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Abstract

Purpose – This paper aims to examine the effects of interest-free and interest-based monetary policy on inflation and unemployment rates for two groups of countries where in one group, interest-free monetary policy (IFMP) was pursued, while in the other group, interest-based monetary policy (IBMP) was followed.

Design/methodology/approach – This study involves a sample of 23 developed countries divided into two groups. The authors measure economic performance by misery index (MI), and MI is calculated as unemployment rate plus inflation rate. A group of countries, where MI is lower, performs better compared to the other group where MI is relatively higher.

Findings – The results reveal that in group of 12 countries where IFMP is adopted, the MI is lower and thus performs better compared to a group of countries where IBMP is pursued.

Research limitations/implications – The findings of this study have profound implications for the policymakers and government leaders who look for a solution to maintain both low inflation and unemployment rates. The findings in this study clearly portray that such ideal situations can only be achieved by pursuing IFMP. No wonder the countries which have been historically pursuing IFMP such as Japan, Switzerland, Sweden, the Netherlands and Denmark have been able to contain both inflation and unemployment rates compared to their counterparts among the English-speaking countries.

Originality/value – This is one of the most recent tests on the differences in economic performance between IFMP and IBMP. These results have significant value for policymakers and central bankers who have been struggling to maintain lower MI for decades.

Keywords Economic performance, Interest-based monetary policy, Interest-free monetary policy, Misery index, Qard-al Hasan

Paper type Research paper

Introduction

For over a year, Eurozone countries have pursued an interest-free monetary policy (IFMP). Some Organisation for Economic Co-operation and Development (OECD) countries such as Japan, Denmark, Sweden and Switzerland went even further and followed negative central

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bank (CB) interest rates (see sources of CB interest rates), while other OECD countries pursued positive bank rates. The decision to follow negative interest or IFMP is a new development for these Eurozone countries plus another five prominent OECD members, most of which are developed capitalist countries. IFMP, or interest-free banking, has its roots in the divine revelations of the Qur'ān, the words of Allah (may He be exalted), and the traditions (*ḥadīth*) of Prophet Muhammad (peace be upon him). As such, an interest-free economic system has profound and positive impacts on investment spending, consumption spending and aggregate expenditures, all of which in turn increase output, employment and income. An increase in output eliminates shortages and excess demand and thereby stabilises the price level. In addition, IFMP lowers the overall costs of financing, resulting in a rightward shift of the aggregate supply curve, and thereby increases real gross domestic product (GDP) and reduces the price level. An increase in real GDP increases employment and decreases the unemployment rate. The reduction in the price level caused by the rightward shift in the aggregate supply curve decreases the inflation rate.

Monetary policy (MP) is designed to achieve full employment and to stabilise the price level. The success of MP depends on how effectively both unemployment rate (*UR*) and inflation rate ($\dot{P}$) can be contained or even reduced, thereby shifting the Phillips curve leftward towards the origin. Successful reduction in *UR* and $\dot{P}$ will certainly improve macroeconomic performance. Therefore, macroeconomic performance (*MEP*) can be measured as $MEP = UR + \dot{P}$. If the *MEP* index falls, macroeconomic performance improves and vice versa. *MEP* is similar to the misery index (*MI*) or discomfort index (*DI*). *MI* and *DI* are measured in a similar fashion, as the sum of the unemployment rate and the inflation rate. If the misery index (*MI*) or discomfort index (*DI*) decreases, macroeconomic performance improves, and vice versa. In this paper, macroeconomic performance (*MEP*) is measured as the sum of unemployment rate and inflation rate. In this study, *MI* is calculated for the two groups of countries in Table II. For Group x, where a positive interest-based monetary policy (IBMP) was followed, *MI* is relatively higher compared to Group y, where IFMP was pursued. In this paper, the following three hypotheses will be tested:

H1. What economic model or theory can explain why IFMP may yield better macroeconomic performance for Group y compared to Group x?

H2. Does Group y (where IFMP was followed) really perform better compared to Group x (where IBMP was followed)? In other words, does Group y have a relatively lower *MI* compared to Group x?

H3. If Group y does have a lower *MI* than Group x, are the mean differences in *MI* statistically significant at the 5 per cent level of significance or not?

This paper addresses the above three issues and establishes the relative effectiveness of IFMP compared to IBMP. Accordingly, this paper is designed as follows: the second section outlines the foundations of IFMP and reviews recent literature. A theoretical model is developed in the third section to address the above issues. A sample of 11 developed capitalist OECD countries was selected in the fourth section where positive conventional IBMP was pursued. In addition, another sample of 12 developed Eurozone and OECD countries was selected where zero or negative IBMP was pursued. In this paper, the mean differences in *MI* between the above two groups of countries will be investigated. The fifth section tests whether the mean differences between Groups x and y are statistically significant at the 5 per cent level of significance or not. Concluding remarks are summarised in the sixth section.

Foundations of interest-free monetary policy and review of recent literature

Interest-free lending, often called *qarḍ al-ḥasan* (QH), originates from the divine revelations of the Qurʾān and the traditions of Prophet Muhammad (peace be upon him). IFMP or QH, when used by the CB to increase or decrease the money supply, tend to have zero financing costs, thus shifting the aggregate demand curve of the economy to the right and increasing both real GDP and employment. Interest-free lending and borrowing, or QH, was practised during the time of Prophet Muhammad (peace be upon him) and he himself practised it. Abu Rafi' (may Allah be pleased with him) narrated that the Prophet (peace be upon him) had borrowed a young female camel from someone and when he received *zakāh* (almsgiving) of camels, he ordered him to send a young female camel to the man as settlement of the loan. He said to him, "I could not find among the camels except a female camel which is ready for pregnancy." The Prophet (peace be upon him) said, "Give it to him, indeed, the good person amongst you is he who settles loan with something better" (Al-Muslim, *ḥadīth* no. 1224/3). Isma'il bin Abi Rabi'ah Al-Makhzumi (may Allah be pleased with him) narrated from his father, from his grandfather, that the Prophet (peace be upon him), borrowed 30 or 40 thousand from him when he fought at Hunain. When he came back he paid the loan. Then the Prophet (peace be upon him) said to him: "May Allah, may He be exalted, bless your family and your wealth. The reward for lending is repayment and words of paradise." Both of the above traditions have clearly established the foundation for interest-free loans as a mode of borrowing and lending with immense rewards.

Allah, may He be exalted, promised bountiful rewards for QH in the following verses in the Qurʾān: "Who is it that would loan Allah a goodly loan so He may multiply it for him many times over? And it is Allah who withholds and grants abundance, and to Him you will be returned," (Qurʾān, 2:245).

Allah, may He be exalted, promised noble rewards for both men and women for engaging in QH as He said, "Indeed, the men who practise charity and the women who practise charity and (they who) have loaned Allah a goodly loan-it will be multiplied for them, and they will have a noble reward," (Qurʾān, 57:18). Allah, may He be exalted, also promised immense rewards for QH along with other good deeds in the following verse: "Establish the *salat* and pay the *zakāh*, and give to Allah a goodly loan. Whatever good you may send forward for yourselves, you shall find it with Allah. That is best and richest in reward. Seek forgiveness from Allah, indeed Allah is All-Forgiving, All-Merciful" (Qurʾān, 73:20).

Therefore, QH, or interest-free lending, has its roots and origin in the traditions of Prophet Muhammad (peace be upon him), and in the divine revelations in the Qurʾān. Its practical application will not only maximise the economic benefits and well-being in this world but will also bring great success in the hereafter.

Literature review

Zero and negative IBMP has created lots of interest in recent years. To revitalise the economy and for fighting deflation, often policymakers pursue zero IBMP. Jung *et al.* (2005) emphasised that zero-interest rate monetary policy should be pursued as long as the economy faces the prospect of weak aggregate demand, while Bernanke and Reinhart (2004) suggested that CBs should pursue zero-interest rate monetary policy to fight deflation.

Krugman *et al.* (1998) argue that zero IBMP will lead to a liquidity trap where monetary policy will lose its grip. Svensson (2000) suggests that the optimal way to escape the liquidity trap and deflation is for CBs to commit to a higher future price level and have an exit strategy from a zero-interest rate monetary policy. Adam and Billi (2004) attempt to determine the optimal monetary policy in the New Keynesian model when the nominal interest rate is zero.

Eggertsson and Woodford (2003) argue that in the presence of a zero-interest rate monetary policy, the optimum policy requires a commitment to adjust interest rates to achieve a time-varying price-level target. Oda and Ueda (2007) find evidence that the zero-interest rate commitment of the Bank of Japan lowered overall interest rates.

Some countries such as Japan, Switzerland, Denmark and Sweden went further and pursued negative IBMP. Rogoff (2017) suggests that certain institutional changes must be made for accommodating negative IBMP and policy makers need to find ways and strategies for pursuing negative interest policy as normal monetary policy. McNelis and Naoyuki (2016) estimated a dynamic stochastic general equilibrium model and found that zero or negative interest-based non-traditional monetary policy, often called quantitative easing, outperformed optimally derived simple tax rate rules or Taylor rules in Japanese economy during the past two decades, 1990-2010 in minimising the costs of crisis.

Chapra (1996) argues that newly created money by the CB can be used to finance budget deficits as QH or interest-free loans. Arrif (1996) suggests that commercial banks should lend a certain percentage of demand deposits as interest-free loans. Fahmy (2006) and Al-Jarhi (1981) argue that CBs can use "deposit certificates" for open market operations and thus can increase or decrease the supply of money.

The remaining literature is related to other forms of Islamic or *Sharīʿah*-compliant MP. Awad (2015) surveys almost all the literature related to Islamic or *Sharīʿah*-compliant MP and discusses the application of such tools of MP by the Central Bank of Sudan. Selim (2013) argues that MP based on *muḍārabah* is more effective than IBMP. Selim (2015) further demonstrates that MP based on *ṣukūk* works better when *ṣukūk* are bought and sold in the open market by the CB. Islamic MP involving buying and selling of securities was initially emphasised by Chapra (1982) and Siddiqi (1982). In addition, Kahf (1982) argued that MP based on variable rates of return on securities can be used as tools of MP. However, if the securities yield variable rates of return, it is neither a necessary nor a sufficient condition for Islamic MP unless those securities are *Sharīʿah*-compliant assets. Ismal (2011) argues that asset-backed securities such as *wakālah wa ijārah* (agency and leasing) certificates and *wakālah wa ijārah muntahia bitamlik* (agency and leasing-sale) certificates can be used as tools of MP and such certificates can be bought and sold in the open market for increasing or decreasing the supply of money.

Khan and Mirakhor (1989) attempts to analyse *Sharīʿah*-compliant MP by using the IS-LM (investment-savings, liquidity-money) model, but it is based on interest rate, and as such, it cannot be applied as long as interest rate is embedded into it.

Farahani and Dastan (2013) argue that the financing activities of Islamic banks positively and directly contribute to the expansion of real sectors of the economy. Ben Jedidia and Hamza (2014), and Kayed (2012) argue that most Islamic banks usually lend on the basis of low risk *murābaḥah* and often avoid medium to high risk *mushārakah* and *muḍārabah*-based economic activities.

Khatat (2016) finds certain problems, heterogeneity and complexities in applying MP in both Islamic and conventional systems. However, the application of IFMP will be welcomed in both systems because IFMP will maximise economic benefits and well-being for all.

A clear comparison between IFMP and IBMP and their impacts on inflation and unemployment rates are indeed useful to the policymakers. However, to the best of our knowledge, such comparative empirical work on IFMP and IBMP and their impacts on economic performance in very recent time, is missing and, therefore, the current study attempts to bridge this gap.

The model

Theoretically, IFMP should reduce the misery index (*MI*). In other words, IFMP is expected to reduce both the inflation rate and the unemployment rate, and, therefore, *MI* should be lower in the countries where IFMP is pursued compared to IBMP. But what are the theoretical foundations? Especially, what are the fundamental economic theories that may support such assertions? To answer the above questions, let us first postulate the investment spending function (*I*) as follows:

$$I = Io - \mu r + \beta QH + \gamma Y; \qquad \mu < 0; \qquad \beta > 0; \quad \gamma > 0 \tag{1}$$

If the rate of interest (r) falls, I will increase, and vice versa. If $r = 0$, I will reach its maximum level. If interest-free lending, such as QH, increases in the economy, I will increase at the following rate:

$$\frac{\partial I}{\partial QH} = \beta > 0 \tag{2}$$

Equation (2) shows that interest-free QH-based lending will have a positive impact on investment spending (*I*). As IFMP is very similar to QH, IFMP will also have a positive impact on *I*. Substituting QH for IFMP and using *ifm* as a shorter notation for IFMP in equation (2) yields:

$$\frac{\partial I}{\partial ifm} = \beta > 0 \tag{3}$$

$$or, \quad \partial I = \beta(\partial ifm) \tag{4}$$

Equation (4) demonstrates that an increase in money supply (MS) in IFMP will increase I by β times the change in MS, where $\beta > 0$. Now as I increases, the aggregate expenditure function (*aef*) will shift up and equilibrium income Y will increase. The increase in Y will further increase I through the multiplier-accelerator process. From equation (1), the increase in Y will increase I positively as shown below:

$$\frac{\partial I}{\partial Y} = \gamma > 0 \tag{5}$$

$$or, \quad \partial I = \gamma(\partial Y) \tag{6}$$

Equation (6) clearly indicates that an increase in Y resulting from IFMP will further increase I by γ times the change in Y, where $\gamma > 0$.

IFMP, or QH-based MP, will also have a positive impact on consumption expenditures (*C*), as well as on government expenditures (*G*). Now the impact of IFMP, or QH-based MP, on *C* and *G* will be examined, and the IFMP model will be developed in subsequent sections.

Interest-free monetary policy and its impact on the consumption function, C

Consumption expenditure, *C*, depends positively on disposable income, *Yd*, where $Yd = Y - T$ and $T = To + tY$, and negatively on interest rate. Now, if financing is based on QH rather than on interest rate, then the relationship between *C* and QH will be positive because as

QH-based loans increase, C will also increase, and vice versa. For example, if a household can buy a home, car, or appliances on QH or interest-free basis, C will increase because households will buy more, and more households will use QH-based consumption loans on housing as well as on other durable and non-durable consumption goods. This relationship can be postulated as follows:

$$C = Ca + bYd - \theta r; \qquad Yd = Y - T; \qquad T = To + tY \tag{7}$$

where $\theta < 0; b > 0$

Replacing interest rate, r, by IFMP (*ifm*) in equation (7), yields:

$$C = Ca + b[Y - (To + tY)] + \omega ifm \tag{8}$$

where $\omega > 0$

As *ifm* lending increases, consumption will increase and vice versa. The effects of interest-free MP on C can be explained as follows:

$$\frac{\partial C}{\partial ifm} = \theta > 0 \tag{9}$$

The change in C can be calculated as:

$$\partial C = \theta(\partial ifm) \tag{10}$$

In equations (9) and (10), the impact of *ifm* on C is positive, which indicates that increasing *ifm* will increase C. This increase in C will increase aggregate expenditure. The *aef* line will shift up and equilibrium real GDP and employment will increase. The unemployment rate and *MI* will fall, and economic performance will improve.

Now, the government spending function in IFMP can be defined as:

$$G = Go + \epsilon ifm \tag{11}$$

where $\epsilon > 0$

Government spending, G, will increase if the government can borrow funds at zero-interest rate and public investment spending in the economy will increase compared to public borrowing at relatively higher interest rates. Government borrowing for financing budget deficits at positive interest rates will result in the crowding out effect because budget deficits will lead to a reduction in public savings. As a result, the supply of loanable funds curve will shift leftward, the interest rate will increase, and the equilibrium quantity of loanable funds will decrease. Private investment spending will fall and thus an increase in public investment will crowd out private investment spending. The effect of IFMP on G is positive as shown below:

$$\frac{\partial G}{\partial ifm} = \epsilon > 0 \tag{12}$$

The change in G can be found as:

$$\partial G = \epsilon(\partial ifm) \tag{13}$$

In both equations (12) and (13), *ifm* will cause an increase in G. The increase in G will increase the aggregate expenditures and the *aef* line will shift up. Equilibrium real GDP will

increase, and the unemployment rate will fall further. *MI* will fall, and economic performance will improve.

Interest-free monetary policy and the aggregate expenditure function

The aggregate expenditure function, *aef*, can be written as:

$$aef = C + Ig + G + Xn \tag{14}$$

Substituting the values from the above equations for *C*, *I*, *G* and assuming exports ($X = Xo$) and imports ($M = Mo$) are autonomous, the *aef* can be written as follows:

$$\begin{aligned} aef &= \{Ca + b[Y - (To + tY)] + \omega ifm\} + \{\mathrm{Io} - \mu r + \beta ifm + \gamma Y\} \\ &\quad + \{Go + \epsilon ifm\} + (Xo - Mo) \\ or,\quad aef &= [Ca - bTo + Io - \mu r + Go + (Xo - Mo)] + [bY - btY + \gamma Y] \\ &\quad + [\omega ifm + \beta ifm + \epsilon ifm] \\ aef &= Ao + [b(1-t) + \gamma]Y + [\omega + \beta + \epsilon]ifm \end{aligned} \tag{15}$$

Where $Ao = [Ca - bTo + Io - \mu r + Go + (Xo - Mo)]$

In equation (15), Ao = autonomous expenditures. In IFMP, $r = 0$. Therefore, $\mu r = 0$ and the *aef* line will shift up because Ao will increase. The upward shift in the *aef* line will increase aggregate expenditure, and equilibrium income, Y and employment, E will increase, and the unemployment rate will fall. The fall in the unemployment rate will reduce *MI* and economic performance will improve.

Interest-free monetary policy and macroeconomic equilibrium

In equilibrium, aggregate output (Y) equals aggregate expenditures (*aef*) and accordingly from equation (15), the macroeconomic equilibrium condition can be written as follows:

$$\begin{aligned} Y &= aef \\ or,\quad Y &= Ao + [b(1-t) + \gamma]Y + [\omega + \beta + \epsilon\ ]ifm \\ or,\quad Y - [b(1-t) + \gamma]Y &= Ao + [\omega + \beta + \epsilon\ ]ifm \\ or, Y &= \frac{1}{1 - [b(1-t) + \gamma]}\{Ao + [\omega + \beta + \epsilon\ ]ifm\} \\ or,\qquad Y &= \sigma Ao + \sigma(\omega + \beta + \epsilon)ifm \end{aligned} \tag{16}$$

where

$$\sigma = \frac{1}{1 - [b(1-t) + \gamma]}$$

In equation (16), σ is the multiplier and, therefore, a positive number. If interest-free lending increases through IFMP, its effect on Y can be calculated as follows:

$$\frac{\partial Y}{\partial ifm} = \sigma(\omega + \beta + \epsilon) \tag{17}$$

Equation (17) indicates that as *ifm* increases through IFMP, equilibrium income will continue to grow because $\sigma(\omega + \beta + \epsilon) > 0$.

In addition, total increase in equilibrium income can be calculated as follows:

$$\partial Y = \sigma(\omega + \beta + \epsilon)\partial ifm \tag{18}$$

Equation (18) indicates that equilibrium income Y will increase, and as a result, the unemployment rate will fall, *MI* will decrease, and the overall performance of the economy will improve.

Theoretical foundation of interest-free monetary policy and its impact on reducing both inflation and unemployment rates

In competitive markets, price (*P*) equals marginal cost (*MC*):

$$P = MC \tag{19}$$

In imperfect markets, price also depends mostly on cost of production, and therefore, price is a function of cost (*C*):

$$P = f(C) \tag{20}$$

Therefore, in both perfect and imperfect competition, cost of production plays a vital role in the determination of market price, and other things remaining the same, the higher the cost of production, the higher will be the price and vice versa.

Interest cost is an important component of the cost of goods sold in income statements. In IFMP, the cost of borrowing will decrease across the different sectors of the entire economy and the interest cost component will decrease. As interest cost decreases, the price level will also decrease and vice versa. As overall price level falls in IFMP, the inflation rate will fall.

In addition, in IFMP, the firms will be able to afford more capital goods and investment spending in the economy will increase. As investment spending increases, aggregate expenditures in the economy will increase and equilibrium income and employment will increase and as a result unemployment rate (*UR*) will fall. Therefore, in IFMP, there will be simultaneous decrease in both inflation and unemployment rates and consequently the discomfort index or misery index will fall, and the Phillips curve will shift towards the origin. From the above relationship between IFMP and *MI*, we can postulate the following Theorem 1 as follows:

Theorem 1: ***Effects of IFMP on Inflation Rate*****:**

In IFMP, marginal cost is less compared to the marginal cost in IBMP, i.e., *(MCifmp) < (MCibmp) because of relatively low financing cost across the economy under IFMP*:

$$\begin{aligned} &Since\ MCibmp(MC\ in\ interest\ based\ MP) \rightarrow Pifmp < Pibmp \\ &\rightarrow Inflation\ rate\ in\ IFMP\ \left(\dot{P}ifmp\right) < \dot{P}ibmp, \\ &where\ \ \dot{P}ibmp = Inflation\ rate\ in\ interest\ based\ MP\ and\ \dot{P}ifmp \\ &= Inflation\ rate\ in\ IFMP, \\ &Pifmp = Price\ level\ in\ IFMP\ \&\ Pibmp = Price\ level\ in\ IBMP. \end{aligned}$$

Similarly, in IFMP, the overall financing cost across the economy will decrease and as a result, investment spending (*I*) will increase, aggregate expenditure line (*aef*) will shift up, equilibrium income (*Y**) and employment (*E**) will increase and unemployment rate (*UR*) will fall. Such interrelated scenario can be postulated in theorem 2 as follows:

Theorem 2: Effects of IFMP on unemployment rate:

$$\begin{aligned}
&As\ overall\ financing\ cost\ across\ the\ economy \downarrow in\ IFMP \rightarrow I \uparrow \rightarrow AE \gg up\\
&\rightarrow Y^* \uparrow . As\ Y^* \uparrow \rightarrow Y \rightarrow Yf\ or\ Yp\ where\ Yf = Yp\\
&= Full\ employment\ or\ potential\ real\ GDP\ or\ equilibrium\ income. At\ Yf = Yp,\\
&\rightarrow UR \downarrow \&\ UR = NRU, since\ CU = 0, where\ NRU\\
&= Natural\ rate\ of\ unemployment;\ CU = Cyclical\ UR.
\end{aligned}$$

The above Theorem 1 and Theorem 2 have clearly established that under IFMP, both inflation and unemployment rates will be lower compared to IBMP. Such theoretical assertion will be re-examined by empirical tests in the sections that follow.

Rightward shift in the aggregate supply curve

IFMP will lower the cost of borrowing across the economy. As a result, the net cost of capital inputs will fall and the aggregate supply (AS) curve will shift to the right. A rightward shift in the AS curve will cause an increase in real GDP and a decrease in the aggregate price level. An increase in real GDP will cause an increase in employment and a decrease in the unemployment rate. As the unemployment rate falls, *MI* will also fall, and macroeconomic performance will improve. In addition, the fall in price level will cause a decline in the inflation rate. As the inflation rate falls, the economy becomes more competitive and *MI* decreases. Therefore, a simultaneous decrease in both unemployment and inflation rates will substantially reduce *MI*, and such ideal and competitiveness will lead to steady state economic growth with full employment and price stability – a combination that can hardly be achieved in an IBMP regime. Therefore, IFMP not only guarantees full employment but also price stability. In other words, IFMP lowers *MI* and thus shifts the Phillips curve to the left, towards the origin, and makes the economy more competitive than ever.

The next section presents evidence of low *MI* in countries where IFMP was pursued compared to those countries where positive IBMP was followed.

Evidence from 23 developed capitalist countries on mean differences in misery index between interest-based monetary policy (Group X) and interest-free monetary policy (Group Y) countries

As presented in Table I, Group Y pursued IFMP for a period of more than one year. Some countries in Group Y, mainly from the Eurozone, followed a zero bank rate or zero CB interest rate while other OECD countries such as Japan, Switzerland, Sweden and Denmark followed negative CB interest rates. The *MI* index for the 12 countries in Group Y is 5.63, while the 11 countries in Group X have an *MI* of 9.11. Group X pursued positive IBMP and experienced both higher inflation and higher unemployment rates. This raises the question of whether the differences in *MI* between Group X and Group Y countries are statistically significant. If the differences are not statistically significant then it can be concluded that such differences are minimal and immaterial and IFMP

Table I.
Negative and zero bank rates, IFMP and IBMP and their relative effectiveness on inflation rate ($\dot{P}$) and unemployment rate (UR) and their combined effects on MI or economic performance where MI is calculated as inflation rate plus unemployment rate

Group X: 11 Countries with positive CB interest rates

	CB interest rates	UR	$\dot{P}$	$MI = UR + \dot{P}$
USA	1.00	4.8	0.1	4.9
UK	0.25	4.8	0.1	4.9
Canada	0.50	6.8	1.1	7.9
Norway	0.50	4.8	2.2	7.0
Australia	1.50	5.7	1.5	7.2
New Zealand	1.75	5.1	0.2	5.3
USA Virgin Islands	1.00	12.3	2.2	14.5
South Korea	1.25	4.9	0.7	5.6
Guam	1.00	8.2	4.0	12.2
The Bahamas	4.50	16.2	1.0	17.2
Barbados	3.00	11.4	2.1 13.5	
Average	1.48	7.73	1.38	9.11

Group Y: 12 Countries with zero or negative CB interest rates

	CB interest rates	UR	$\dot{P}$	$MI = UR + \dot{P}$
Japan	−0.10	3.0	0.8	3.8
Switzerland	−0.75	3.6	−1.1	2.5
Sweden	−0.50	6.1	0.0	6.1
Denmark	−0.65	4.2	0.5	4.7
Germany	0.00	3.8	0.2	4.0
The Netherlands	0.00	5.7	0.6	6.3
Luxemburg	0.00	6.1	0.5	6.6
Austria	0.00	5.7	0.9	6.6
Belgium	0.00	8.0	0.6	8.6
Estonia	0.00	6.3	−0.5	5.8
Ireland	0.00	6.6	−0.3	6.3
Malta	0.00	5.2	1.1	6.3
Average	−0.17	5.36	0.275	5.63

Sources: Global Interest Rate Monitor (GIRM), (2017); Central banks (2017), Federal Funds Rate (2017); UK consumer price inflation (2017); Also, please see list of countries by Central bank interest rates from Wikipedia, list of countries by inflation rates from Wikipedia, and list of countries by unemployment rates from Wikipedia; https://en.wikipedia.org/wiki/List_of_countries_by_central_bank_interestrates, https://en.wikipedia.org/wiki/List_of_countries_by_inflation_rate, https://en.wikipedia.org/wiki/List_of_countries_by_unemployment_rate (accessed 13 July 2017)

and IBMP yield basically similar results. However, if it is found that the differences are statistically significant, then it can be concluded that the lower MI in Group y countries are the obvious outcome of IFMP because MP is designed to control both inflation and unemployment rates, and only IFMP delivers both low inflation and low unemployment rates compared to IBMP. The data on MI, inflation rates and unemployment rates for Groups X and Y countries are presented in Table I.

Statistical test of mean differences between Group X and Group Y

It is evident from Table I that the MI is higher in Group X compared to Group Y countries where IFMP has been pursued. Now it is important to test whether the differences in MI between the groups are statistically significant at the 5 per cent level. If it is found that the differences in MI are statistically significant at the 5 per cent level, then it can be concluded that Group Y, where IFMP has been pursued for more than a

year, yields relatively lower *MI* and thus performs better compared to Group X, where IBMP has been pursued.

For testing mean differences in *MI*, the null and alternative hypotheses are postulated. The null hypothesis can be stated as follows:

$$Ho: \quad \mu_x - \mu_y = 0 \qquad or, \quad \mu_x = \mu_y \tag{21}$$

The alternative hypothesis can be stated as:

$$H1: \quad \mu_x - \mu_y \neq 0 \qquad or, \quad \mu_x \neq \mu_y \tag{22}$$

The null hypothesis in equation (21) states that there is no significant difference in the misery index (*MI*) between Group X, where IBMP is followed, and in Group Y, where IFMP is followed. The alternative hypothesis in equation (22) indicates that the mean *MI* of Group X differs significantly from that of Group Y.

In this statistical test procedure, the significance level is set at α = 5 per cent. The degrees of freedom (d.f) are determined by the following standard formula:

$$d.f = \frac{\left(\frac{s_x^2}{n} + \frac{s_y^2}{m}\right)^2}{\frac{\left(\frac{s_x^2}{n}\right)^2}{n-1} + \frac{\left(\frac{s_y^2}{m}\right)^2}{m-1}} \tag{23}$$

From Table II, $s_x^2 = 19.52;\ n = 11;\ \ s_y^2 = 2.633;\ m = 12$ (24)

Standard deviation, $s = \sqrt{s_x^2}$, and sample variances, s_x^2, s_y^2 were calculated as follows: $s_x^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2$ and $s_y^2 = \frac{1}{n-1}\sum_{i=1}^{n}(y_i - \bar{y})^2$

Substituting the above values from equation (24) into equation (23) yields:

$$d.f = \frac{\left(\frac{19.52}{11} + \frac{2.633}{12}\right)^2}{\frac{\left(\frac{19.52}{11}\right)^2}{10} + \frac{\left(\frac{2.633}{12}\right)^2}{11}} \tag{25}$$

$$or, \qquad d.f = \frac{(1.7745 + 0.2194)^2}{\frac{\left(\frac{19.52}{11}\right)^2}{10} + \frac{\left(\frac{2.633}{12}\right)^2}{11}} \tag{26}$$

$$or, \qquad d.f = \frac{3.9756}{0.3149 + 0.0044} = \frac{3.9756}{0.3193} = 12.45 \sim 12 \tag{27}$$

Now the t-statistic will be applied as follows:

Group X:	CB interest rates (Positive bank rate)	$x_i = MI = UR + \dot{P}$	$\sum (x_i - \bar{x})^2$
USA	1.00	4.9	17.72
UK	0.25	4.9	17.72
Canada	0.50	7.9	1.46
Norway	0.50	7.0	4.45
Australia	1.50	7.2	3.65
New Zealand	1.75	5.3	14.52
U.S. Virgin Islands	1.00	14.5	29.05
South Korea	1.25	5.6	12.32
Guam	1.00	12.2	9.55
The Bahamas	4.50	17.2	65.45
Barbados	3.00	13.5	19.27
Average	1.48	$\bar{x} = 9.11$	*Total 195.16*
Group Y:	CB interest rates (Zero or negative)	$y_i = MI = UR + \dot{P}$	$\sum (y_i - \bar{y})^2$
Japan	−0.10	3.8	3.3489
Switzerland	−0.75	2.5	9.7969
Sweden	−0.50	6.1	0.2209
Denmark	−0.65	4.7	0.8649
Germany	0.00	4.0	2.6569
The Netherlands	0.00	6.3	0.4489
Luxemburg	0.00	6.6	0.9409
Austria	0.00	6.6	0.9409
Belgium	0.00	8.6	8.8209
Estonia	0.00	5.8	0.0289
Ireland	0.00	6.3	0.4489
Malta	0.00	6.3	0.4489
Average	0.17	$\bar{y} = 5.63$	*Total 28.9668*

Sources: Global Interest Rate Monitor (GIRM), (2017); Central banks (2017), Federal Funds Rate (2017); UK consumer price inflation (2017); Also, please see list of countries by Central bank interest rates from Wikipedia, list of countries by inflation rates from Wikipedia, and list of countries by unemployment rates from Wikipedia; https://en.wikipedia.org/wiki/List_of_countries_by_central_bank_interestrates, https://en.wikipedia.org/wiki/List_of_countries_by_inflation_rate, https://en.wikipedia.org/wiki/List_of_countries_by_unemployment_rate (accessed 13 July 2017)

Table II. Statistical test of mean differences in *MI* in Group X and Group Y countries where $\dot{P}$ is inflation rate, *UR* is unemployment rate and *MI* or economic performance is calculated as: $MI = UR + \dot{P}$

$$t = \frac{(\bar{x} - \bar{y}) - (\mu_x - \mu_y)}{\sqrt{\frac{s_x^2}{n} + \frac{s_y^2}{m}}} \tag{28}$$

$$or, \qquad t = \frac{(9.11 - 5.63) - 0}{\sqrt{\frac{19.52}{11} + \frac{2.633}{12}}} \tag{29}$$

$$or, \qquad t = \frac{3.48}{\sqrt{1.7745 + 0.2194}} = 2.4645 \tag{30}$$

From the t-table, the t-tabulated value at $\alpha = 5$ per cent with 12 degrees of freedom is 2.179. The t-calculated value from equation (30) is 2.4645. As the t-calculated value (2.4645) is

greater than the t-tabulated value (2.179), the null hypothesis is rejected, and it can be concluded that there is significant difference in mean *MI* between Group X and Group Y. Therefore, *MI* is lower in the 12 Group Y countries compared to the 11 countries in Group X, and it is statistically significant at the 5 per cent level of significance. Thus, it can be concluded that the economic performance in Group Y, where IFMP has been pursued, is better than that of Group X, where IBMP has been adopted.

Conclusion

This study examines the effects of IFMP and IBMP on the economic performance of 23 developed capitalist countries. The total sample of 23 countries was divided into 2 groups. In Group X, 11 developed capitalist countries pursued IBMP, while in Group Y, 12 developed capitalist countries followed IFMP. Misery index (*MI*) is used as a measure of economic performance and for testing the relative economic performance of Groups X and Y by using *t*-test at the 5 per cent level of significance.

The test results reveal that Group Y, where IFMP has been followed, has relatively lower inflation and unemployment rates than Group X. Therefore, Group Y has a lower *MI* and performs better than Group X, which has been pursuing IBMP. Both groups consist of developed capitalist countries with similar levels of development, sophistication and per capita income.

On the basis of the current findings, it can be concluded that the arguments of Krugman *et al.* (1998) that zero IBMP will lead to a liquidity trap, and monetary policy will lose its grip, are not valid as it has been found that IFMP is indeed, relatively more effective compared to IBMP and thus real-world empirical results contradict their assertion. In addition, Svensson (2000) is also wrong when he suggests that "the optimal way to escape the liquidity trap and deflation is for CBs to commit to a higher future price level and to have an exit strategy from a zero-interest rate regime". The test results reveal that Group Y performed better with relatively lower *MI* and did not need any exit strategy from IFMP. In addition, these countries have pursued IFMP for more than a year and are doing much better than those countries which have pursued IBMP.

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