification in financial services, as the majority of BI-RTGS members. Threshold calculation is based on formula below.

$$t \ = \ i_x \ . \ \sigma + \ \bar{x} \tag{10}$$

$$i_x = \frac{t_k (i_{max} - i_{min})}{2} + \ i_{min} \tag{11}$$

$$i_{max} = (\ x_{max} + \bar{x})/\sigma \tag{12}$$

$$i_{min} = (\ x_{min} + \bar{x})/\sigma \tag{13}$$

t : converted threshold
t_k : threshold ISLSP or IOSP
i_x : beginning threshold index
i_{max}: maximum threshold index
i_{min}: minimum threshold index
σ : standard deviation for base year
x : indicator value (threshold beginning)
$\bar{x}$: average base year

Threshold then divided into four conditions, which are normal (ISLSP < 0.33), guarded (ISLSP 0.33 < 0.51), elevate (ISLSP 0.51 < 0.64), and severe (ISLSP > 0.64) that are marked by color green, yellow, orange, and redrespectively.

3.10.3. Trace Back with Heatmap

Before creating heatmap, we should determine threshold, choose main indicators, determine composite index and nowcasting that can show pressure on payment system liquidity. Threshold observation that is based on simulation results is done through comparing crisis in different period. After that, we will create heatmap and assign colors as specified before. Based on determined threshold, we produce heatmap below.

Fig. 17. ISLSP

		2005												2006											
	Bobot	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
ISLSP		0,41	0,40	0,38	0,38	0,41	0,40	0,39	0,58	0,49	0,44	0,53	0,47	0,45	0,45	0,48	0,46	0,43	0,46	0,49	0,54	0,46	0,42	0,37	0,35
Likuiditas	0,6	0,42	0,42	0,41	0,39	0,40	0,44	0,40	0,48	0,48	0,51	0,57	0,48	0,45	0,44	0,50	0,38	0,38	0,43	0,40	0,46	0,48	0,46	0,42	0,41
PUAB	0,3	0,31	0,27	0,27	0,29	0,34	0,27	0,32	0,77	0,43	0,28	0,35	0,38	0,36	0,41	0,41	0,55	0,48	0,49	0,63	0,66	0,40	0,27	0,18	0,17
Interconnectedness	0,1	0,66	0,67	0,57	0,59	0,66	0,60	0,59	0,63	0,71	0,52	0,87	0,70	0,67	0,67	0,59	0,66	0,53	0,54	0,60	0,62	0,53	0,64	0,66	0,56
		2007												2008											
	Bobot	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
ISLSP		0,30	0,40	0,38	0,49	0,46	0,42	0,42	0,41	0,46	0,51	0,55	0,45	0,40	0,53	0,51	0,51	0,60	0,67	0,62	0,71	0,69	0,77	0,94	0,84
Likuiditas	0,6	0,38	0,54	0,36	0,41	0,47	0,44	0,47	0,42	0,47	0,46	0,52	0,57	0,45	0,49	0,46	0,43	0,51	0,53	0,47	0,67	0,58	0,69	1,00	0,82
PUAB	0,3	0,08	0,09	0,40	0,63	0,46	0,35	0,27	0,29	0,44	0,53	0,61	0,20	0,43	0,54	0,55	0,60	0,70	0,84	0,80	0,72	0,86	0,93	0,90	0,92
Interconnectedness	0,1	0,55	0,54	0,40	0,54	0,46	0,48	0,51	0,66	0,49	0,73	0,58	0,47	-	0,75	0,71	0,72	0,85	0,97	0,93	0,98	0,81	0,70	0,70	0,71
		2009												2010											
	Bobot	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
ISLSP		0,76	0,62	0,61	0,62	0,66	0,68	0,64	0,56	0,63	0,65	0,74	0,60	0,53	0,50	0,47	0,52	0,50	0,56	0,55	0,46	0,53	0,50	0,43	0,36
Likuiditas	0,6	0,73	0,55	0,55	0,58	0,63	0,67	0,63	0,52	0,64	0,65	0,79	0,57	0,47	0,43	0,38	0,44	0,44	0,54	0,47	0,38	0,42	0,41	0,33	0,23
PUAB	0,3	0,85	0,73	0,71	0,66	0,69	0,66	0,63	0,58	0,59	0,63	0,66	0,63	0,60	0,57	0,60	0,61	0,56	0,52	0,63	0,56	0,66	0,63	0,56	0,54
Interconnectedness	0,1	0,65	0,71	0,69	0,75	0,73	0,76	0,75	0,76	0,74	0,67	0,74	0,70	0,67	0,70	0,64	0,73	0,77	0,82	0,79	0,66	0,74	0,70	0,63	0,61
		2011												2012											
	Bobot	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
ISLSP		0,37	0,45	0,44	0,49	0,41	0,37	0,39	0,40	0,49	0,36	0,39	0,49	0,29	0,28	0,26	0,30	0,23	0,29	0,32	0,35	0,42	0,33	0,35	0,34
Likuiditas	0,6	0,31	0,41	0,33	0,44	0,31	0,27	0,28	0,25	0,46	0,24	0,31	0,48	0,09	0,09	0,05	0,13	0,09	0,21	0,20	0,26	0,34	0,25	0,25	0,22
PUAB	0,3	0,40	0,44	0,53	0,48	0,49	0,43	0,41	0,50	0,40	0,39	0,43	0,45	0,56	0,51	0,48	0,50	0,31	0,25	0,40	0,37	0,47	0,38	0,44	0,49
Interconnectedness	0,1	0,65	0,69	0,82	0,82	0,78	0,76	0,98	1,00	0,98	0,98	0,77	0,65	0,70	0,73	0,88	0,73	0,83	0,88	0,84	0,80	0,76	0,71	0,69	0,69
		2013												2014											
	Bobot	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
ISLSP		0,33	0,34	0,35	0,33	0,32	0,32	0,29	0,29	0,28	0,31	0,33	0,29	0,29	0,35	0,36	0,34	0,36	0,32	0,29	0,34	0,27	0,29	0,27	0,24
Likuiditas	0,6	0,21	0,24	0,27	0,21	0,22	0,24	0,19	0,13	0,14	0,18	0,20	0,15	0,15	0,21	0,25	0,21	0,22	0,20	0,18	0,19	0,14	0,08	0,11	0,14
PUAB	0,3	0,41	0,38	0,35	0,42	0,34	0,30	0,34	0,43	0,41	0,43	0,44	0,41	0,40	0,45	0,46	0,42	0,47	0,39	0,32	0,52	0,39	0,52	0,43	0,27
Interconnectedness	0,1	0,76	0,82	0,80	0,79	0,79	0,83	0,79	0,82	0,76	0,75	0,76	0,78	0,76	0,83	0,78	0,86	0,87	0,82	0,83	0,74	0,70	0,86	0,74	0,80

Table. 3. Heatmap ISLSP

Graph and table above show that in June 2008-January 2009, ISLSP's threshold is above 0.638. It aligns with global financial crisis that happened during this period. However, since 2009, pressure on payment system liquidity has recovered to elevate and guarded until noremal in 2015.

4. Conclusion and Recommendation

4.1. Conclusion

Test and evaluation towards variables used in forming ISLSP is done to ensure data sensitivity to important events stated. To get ISLSP that is sensitive to RTGS liquidity condition, we use coefficient from each weighted variable

through simultaneous regression. We get parameter β_1, β_2 and β_3 that are used as weight for each variable. Based on observation to these weighted variables, liquidity variables contribute 60%, PUAB contribute 30%, and interconnectedness contribute 10% in forming ISLSP.

Analysis on this paper shows that pressure on liquidity can cause risk to SSK. It does not only come from fundamental factors, but also technical factors that can cause unsettled transactions in RTGS

4.2. Recommendation

Dashboard is needed to observe variable's daily movements in payment system. We need further research of variables that form index to get a better understanding of index movements. It can be done by daily dashboard monitoring for each variable. Dashboard will wase central banks to understand condition and development of payment system, as well as an early warning before crisis.

We also need further research about interconnectedness variables as one of the variables that affects high value payment system. We can use network topology method to see changes in interbank transactions structure. In this paper, weighted interconnectedness variable is relatively small compared to liquidity and PUAB due to limited data.

Considering ISLSP as a main quantitative indicator from sub-protocol payment system in PMK, further research has to be done routinely, so ISLSP can be a robust indicator in capturing pressure on liquidity.

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