JOURNAL OF EASTERN EUROPEAN AND CENTRAL ASIAN RESEARCH
Vol.11 No.2 (2024)

PSYCHOLOGICAL INFLATION: DEFINITION AND MEASUREMENT

Thi Thanh Xuan Pham
University of Economics and Law at Vietnam National University, Ho Chi Minh City, Vietnam

Thi Canh Nguyen
University of Economics and Law at Vietnam National University, Ho Chi Minh City, Vietnam

Huu Tin Ho
University of Economics and Law, Vietnam National University, Ho Chi Minh City, Vietnam

ABSTRACT

Conventional monetary policy tools became less effective, with nominal short-term interest rates approaching the zero-lower bound during COVID-19. Instead, central banks adopted a range of unconventional monetary policies. Thus, perceived inflation has become a key channel for monetary policy transmission. Despite how vital perceived inflation is, quantifying perceived inflation with accuracy remains questionable and challenging. As a result, we focus on developing a novel measurement of perceived inflation - the psychological inflation index. Our approach is based on psychological theories and considers loss aversion, which creates advancements to previous versions. The new index satisfies many expected criteria: (i) it broadly co-moves with the headline inflation index during everyday contexts; (ii) it captures abnormal price evolution better than headline inflation during crisis periods; (iii) it links tightly with monetary policy and economic dynamics. Psychological inflation, therefore, might be helpful in forecasting headline inflation, estimating real interest rates, predicting economic players' behavior, and setting salaries and prices. Psychological inflation, combined with headline inflation, provides a clearer picture of the credibility of monetary policy.

Keywords: psychological inflation index; perceived inflation; loss aversion; relative price changes; purchasing frequencies

DOI: https://doi.org/10.15549/jeecar.v11i2.1611

INTRODUCTION

During the COVID-19 pandemic, nominal interest rates were set at unprecedentedly low levels in many countries to stimulate the economy. This zero-bound interest rate policy further diminished Central Banks' scope to boost economic activities by cutting interest rates. Therefore, many central banks sought, and are now seeking, unconventional monetary tools for a new monetary era, i.e., CRIX (Trimborn & Härdle, 2018), UCRY (Lucey et al., 2021), ICEA (Wang et al., 2022b), CBDC (Wang et al., 2022a), or are turning their focus on the perceived inflation index in conducting monetary policy (O.

Coibion et al., 2019; O. Coibion, Gorodnichenko, & Ropele, 2020; O. Coibion, Gorodnichenko, Kumar, et al., 2020).

In the economy, perceived inflation plays many essential roles. It is closely related to the nominal interest rate and the headline inflation and, therefore, is used to evaluate the real interest rate, an essential variable for the central banks to observe the real economy and adjust their monetary policy appropriately (Pfajfar & Žakelj, 2018). It is also an essential input into the wage-setting process. Abildgren and Kuchler (2021) state that perceived inflation significantly influences prices and saving activities throughout the economy. Furthermore, perceived inflation is used to assess the central bank's credibility (Nautz et al., 2017; Buono & Formai, 2018; Abildgren & Kuchler, 2021; Güler, 2021). Lyziak (2010) emphasized how perceived inflation is established and substantially impacts central bank monetary transmission mechanisms. In addition, the role of perceived inflation is stressed by policymakers in the context that headline inflation has been heavily criticized as introducing significant biases, as was noted by Cavallo (2020) and Diewert and Fox (2020).

Despite how vital perceived inflation is, quantifying it with accuracy remains questionable and challenging. Existing literature shows an increasing number of measures of inflation perceptions from various sources, but all have limitations (Sousa & Yetman, 2016). Furthermore, despite the vast existence of measurements, only a few have been developed and have anchored their methodologies in theoretical underpinnings (Brachinger, 2008; Dräger et al., 2014; Hałka & Łyziak, 2015; Vogel et al., 2009). This fact is considered a significant and under-explored research gap in existing literature. Meanwhile, various theories offer possible explanations for the mechanisms behind the formation of inflation perceptions, spanning from extensions of the rational perception model to behavioral economics theories (Wärneryd, 1986; Brachinger, 2008; Gnan et al., 2010; Ranyard et al., 2017).

That is why we conducted this study to develop a novel measurement of perceived inflation, the psychological inflation index, in line with the psychological mechanism that underlies the formulation of consumers' rationality of price changes. We acknowledge Brachinger's (2008) methodology and develop novel features, including purchasing frequency and loss aversion in decreasing price. These components create advancements for our psychological inflation measurement compared to the previous version.

Our study is the first analysis of psychological inflation survey data on individual consumers across Vietnam. We are also the first to use the time-series dimension of Vietnam consumer price indexes to explore the link between psychological inflation with headline inflation, monetary, and output shock - which has not previously been examined in the literature. Measuring psychological inflation satisfies many expected criteria, showing its potential usefulness. Moreover, our analysis confirms the importance of the loss aversion effect in psychological inflation in decreasing price cases, which has been ignored in the existing literature. However, this novel psychological measurement of inflation is empirically checked only in Vietnam, suggesting that much work is needed through other economies for a more insightful look into this psychological inflation measurement.

The remainder of this paper is organized as follows. Section 2 offers the theoretical backgrounds and measurement of psychological inflation in mathematical language. Section 3 describes our dataset, which we used to estimate Vietnam's psychological inflation. Section 4 presents the measured psychological inflation in the Vietnamese economy. Checking for expected features of psychological inflation and the linkage from psychological inflation to headline inflation, monetary, and output shocks are also presented in detail in Section 4. Finally, section 5 concludes on the potential usability of psychological inflation for economic policy and offers some thoughts on further research.

LITERATURE REVIEW

Existing measurements of perceived inflation

Being aware of its macroeconomic importance, central banks (policymakers) and researchers (academia) closely track the perceived (and/or expected) inflation of various groups of economic agents. However, measuring agents' inflation perceptions must be considered a top priority. Until now, two main strands of inflation perception measurements use either financial market data or direct measures from surveys

(e.g., surveys of professionals as economists and market participants and surveys of firms and households). The two main strands of measures, nonetheless, have advantages and drawbacks. It is, therefore, crucial for the central bank to use a variety of measures that complement one another. For example, while using historical data to forecast inflation may not adapt to new economic events, inflation surveys do not incentivize thoughtful and truthful responses. They then suffer from a cheap-talk problem due to the absence of direct financial consequences (Armantier et al., 2013).

Based on surveys, a wide range of techniques exist in parallel and complement each other because each has its own merits and drawbacks, but they could be categorized into three main groups as follows.

First, in terms of qualitative techniques, balance statistics proposed by Anderson (1952) is frequently used to summarize survey responses that concern observed price changes. Even though it should not be interpreted as direct proxies of perceived price dynamics because the lack of numerical perception that policymakers need in determining inflation targets (Halka & Lyziak, 2015), changes in the balance statistic mirror changes in perceived inflation (Fritsche et al., 2009). For instance, a positive result of balance statistics reflects that a respondent perceives "prices have risen," whereas the opposite is valid for a negative result. However, it does not show how many percent of people perceive that the price has increased (or decreased).

Second, different quantified methods have been developed due to interpretation constraints in balance statistics. Probability, regression, and logistic function methods are the most popular. Nevertheless, these methods may lead to biased measures, or they may not be well suited to work with survey questions, resulting in a loss of information (Maag, 2009; Lyziak,2010). Though quantified measures are better than balanced statistics in providing numerical results, the reliability of quantitative survey data is mixed. Jonung (1986) claimed that uncertainty considerably increases when numerical estimates about the inflation perception are asked. Meanwhile, Pesaran & Weale (2006) indicated that obtaining reliable responses to qualitative questions is easier. On the other hand, Lindén (2004) and Poncert (2004) suggested that quantitative and qualitative data in euro area countries are similar even though the latter has a long time series.

In summary, balance statistics and quantified measures are not built upon the use of heuristics by consumers or any consumers' theoretical foundations, which creates a gap between the inflation perceptions of consumers and the inflation rates from official statistics. This strand of literature has motivated economists and researchers to propose alternative inflation indexes to assist monetary authorities in minimizing misleading signals about current and future trends in inflation. They may include the inflation perception index (IPI), frequently purchased out-of-pocket inflation index (FROOP), consumer-perceived inflation index (CPPI), and subjective inflation index (Brachinger, H, 2008; Eurostat, 2009; Halka & Lyziak, 2015; Stanislawska, 2019). These indexes are constructed based on a framework of consumer behavior theories (e.g., prospect theory, Weber-Fechner psychological law, and availability heuristic theory).

Further, these indexes have only been investigated in developed countries such as the U.S. or euro areas, leaving a research gap in developing countries like Vietnam. Hence, they are the best and most modern indexes and are considered the development direction of this research to build a new index, psychological inflation. The new index is expected to satisfy two basic standards of a proper monetary policy tool. First, it could predict headline inflation or could be used as an alternative to headline inflation. Second, it relates to other macroeconomic variables (Brachinger, H, 2006, 2008; Bhat et al., 2022).

Theoretical background of our psychological inflation

We define perceived inflation as psychological inflation based on consumers' rationality of relative price changes. In particular, the psychological mechanism that underlies the formulation of consumers' rationality of price changes consists of the mutual interaction of two critical factors: ***the judgments of price changes*** and ***the experience of price changes***. First, judgments of price changes form following the Prospect theory in which (i) an increased price is perceived as a loss and a decreased price as a gain, and (ii) consumers usually perceive

losses more strongly than gains. Second, the experience of price changes is closely related to ***purchasing frequency***, meaning that individuals perceive a more critical price change with more frequently bought goods and services. Therefore, relative price changes, purchasing frequency, and loss aversion are the three components of our psychological inflation. The following sub-section describes the above definition of psychological inflation from a theoretical background.

The theoretical background underlies our psychological inflation formulation, including the following.

First, according to ***Weber-Fechner's Psychophysical law*** (Weber, 1834; Fechner, 1860), inflation perception depends only on ***relative price changes***, not on the initial price level, even independent of the price level. Therefore, our psychological inflation is interpreted as the change in perception induced by a sum of relative price changes as $\sum_{i=1}^{n}\left(\frac{p_{t(i)}-p_{0(i)}}{p_{0(i)}}\right)$.

Second, following the ***Availability heuristic theory*** (Amos Tversky & Kahneman, 1973), people tend to determine the likelihood of uncertain events or assess the frequency of these events according to how easily they can recall similar instances. In the inflation context, individuals' perception of overall price changes is strongly affected by the prices of their goods with most ***purchasing frequencies***. Brachinger (2008) also stated that the more often a good or service is bought, the more influential it should be on perceived inflation. That is why our psychological inflation adopts purchasing frequencies as weights instead of expenditure weights as in headline inflation.

Third, the ***Prospect theory*** (Kahneman & Tversky,1979), as an alternative decision theory under risk and uncertainty to the traditional expected utility theory, shows the importance of the loss aversion effect, which strongly impacts consumers' inflation perception. Thus, consumers perceive price changes differently depending on a price increase or decrease.

Accordingly, in a preliminary perception phase, a price increase or decrease is encoded by consumers respectively as a "loss" or "gain" relative to a reference price particular to a commodity, isolated from other goods. A "loss" is always evaluated more severely than a "gain," indicating that price increases are significantly more responsive to consumers than price decreases. This asymmetric treatment of consumers becomes more severe and observable when price changes are significant. This effect also becomes a focus of consumers' concern when the price of goods and services that consumers buy at a high frequency fluctuates strongly. This phenomenon, namely ***loss aversion,*** has been observed by Daniel Kahneman & Tversky (2000), Ranyard et al. (2008), and Brachinger (2008) in several experiments on decision-making under risks and ambiguities. Consequently, when predicting the future, people refer back to their past as expectation-based reference points; even more, harrowing experiences are the most likely to spring to mind (Morewedge et al., 2005).

METHODOLOGY

Mathematical measurement of psychological inflation

Considering the features mentioned above, psychological inflation is shown in mathematical language as follows:

$$Psychological\ Inflation_t = \sum_{i=1}^{n}\left(\left(\frac{P_{t(i)}-P_{0(i)}}{P_{0(i)}}\right)*\boldsymbol{l}_{In}\right)*\boldsymbol{w}_{(i)} + \sum_{i=1}^{n}\left(\left(1-\left(\frac{P_{t(i)}-P_{0(i)}}{P_{0(i)}}\right)\right)*\boldsymbol{l}_{De}\right)*\boldsymbol{w}_{(i)} \quad (1)$$

Equation (1) can be re-written as:

$$Psychological\ Inflation_t = \sum_{i=1}^{n}\left(\left(\frac{P_{t(i)}-P_{0(i)}}{P_{0(i)}}\right)*\boldsymbol{l}_{In}\right)*w_{(i)} + \sum_{i=1}^{n}\left(\left(\frac{P_{t(i)}}{P_{0(i)}}\right)*\boldsymbol{l}_{De}\right)*\boldsymbol{w}_{(i)} \quad (2)$$

where,

$P_{t(i)}$ is the average price of a group of goods and services i at time t (current prices);

$P_{0(i)}$ is the average price of a group of given goods and services i by the base period 0 (reference prices);

l_{In} is the loss aversion coefficient in increasing prices, assumed to be always higher than one and being fixed in a given period;

l_{De} is the loss aversion coefficient in decreasing price, which is assumed to have a negative value and be fixed in a given period;

$w_{(i)}$ is the weight measured by the purchasing

frequency of a group of goods and services set during a given period (monthly).

As can be seen from Equations (1) and (2), our psychological inflation is derived from the IPI (Index of Perceived Inflation) formula proposed by Brachinger (2008) and shown in Equation 3 below, except for the way we have calculated loss aversion coefficients.

$$IPI^{0,t} = \sum_{i:\, p_t(i)>p_0(i)} \left[c\left(\frac{p_t(i)-p_0(i)}{p_0(i)}\right)+1\right] f_i^0 + \sum_{i:\, p_t(i)\le p_0(i)} \frac{p_t(i)}{p_0(i)} f_i^0 \quad (3)$$

On the one hand, in the IPI formula, the loss aversion assumptions imply c > 1 for the price increase and c = 1 for the price decrease (at the aggregate level). Brachinger (2008) adopted the loss aversion assumption of Kahneman and Tversky "losses loom larger than gains" or "losses and disadvantages have a greater impact on preferences than gains and advantages" (Tversky & Kahneman, 1991). Brachinger's (2008) adoption of loss aversion is illustrated in Figure 1 below.

Due to the asymmetry in consumer reactions, price decreases are usually ignored in forming the IPI formula (c = 1); however, that is a wrong view because not taking the loss aversion effect in decreasing prices might be a shortcoming in some specific economies, i.e., Vietnam. Five of eleven groups of goods and services have followed a decreasing trend in price in the past ten years, including (1) transportation, (2) culture, sport, and entertainment, (3) communications, (4) housing and material construction, and (5) medicine and health care services. Specifically, the number of observations reflecting price decreases in 11 groups makes up nearly 20% of the total observations. Based on our observations, reducing the prices of goods and services has driven Vietnamese consumers to increase their spending and gradually shift their spending structures toward these groups. Typically, spending on housing and material construction has increased from 10% (average between 2010 and 2015) to 15.73% (average between 2016 and 2020) of Vietnamese households' expenditures. Therefore, our psychological inflation integrates loss aversion into decreasing prices as an additional feature.

On the other hand, in our psychological inflation, we reuse the methods of Gachter et al. (2007) when measuring individual loss aversion by eliciting both WTA (Willingness-To-Accept) and WTP (Willingness-To-Purchase). In more detail, the loss aversion coefficient of an individual is measured by $\frac{P_{WTA}}{P_{WTP}}$. Nonetheless, several drawbacks in his study are of concern, such as (1) using absolute prices, (2) factors not in the context of inflation (price decrease or increase), and (3) factors not in the context of a limited budget. As a result, our study uses relative price changes instead of absolute price changes (1), as well as putting them in the context of inflation by capturing loss aversion in both increasing and decreasing prices from consumer perspectives (WTP) (2), and a limited budget according to the purchasing frequency (3). All additional features are mentioned in Equation (2). Finally, in our study, the loss aversion coefficient in the inflation context is calculated as follows:

- Loss aversion coefficient in increasing prices: $l_{in} = \sum_{i=1}^{n} \frac{P_{WTP\,(i)} - P^*}{P_{Increase}}$ (4)
- Loss aversion coefficient in decreasing prices: $l_{de} = \sum_{i=1}^{n} \frac{P_{WTP\,(i)} - P^*}{P_{Decrease}}$ (5)

in which P* is used as a reference price in each question of WTA and WTP; $P_{Increase}$ and $P_{Decrease}$ are increasing prices and decreasing prices, respectively (see more in the Appendix – The survey design for loss aversion coefficient).

The above arguments have led us to integrate loss aversion (in both increasing and decreasing prices) into our measurement of psychological inflation to capture its effects; however, we have modified the measurement with our arguments. By nature, "loss aversion" appears when people have to choose among several alternatives; they tend to avoid losses and optimize for sure wins because the pain of losing is greater than the satisfaction of an equivalent gain. For example, in the pricing setting process, consumers expect to buy the product, so given that the reference price is 10 USD and the discount is offered at a maximum of 50%, consumers will experience a loss if they end up not consuming it. This fact pushes their willingness to pay 5, 6, 7, 8, and even 9 USD for this product. In this case, consumers are willing to pay the price of 9 USD to realize a sure win, although the discount might reach up to 5 USD, with high uncertainty. The more they are willing to pay, the higher their loss aversion. The case for price increases is explained similarly. Based on this fact, we argue that loss aversion does not only show up in cases of increasing and decreasing prices. It is also worth

noting that the loss aversion effect might be more elastic for price increases than price decreases. Unfortunately, in the existing literature on inflation perception, the effect of loss aversion on price seems to be ignored, although it has a vital role. Brachinger (2008), Fritsche et al. (2009), and Jungermann et al. (2007) did not consider this effect in their measurement of inflation perception, which motivates us to propose our new psychological inflation measure.

Loss aversion is also a basic characteristic of behavioral choice explanations as it captures behavioral factors. In exploring the nature of loss aversion, Johnson, Gächter, and Herrmann (2006) pointed out several characteristics of loss aversion. One of the remarkable characteristics is that loss aversion might vary systematically across attributes (Sayman & Öncüler, 2005; Tversky & Kahneman, 1991). For example, hedonistic attributes exhibit more loss aversion than do utilitarian attributes (Dhar & Wertenbroch, 2000), and loss aversion for quality attributes is greater than that for price (Bruce, Johnson, & Fader, 1993; Heath et al., 2000). Thus, psychological inflation, as a whole, can be controlled and used as a basis for monetary policy following varied conditions.

Expected criteria for psychological inflation

Psychological inflation is expected to satisfy some criteria. For instance, it must (i) broadly co-move with the headline inflation index during normal contexts but capture abnormal price evolution perception better than headline inflation during crisis periods (Sousa & Yetman, 2016) and (ii) link tightly with monetary policy and economic dynamics. Once psychological inflation meets the above qualifying criteria, it might be available for many applications, including forecasting headline inflation, estimating real interest rates, predicting economic players' behavior, and setting salaries and prices. Psychological inflation combined with headline inflation also provides a picture of the credibility of monetary policy.

Robustness tests

Our paper aims to develop a new index of perceived inflation or psychological inflation, so it is essential to look for the most appropriate approach to check if the new index satisfies the criteria mentioned in the above section.

To achieve this, we reviewed several studies on building a new index, i.e., the EPU index (Baker et al., 2016), the China EPU index (Huang & Luk, 2020), and the ICEA index (Wang et al., 2022b). Consequently, we used correlation and cointegration tests for the first criterion. On the other hand, the Structural Vector Autoregression (SVAR) model, initially proposed by Sims (1980), appears appropriate for the second criterion.

Specifically, our SVAR model is built on the Quah-Vahey (1995) model's theoretical and practical practices. Many studies primarily choose the Quah-Vahey (1995) model as a benchmark method (Quah & Vahey, 1995; Xuan, 2015; Günay, 2018; Fan et al., 2021). In the interest of considering the effect of a monetary shock on psychological inflation, we expanded the bivariable model of Quah-Vahey into a tri-variate SVAR, taking the money supply growth rate as an additional variable. This approach is appropriate, as demonstrated by several studies (Blix, 1995; Fase & Folkertsma, 1996; Dewachter & Lustig, 1997; Gartner & Wehinger, 1998; Lütkepohl, 2005 Hossain, 2010; Cukierman, 2017; Samargandi, 2020).

Why should VAR/SVAR be used? First, the VAR model enables us to understand the dynamic behavior of various disturbance components on the variables thought to be endogenous using lag functions (Algaeed, 2020). As a result, VAR forecasts are flexible because they are built based on the potential of a variable's future path. In other words, using the VAR approach, we may relate changes in one variable to changes in its own and other variable lags. As a result, the VAR model is a popular choice for structural deduction, policy-making, and macroeconomic analysis (Liu et al., 2020). Second, VAR is constructed to identify the relation of the variables rather than parametric estimation; thus, VAR is used in the case of variables that have a two-way causality relationship, such as inflation, money supply, and output (Zhang & Chen, 2015; Beckmann et al., 2017; Algaeed, 2020).

According to Wang et al. (2022a), a reduced form of the VAR model can be specified as follows:

$$y_t = \sum_{i=1}^{\rho} A_i y_{t-i+} + \beta D_t + u_t \quad (6)$$

Where y_t is the 3-vector of endogenous variables observed at time t, including money supply

growth (M2), and output growth (IIP), and psychological inflation (Psy). A_i is the 3-vector of coefficient matrices. D_t is a vector of deterministic terms, and β is the coefficient matrices corresponding with D_t. u_t is a 3-vector of unobserved zero mean vector white noise process and has a covariance matrix $\sum u$. u_t denotes the reduced form disturbance and may have a contemporaneous correlation but is uncorrelated with its lagged values or any right-side variables. When applied to the VAR model, the impulse response function (IRF) gauges how one variable responds to a shock coming from another. Nonetheless, Cooley and Leroy (1985) criticized the classic VAR because shocks are linear combinations of structural disturbances.

In this circumstance, structural VAR (SVAR) comes with restrictions based on economic theory to provide links between forecast errors and fundamental structural shocks (Wang et al., 2020a). Accordingly, SVAR can easily and precisely distinguish between different shocks (Sims, 1986; Bernanke, 1986; Blanchard & Watson, 1986; Algaeed, 2020); hence, the SVAR model, based on the VAR, can be estimated:

$$\bar{A}_0 y_t = \sum_{i=1}^{\rho} \bar{A}_i y_{t-i+} + \bar{\beta} D_t + \varepsilon_t \qquad (7)$$

Where ε_t is a 3×1 dimensional vector white noise process with covariance matrix $\sum u$, meaning structural shocks. A_i is the 3-vector of coefficient matrices. From Equations 6 and 7, we can infer that $u_t = \bar{A}_0^{-1} \varepsilon_t$. Wang et al. (2022a) stated that pre-multiplying both sides of the Equation 6 by $\bar{A}_0^{-1}$ can link the reduced form disturbances (forecast errors) u_t to the underlying structural shocks ε_t. Equation 7 can be rewritten as:

$$\begin{pmatrix} \Delta M2 \\ \Delta IIP \\ \Delta Psy \end{pmatrix} = \begin{pmatrix} a_{11}(H) & 0 & 0 \\ a_{21}(H) & a_{22}(H) & 0 \\ a_{31}(H) & a_{32}(H) & a_{33}(H) \end{pmatrix} \begin{pmatrix} \varepsilon_t M2 \\ \varepsilon_t IIP \\ \varepsilon_t Psy \end{pmatrix} \qquad (8)$$

Where a_i are matrices in lag operator H, such that $H^K x_t = X_t - K_j$; a_{ij} is estimated coefficient j, and $a_{ij} = \sum_k a_{ij} H^K$ is the sum of the moving average coefficients for K = 1, 2, ..., ρ, where ρ is the degree of polynomial a_{ij}. It is the optimal lag operator of the VAR model. Lastly, $\varepsilon_t M2$, $\varepsilon_t IIP$, $\varepsilon_t Psy$ are structural shocks of money supply growth, output growth, and psychological inflation, respectively. The above-identified SVAR could utilize Blanchard and Quah's decomposition, and the long-run restrictions imposed are as follows (Quah and Vahey, 1995; Algaeed, 2020).

- $a_{12} = 0$. The level of output is independent of the level of the money supply in the long run (Meyer, 2001).
- $a_{13} = 0$. The level of psychological inflation is independent of the level of the money supply in the long run (Meyer, 2001).
- $a_{23} = 0$. The level of output is independent of the psychological level in the long run (Quah and Vahey, 1995).

To capture the dynamic and instantaneous impacts of structural shocks within the variable system, the SVAR model allows for three tools: the impulse response function (IRF), forecast error variance decomposition (FEVD), and historical decomposition (HD). The tools are intensively defined in the study of Wang et al. (2022a). We do not present them here for space.

However, some requirements must be satisfied before SVAR can be used effectively. For instance, the biggest problem of SVAR, in general, is that the variables included in the model must be stationary, and the estimated results depend heavily on the number of lags of the variables. If the series are non-stationary, estimating SVAR may commit spurious relationships that lead to erroneous conclusions. For a reasonable estimate, it is worth noting that the variables included in the model should be stationary in the same order. Further, the number of lags applied to the model largely determines the estimate's accuracy. It is possible to pick up the appropriate number of lags based on suggestions from AIC (Akaike Information Criterion) or SC (Schwarz Criterion) criteria. However, they do not always give the best suggestions. Other requirements of SVAR are the causal relationship of psychology with money supply growth and output growth, as well as the long-term relationship among them, which can be checked by correlation, cointegration, and Granger causality tests.

DATA

Monthly data for $\boldsymbol{P_{0(i)}}$ and $\boldsymbol{P_{t(i)}}$ were collected from the 11 sub-indexes of Vietnam headline inflation (CPI), available on the General Statistic Office of Vietnam. In addition, the purchasing frequency weights $\boldsymbol{w_{(i)}}$ (Table 1), and the loss aversion coefficients in increasing and decreasing prices ($\boldsymbol{l_{In}}$ $\boldsymbol{l_{De}}$) (Table 2) were collected and estimated through the survey project joined by the State Bank of Vietnam (SBV) and the authors.

It is worth noting that we chose the month-to-month price index for many reasons. It matches the SVAR Quah & Vahey (1995) model well, which we use to test whether psychological inflation links tightly with monetary policy and economic dynamics; that is a highly expected criterion of measured psychological inflation. Furthermore, the monthly index more closely reflects price evolution in the real economy. In our estimation for Vietnam, the time series starts in January 2009 and continues until now, when it is the longest available. In 2009, there was an essential modification in the method of collecting the price index in Vietnam; therefore, data before 2009 are unavailable and not suited. For SVAR estimation, we collected data for Broad money supply growth (M2) and the index of industrial production (IIP), which is available from the Central Bank of Vietnam and General Statistic Officials of Vietnam, respectively. Figure 2 displays time series graphs for each variable and monthly frequency data are taken into account for further empirical analysis, from January 2009 to October 2020.

RESULTS AND DISCUSSION

Psychological inflation in Vietnam's economy

The measured psychological inflations are shown in Figure 3 below, including:

- Psychological inflation is adjusted by both loss aversion in increasing and decreasing prices (Psy)
- Psychological inflation-adjusted with only loss aversion in increasing price (Psy_{In})
- Headline inflation (CPI) is also shown as the reference index.

We estimate Psy_{In} besides Psy for comparison interest, pointing out the empirical evidence of the viral role of loss aversion in decreasing price cases.

The measured psychological inflations are very promising:

Psy_{In} and Psy fluctuate up and down at the same rhythm as headline inflation, and this co-movement lasts for a very long time without a lag. The significant gaps between psychological inflation and headline inflation appear in crisis periods in 2009, 2013, and 2020, showing that psychological inflation captures abnormal or price shocks better than headline inflation, which is constantly critiqued to average all shocks.

Psy does not exaggerate the shock of price increases like the Psy_{In} index does. During the crisis, the Psy_{In} index exaggerated the increasing price shock to double or triple compared to the average price level referred to by headline inflation. This fact is empirical evidence strongly supporting our arguments above that the loss aversion effect on price decreases is significant and should be considered when measuring psychological inflation.

A point worth mentioning is that psychological inflation Psy is always higher than headline inflation. This fact can be observed in our estimations, which are strongly consistent with many previous studies. A common phenomenon is that economic agents always think that the government's published price index is lower than it actually is. By that the larger the bias between psychological and headline inflation is, the lower the creditability of the government is (Szyszko & Tura-Gawron, 2021). In our estimation for Vietnam, the psychological and headline inflation difference is insignificant except during crisis periods.

Taking all things together shows that the Psy is significantly better than the other. Therefore, Psy –psychological inflation-adjusted with the loss aversion effect in increasing and decreasing prices –is used as an official proxy for the psychological inflation index from now on in this study.

Criteria 1 – Long-term relationship of psychological inflation and headline inflation

Correlation and cointegration analyses are implemented to check for the long-run relationship between psychological and headline inflation; the results are shown in Figure 3 and Tables 3 and 4 below.

Psychological inflation has significantly and positively correlated with headline inflation, with the correlation coefficient reaching 0.98 (Table 3). The Engle-Granger test points out that psychological and headline inflation is well cointegrated. In Table 4, the absolute value of 5.84769 of the Tau-statistic passes all critical values: 3.98 (1%), 3.38 (5%), and 3.08 (10%), rejecting the null hypothesis of no cointegration. This cointegrated relationship indicates that psychological inflation would not drift too far away from headline inflation and quickly revert to headline inflation.

These findings draw exciting conclusions. First, psychological inflation has a tight relationship with headline inflation and might be anchored by headline inflation in the short and long run. Therefore, in the case of Vietnam, these two price indices can be used alternatively in further studies on inflation and operating monetary policies. Psychological inflation would be used as a predictor of headline inflation. Another point worth mentioning is that the large gap between psychological and headline inflation is an early warning of a deep level of economic uncertainty. In that case, policymakers need to anchor psychological inflation well, evincing an unexpected economic effect.

Criteria 2 – Long-term relationship of psychological inflation, monetary and supply shocks

All three variables, psychological inflation, money supply, and output growth rates, are stationary. Money supply and output growth rates cause psychological inflation, which is consistent with monetary theories. All things taken together ensure the best suit for SVAR modeling. Details of the unit root tests, and Granger causality test are shown in Tables 5 and 6.

SVAR estimation provides strong evidence of the tight linkage between psychological inflation, money growth rate, and output growth movement, shown in the impulse response function and the variance decompositions in Figure 4, and Table 7 and Table 8 below.

Psychological inflation reacts strongly and on time to the shock from money supply and output movements. Money supply shocks left primarily a clear and almost immediate impact on both positive and negative psychological inflation. Psychological inflation reacts to a struggle with money supply shock without lag, reversing continuously before turning into a stable condition after about two months. An increasing shock from the money supply leads to an increase in psychological inflation. This effect lasts a long period before completely fading after ten months. The most significant effect of money supply shock on psychological inflation appears in the ninth month (see Table 7). Similar effects are found in the response of psychological inflation to output shock, yet the significant effects of output shock are prolonged for more than one and a half years. Psychological inflation goes up along with an increasing shock of output growth rate, with the most pronounced effects appearing soon in the second month. It is worth noting that psychological inflation feeds itself significantly, with only one lag, lasting up to around five months.

The variance decomposition results reconfirm the linkage between psychological inflation with money supply and output growth rate. Monetary policy explains approximately 6% of psychological inflation evolution in the long run, reconfirming inflation as a monetary phenomenon. At the same time, economic output explains about 12%, showing that a supply shock, whether positive or negative, drives psychological inflation to vary (see Table 8).

CONCLUSION

Our novel measurement of perceived inflation and psychological inflation satisfies many expected criteria that might help conduct monetary policy.

Psychological inflation is highly correlated and cointegrated with headline inflation in an everyday context. Psychological inflation is also linked tightly to monetary shock and economic dynamics. Therefore, psychological inflation contains predictive information for forecasting headline inflation. Based on this, psychological inflation is highly recommended for inflation and economic forecasting models.

The advanced point of psychological inflation over headline inflation is that it better captures abnormal price evolution and reflects the price change in consumers' perception during crisis periods. It is a worthy point in the context that headline inflation was criticized as underestimating inflation or smoothing out price fluctuations during the COVID-19 pandemic (Cavallo, 2020; Reinsdorf, 2020).

In another prospect, psychological inflation is also a reference for the credibility of monetary policy. A narrow gap between psychological and headline inflation shows a high level of monetary policy and vice versa (Abildgren & Kuchler, 2021). High credibility facilitates anchoring psychological inflation into the inflation target (Güler, 2021). In turn, well-anchored inflation expectations are critical for giving the central bank the latitude to support the economy without destabilizing inflation (Buono & Formai, 2018; Nautz et al., 2017).

In more significant implications, well-measured psychological inflation matters a lot. First, psychological inflation feeds directly into real interest rates, which are also essential to the economic player's decision-making process, such as saving, spending, investment, or setting salaries or adjusting prices (Abildgren & Kuchler, 2021). From the central bank's perspective, the formulation of monetary policy must be deeply rooted in a thorough analysis of perceived inflation data, with a particular emphasis on interpreting and predicting inflation dynamics. Given inflation's dual nature—comprising both predictable and unpredictable elements such as perceived and expected inflation—a flexible and responsive policy framework is crucial for effectively managing perceived inflation and using it to forecast and influence expected inflation.

Finally, central banks should adopt a proactive approach, informed by the *Theory of Rational Expectations*, to mitigate economic fluctuations caused by both expected and unexpected inflationary pressures. *The Theory of Rational Expectations* posits that individuals and firms base their future expectations on all available information and that, on average, these expectations are accurate. This suggests that policies cannot systematically influence the economy over time, as people will adjust their expectations in anticipation of the effects of those policies. This realization underscores the importance of monetary policy's effectiveness being closely tied to policymakers' credibility and expected actions. Therefore, central banks must communicate their inflation targets clearly and transparently, effectively anchoring public expectations around these targets.

Our study contributes a novel measurement of psychological inflation and provides empirical evidence of its advanced features compared to the existing versions. It is one of the limited measurements backgrounded on combined psychological and economic theories. It is also the first to consider the loss aversion effect in decreasing prices as an overriding factor in forming psychological inflation. Thus, the progressive nature of psychological inflation needs further research to enhance our understanding. Finally, possible avenues for future research are collecting empirical evidence of the loss aversion effects of decreasing prices on forming psychological inflation.

Data statement: Due to the sensitive nature of the questions asked in this study, survey respondents were assured raw data would remain confidential and would not be shared.

ACKNOWLEDGMENT

The research is funded by Vietnam National University, Ho Chi Minh City (VNU-HCM) with grant number NCM2019-34-01.

REFERENCES

Anderson, O. (1952). The Business Test of the IFO-Institute for Economic Research, Munich, and Its Theoretical Model. *Revue de l'Institut International de Statistique / Review of the International Statistical Institute*, *20*(1), 1–17. https://doi.org/10.2307/1401826

Armantier, O., Bruine de Bruin, W., Potter, S., Topa, G., van der Klaauw, W., & Zafar, B. (2013). Measuring Inflation Expectations. *Annual Review of Economics*, *5*(1), 273–301. https://doi.org/10.1146/annurev-economics-081512-141510.

Abildgren, K., & Kuchler, A. (2021). Revisiting the inflation perception conundrum. *Journal of Macroeconomics*, *67*(October 2020). https://doi.org/10.1016/j.jmacro.2020.103264

Algaeed, A. H. (2020). Symmetric oil price shocks and government expenditure-real exchange rate nexus: ARDL and SVAR models for an oil-based economy, 1970–2018. *Cogent Economics & Finance*, *8*(1), 1782076. https://doi.org/10.1080/23322039.2020.1782076

Baker, S. R., Bloom, N., & Davis, S. J. (2016). Measuring Economic Policy Uncertainty*. *The Quarterly Journal of Economics*, *131*(4), 1593–1636. https://doi.org/10.1093/qje/qjw024

Beckmann, J., Czudaj, R. L., & Arora, V. (2020). The relationship between oil prices and exchange rates: Revisiting theory and evidence. *Energy Economics*, *88*, 104772. https://doi.org/10.1016/j.eneco.2020.104772

Bernanke, B. S. (1986). Alternative Explanations of the Money-Income Correlation. *National Bureau of Economic Research Working Paper Series*, *No. 1842*. https://doi.org/10.3386/w1842

Blanchard, O. J., & Watson, M. W. (1986). Are business cycles all alike?. In *The American business cycle: Continuity and change* (pp. 123-180). University of Chicago Press.

Blix, M. (1995). *Underlying inflation: a common trends approach*. Sveriges riksbank.

Brachinger, H. W. (2008). A new index of perceived inflation: Assumptions, method, and application to Germany. *Journal of Economic Psychology*, *29*(4), 433–457. https://doi.org/10.1016/j.joep.2008.04.004

Buono, I., & Formai, S. (2018). New evidence on the evolution of the anchoring of inflation expectations. *Journal of Macroeconomics*, *57*, 39–54.

Bhat, J. A., Imtiyaz ul Haq, Bhat, S. A., & Megits , N. (2022). Employment elasticity of output growth in Kazakhstan economy: Recent evidence from a macroeconomic perspective. *Journal of Eastern European and Central Asian Research (JEECAR), 9*(2), 369–384. https://doi.org/10.15549/jeecar.v9i2.852

Cavallo, A. (2020). *Inflation with Covid consumption baskets*. National Bureau of Economic Research.

Coibion, O., Gorodnichenko, Y., & Ropele, T. (2020). Inflation expectations and firm decisions: New causal evidence. *The Quarterly Jounral of Economics*, *135*(1), 165–219. /https://doi.org/10.1093/qje/qjz029

Coibion, O., Gorodnichenko, Y., & Weber, M. (2019). *Monetary Policy Communications and their Effects on Household Inflation Expectations* (No. 25482). https://doi.org/10.3386/w25482

Coibion, Olivier, Gorodnichenko, Y., Kumar, S., & Pedemonte, M. (2020). Inflation expectations as a policy tool? *Journal of International Economics*, *124*. https://doi.org/10.1016/j.jinteco.2020.103297

Coibion, Olivier, Gorodnichenko, Y., & Ropele, T. (2020). Inflation Expectations and Firm Decisions: New Causal Evidence. *Quarterly Journal of Economics*. https://doi.org/10.1093/qje/qjz029

Cooley, T. F., & Leroy, S. F. (1985). Atheoretical macroeconometrics: A critique. *Journal of Monetary Economics*, *16*(3), 283–308. https://doi.org/10.1016/0304-3932(85)90038-8

Cukierman, A. (2017). Money growth and inflation: Policy lessons from a comparison of the US since 2008 with hyperinflation Germany in the 1920s. *Economics Letters*, *154*, 109–112. https://doi.org/10.1016/j.econlet.2017.02.036

Dewachter, H., & Lustig, H. (1997). A cross-country comparison of CPI as a measure of inflation. *Discussion Paper Series 97.06*.

Diewert, W. E., & Fox, K. J. (2020). *Measuring real consumption and CPI bias under lockdown conditions*. National Bureau of Economic Research.

Dräger, L., Menz, J. O., & Fritsche, U. (2014). Perceived inflation under loss aversion. *Applied Economics*, *46*(3), 282–293. https://doi.org/10.1080/00036846.2013.844328

Eurostat. (2009). *HICP - Frequent out-of-pocket purchases. A new special aggregate*. EuroStat Statistics Explained. https://ec.europa.eu/eurostat/statistics-explained/index.php/Archive:HICP_-_Frequent_out-of-pocket_purchases

Fan, Z., Hu, Y., & Zhang, P. (2021). Measuring China's core inflation for forecasting purposes: taking persistence as weight. *Empirical Economics*, 1–19.

Fase, M. M. G., & Folkertsma, C. K. (1996). *Measuring inflation: an attempt to operationalize Carl Menger's concept of the inner value of money*. Citeseer.

Fechner, G. T. (1860). Elemente der Psychophysik (Leipzig: Breitkopf & Ha «rtel). *English Translation of Vol. 1 by HE Adler 1966*.

Fritsche, U., Vogel, L., & Menz, J. O. (2009). *Prospect theory and inflation perceptions - An empirical assessment*.

Gachter, S., Johson, E. J., & Herrmann, A. (2007). *Individual-level loss aversion in riskless and risky choices* (No. 2961; IZA Discussion Paper).

Gartner, C., & Wehinger, G. (1998). Core inflation in selected European Union countries. *Topics in Monetary Policy Modelling*.

Gnan, E., Langthaler, J., & Valderrama, M. T. (2010). *Understanding Inflation Expectations Uncertainty in the Euro Area. Does Psychology Help*. Mimeo.

Güler, A. (2021). Does Monetary Policy Credibility Help in Anchoring Inflation Expectations? Evidence from Six Inflation Targeting Emerging Economies1. *Journal of Central Banking Theory and Practice*, *1*, 93–111.

Günay, M. (2018). Forecasting industrial production and inflation in Turkey with factor models. *Central Bank Review*, *18*(4), 149–161. https://doi.org/10.1016/j.cbrev.2018.11.003

Hałka, A., & Łyziak, T. (2015). How to define the consumer perceived price index? An application to polish data. *Eastern European Economics*. https://doi.org/10.1080/00128775.2015.1033291

Hossain, A. A. (2010). Monetary targeting for price stability in Bangladesh: How stable is its money demand function and the linkage between money supply growth and inflation? *Journal of Asian Economics*, *21*(6), 564–578. https://doi.org/10.1016/j.asieco.2010.07.003

Huang, Y., & Luk, P. (2020). Measuring economic policy uncertainty in China. *China Economic Review*, *59*, 101367. https://doi.org/https://doi.org/10.1016/j.chieco.2019.101367

Jonung, L. (1986). Uncertainty about inflationary perceptions and expectations. *Journal of Economic Psychology*, *7*(3), 315–325. https://doi.org/10.1016/0167-4870(86)90023-1

Jungermann, H., Brachinger, H. W., Belting, J., Grinberg, K., & Zacharias, E. (2007). The euro changeover and the factors influencing perceived inflation. *Journal of Consumer Policy*, *30*(4), 405–419.

Kahneman, D, & Tversky, A. (1979). *Prospect theory: An analysis of decision under risk Econometrica 47*.

Kahneman, Daniel, & Tversky, A. (2000). *Choices, Values, and Frames* (Daniel Kahneman & A. Tversky (eds.)). Cambridge University Press.

Lindén, S. (2004). Quantified perceived and expected inflation in the euro area. A promising first glance. *Workshop on Business and Consumer Surveys*.

Liu, D., Meng, L., & Wang, Y. (2020). Oil price shocks and Chinese economy revisited: New evidence from SVAR model with sign restrictions. *International Review of Economics & Finance*, *69*, 20–32. https://doi.org/10.1016/j.iref.2020.04.011

Lucey, B. M., Vigne, S. A., Yarovaya, L., & Wang, Y. (2022). The cryptocurrency uncertainty index. *Finance Research Letters*, *45*, 102147. https://doi.org/https://doi.org/10.1016/j.frl.2021.102147

Lütkepohl, H. (2005). *New introduction to multiple time series analysis*. Springer Science & Business Media.

Lyziak, T. (2010). Measurement of perceived and expected inflation on the basis of consumer survey data. In *IFC Working Papers* (No. 5).

Maag, T. (2009). *On the accuracy of the probability method for quantifying beliefs about inflation* (KOF Working Papers, Issues 09–230). KOF Swiss Economic Institute, ETH Zurich. https://EconPapers.repec.org/RePEc:kof:wpskof:09-230

Meyer, L. H. (2001). Does money matter. *Federal Reserve Bank of St. Louis Review*, *83*(September/October 2001).

Morewedge, C. K., Gilbert, D. T., & Wilson, T. D. (2005). The Least Likely of Times: How Remembering the Past Biases Forecasts of the Future. *Psychological Science*, *16*(8), 626–630. https://doi.org/10.1111/j.1467-9280.2005.01585.x

Nautz, D., Pagenhardt, L., & Strohsal, T. (2017). The (de-) anchoring of inflation expectations: New evidence from the euro area. *The North American Journal of Economics and Finance*, *40*, 103–115.

Nguyen, T. M. L., Papyrakis, E., & Van Bergeijk, P. A. G. (2019). Assessing the price and output effects of monetary policy in Vietnam: evidence from a VAR analysis. *Applied Economics*, *51*(44), 4800–4819.

Pesaran, M. H., & Weale, M. (2006). *Survey expectations - Handbook of Economic Forecasting*. Elservier.

Pfajfar, D., & Žakelj, B. (2018). Inflation expectations and monetary policy design: Evidence from the laboratory. *Macroeconomic Dynamics*, *22*(4), 1035–1075.

Poncert, H. (2004). The consequences of European harmonization on the French

Consumer Survey. *27th CIRET Conference*. www.ciret.org

Quah, D., & Vahey, S. P. (1995). Measuring core inflation. *The Economic Journal*, *105*(432), 1130–1144.

Ranyard, R., Del Missier, F., Bonini, N., Duxbury, D., & Summers, B. (2008). Perceptions and expectations of price changes and inflation: A review and conceptual framework. *Journal of Economic Psychology*, *29*(4), 378–400.

Ranyard, R., Missier, F. Del, Bonini, N., & Pietroni, D. (2017). The Citizen's Judgements of Prices and Inflation. *Economic Psychology*, 155–170.

Reinsdorf, M. (2020). *COVID-19 and the CPI: Is inflation underestimated?*

Samargandi, N., Kutan, A. M., Sohag, K., & Alqahtani, F. (2020). Equity market and money supply spillovers and economic growth in BRICS economies: A global vector autoregressive approach. *The North American Journal of Economics and Finance*, *51*, 101060. https://doi.org/10.1016/j.najef.2019.101060

Sims, C. A. (1980). Macroeconomics and Reality. *Econometrica*, *48*(1), 1–48. https://doi.org/10.2307/1912017

Sims, C. A. (1986). Are forecasting models usable for policy analysis?. *Quarterly Review*, *10*(Win), 2-16.

Sousa, R., & Yetman, J. (2016). Inflation expectations and monetary policy. *BIS Paper*, *89d*.

Stanisławska, E. (2019). Consumers' Perception of Inflation in Inflationary and Deflationary Environment. *Journal of Business Cycle Research*, *15*(1), 41–71. https://doi.org/10.1007/s41549-019-00036-9

Szyszko, M., & Tura-Gawron, K. (2021). Eurozone or national inflation projections: Which has greater impact on consumer expectations? *Panoeconomicus*, *68*(1), 53–76. https://doi.org/https://doi.org/10.2298/PAN171128014S

Trimborn, S., & Härdle, W. K. (2018). CRIX an Index for cryptocurrencies. *Journal of Empirical Finance*, *49*, 107–122. https://doi.org/10.1016/j.jempfin.2018.08.004

Tversky, A, & Kahneman, D. (1991). Loss Aversion in Riskless Choice: A Reference-Dependent Model. *Quarterly Journal of Economics*, *106*, 1039–1061.

Tversky, Amos, & Kahneman, D. (1973). Availability: A heuristic for judging frequency and probability. *Cognitive Psychology*, *5*(2), 207–232.

Vogel, L., Menz, J.-O., & Fritsche, U. (2009). Prospect Theory and Inflation Perceptions - An Empirical Assessment. *DEP Discussion Papers Macroeconomics and Finance Series*, *3/2009*, 1–80.

Wang, Y., Lucey, B. M., Vigne, S. A., & Yarovaya, L. (2022a). The effects of central bank digital currencies news on financial markets. *Technological Forecasting and Social Change*, *180*, 121715.

Wang, Y., Lucey, B., Vigne, S. A., & Yarovaya, L. (2022b). An index of cryptocurrency environmental attention (ICEA). *China Finance Review International*, *ahead-of-print*(ahead-of-print). https://doi.org/10.1108/CFRI-09-2021-0191

Wärneryd, K.-E. (1986). Introduction The psychology of inflation. *Journal of Economic Psychology*, *7*(3), 259–268.

Weber, E. H. (1834). *De pulsu, resorptione, auditu et tactu: annotationes anatomicae et physiologicae, auctore*. prostat apud CF Koehler.

Xuan, P. (2015). *L'inflation sous-jacente de l'économie vietnamienne: Conception, Construction et Évaluation*.

Zhang, Q., & Chen, R. (2015). Financial Development and Income Inequality in China: An Application of SVAR Approach. *Procedia Computer Science*, *55*, 774–781. https://doi.org/10.1016/j.procs.2015.07.159

ABOUT THE AUTHORS

Thi Thanh Xuan Phamis, email: xuanptt@uel.edu.vn

Thi Thanh Xuan Phamis, Associate Professor, is affiliated with the University of Economics and Law at Vietnam National University, Ho Chi Minh City. She is a distinguished "Strong Economic Research Group" member at Vietnam National University, Ho Chi Minh City. Her current focus is on the development of psychological inflation measurement under the supervision of Professor Nguyen Thi Canh. Additionally, she is keenly interested in data science in banking and finance.

Thi Canh Nguyen is a Professor at the University of Economics and Law at Vietnam National University in Ho Chi Minh City. She is known as the leader of the "Strong Economic Research Group" at Vietnam National University, Ho Chi Minh City. Her team's current focus is on the development of psychological inflation measurement.

Huu Tin Ho, MBA, is a researcher at the Institute for Development & Research in Banking Technology, University of Economics and Law, Vietnam National University, Ho Chi Minh City, Vietnam. His research focuses is on financial performance, stability, diversification, and digitalization in the banking sector.

Annex

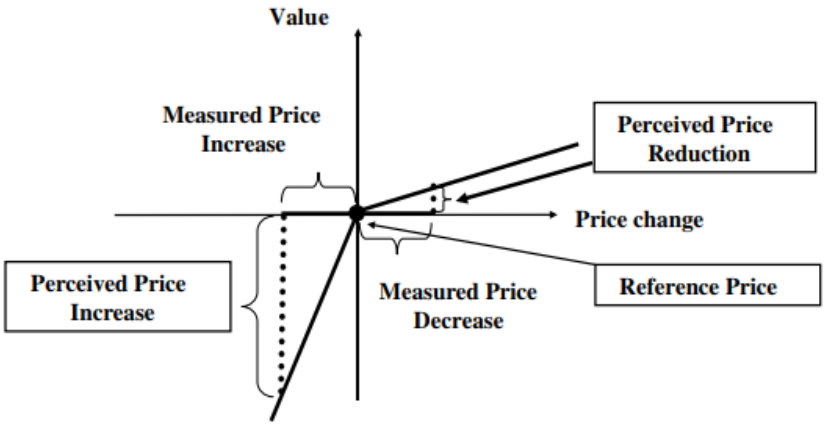

Figure 1. Typical IPI value function with loss aversion coefficient c > 1
Source: Brachinger (2008)

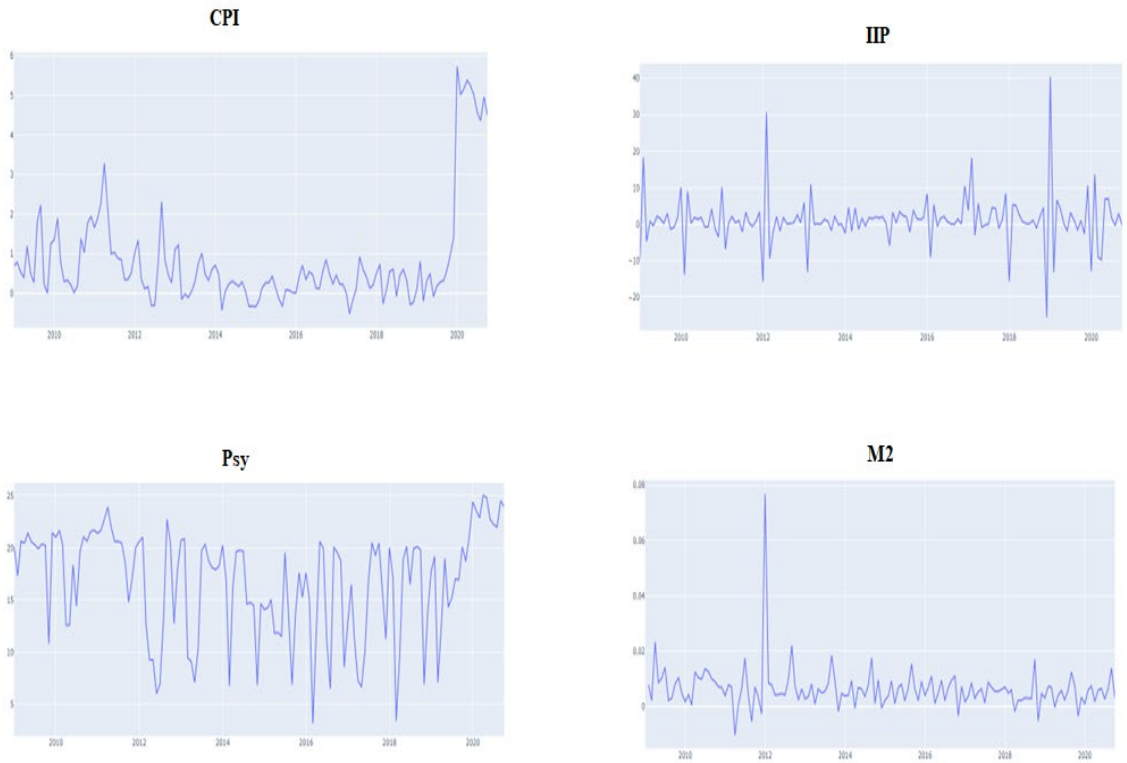

Figure 2. Time series of inflation, output, and money supply
Source: Authors' estimation

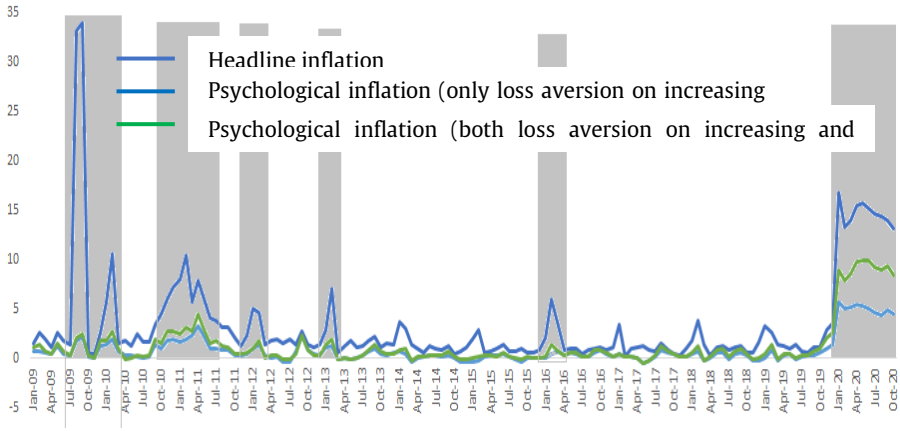

Figure 3. Psychological inflation and headline inflation in Vietnam's economy
Source: Authors' estimation

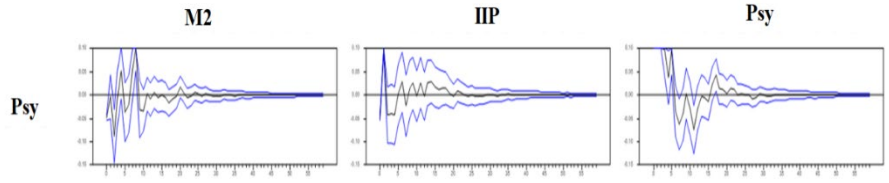

Figure 4. Impulse responses of psychological inflation to monetary and supply shock
Source: Authors' estimation

Table 1. Vietnam's structure of psychological inflation Vietnam

Code	Goods and services groups	Purchasing frequency weights $w_{(i)}$
Sub1	Food. foodstuffs	62.06%
Sub2	Beverages and cigarette	2.80%
Sub3	Garments, footwear, hats	2.80%
Sub4	Housing and material construction	1.84%
Sub5	Household, equipment, goods	0.44%
Sub6	Medicine and health care services	3.42%
Sub7	Transportations	11.40%
Sub8	Communications	3.33%
Sub9	Education	7.63%
Sub10	Culture, sport, entertainment	2.19%
Sub11	Miscellaneous goods and services	2.10%

Source: Authors' estimation

Table 2. The loss aversion coefficients in Vietnam inflation context

Code	Loss aversion coefficients	Coefficient value
l_{In}	in increasing prices	1.21
l_{De}	in decreasing prices	-0.68

Source: Authors' estimation (See more in the Appendix)

Table 3. Correlation between the psychological and headline inflation

	CPI	Psy
CPI	1	
Psy	0.98134204	1

Source: Authors' estimation

Table 4. Engle-Granger Cointegration between the psychological and headline inflation

Test Statistic	Sig. Level	Crit. Value
	1% (***)	-3.97632
-5.84769**	5% (**)	-3.38047
	10% (*)	-3.07535

Source: Authors' estimation

Table 5. Unit root tests

Augmented Dickey-Fuller test			
Variable	**Test Statistic**	**Sig. Level**	**Crit. Value**
		1% (***)	-3.4775
M2	-12.2985**	5% (**)	-2.8819
		10% (*)	-2.5775
		1% (***)	-3.47784
IIP	-17.9229**	5% (**)	-2.88208
		10% (*)	-2.57760
		1% (***)	-3.47885
Psy	-6.74826**	5% (**)	-2.88253
		10% (*)	-2.57784

Kwiatkowski-Phillips-Schmidt-Shin test			
Variable	**Test Statistic**	**Sig. Level**	**p. Value**
		1% (***)	0.739000
M2	0.545307	5% (**)	0.463000
		10% (*)	0.347000
		1% (***)	0.739000
IIP	0.185858	5% (**)	0.463000
		10% (*)	0.347000
		1% (***)	0.739000
Psy	0.304384	5% (**)	0.463000
		10% (*)	0.347000

Phillips-Perron Test			
Variable	**Test Statistic**	Sig. Level	Crit. Value
		1% (***)	-3.477487
M2	-12.38164	5% (**)	-2.882127
		10% (*)	-2.577827
		1% (***)	-3.477144
IIP	-28.05708	5% (**)	-2.881978
		10% (*)	-2.577747
		1% (***)	-3.477144
Psy	-6.272321	5% (**)	-2.881978
		10% (*)	-2.577747

Note: Money supply growth is measured as first difference of log of M2 in domestic currency; Output growth is measured as the growth rate of industrial production index (IIP) in domestic currency; Observation: 140.

Source: Authors' estimation

Table 6. Pairwise Granger causality tests among the psychological inflation, money supply and output growth rates

Code	Null hypothesis	F-statistic	Prob.	Note
1	Money supply growth does not granger cause psychological inflation	2.40796	0.0939	Reject
2	Psychological inflation does not granger cause money supply growth	0.19773	0.8208	Do not reject
3	Output growth does not granger cause psychological inflation	4.92746	0.0086	Reject
4	Psychological inflation does not granger cause output growth	1.04811	0.3534	Do not reject

Note: Money supply growth is measured as the first difference of log of M2 in domestic currency; Output growth is measured as the industrial production index growth rate in domestic currency (IIP); Observation: 140.

Lags: 2 We opt for two lags for our SVAR estimations, being under the vast majority of the selection criteria and consistent with many previous studies on SVAR for the case of Vietnam (Nguyen et al., 2019; Xuan, 2015).

Source: Authors' estimation

Table 7. Impulse response functions in numeric values

	Maximum		Minimum	
Response of psychological inflation to	Period	Absolute value	Period	Absolute value
M2	9	0.1144597	51	0.0000006
IIP	2	0.1373358	60	0.0000052
Psy	1	0.5593211	60	0.0000274

Source: Authors' estimation

Table 8. Historical decomposition

Step	Std. Error	M2	IIP	Psy
1	0.5634177	1.485	2.922	95.593
2	0.6855085	2.331	12.571	85.097
3	0.7138293	2.652	11.609	85.739
4	0.7214399	2.626	11.412	85.962
5	0.7256190	3.241	11.592	85.167
10	0.7510742	5.507	11.504	82.988
20	0.7606153	5.710	11.710	82.580
30	0.7611875	5.765	11.735	82.500
40	0.7612286	5.766	11.741	82.493

Source: Authors' estimation

The survey design for loss aversion coefficient

In total, a large number of randomly selected customers across Vietnam participated in our survey. Data collection was done in personal interviews through Google Forms.

WTP's purchaser perspective	
Please mark ✓ in each line depending on whether you are ready or not to **buy** a cup of coffee at the respective price from us	
Price in VND	
If the price increases 10,000	
I'm ready to **buy** if the price is 43,000	❑
I'm ready to **buy** if the price is 42,000	❑
I'm ready to **buy** if the price is 41,000	❑
I'm ready to **buy** if the price is 40,000	❑
I'm ready to **buy** if the price is 39,000	❑
I'm ready to **buy** if the price is 38,000	❑
I'm ready to **buy** if the price is 37,000	❑
I'm not ready to **buy**	❑
If the price increases 5,000	
I'm ready to **buy** if the price is 38,000	❑
I'm ready to **buy** if the price is 37,000	❑
I'm ready to **buy** if the price is 36,000	❑
I'm ready to **buy** if the price is 35,000	❑
I'm ready to **buy** if the price is 34,000	❑
I'm ready to **buy** if the price is 33,000	❑
I'm ready to **buy** if the price is 32,000	❑
I'm not ready to **buy**	❑
Reference price is 30,000	
If the price decreases 5,000	
I'm not ready to **buy**	❑
I'm ready to **buy** if the price is 22,000	❑
I'm ready to **buy** if the price is 23,000	❑
I'm ready to **buy** if the price is 24,000	❑
I'm ready to **buy** if the price is 25,000	❑
I'm ready to **buy** if the price is 26,000	❑
I'm ready to **buy** if the price is 27,000	❑
I'm ready to **buy** if the price is 28,000	❑
If the price decreases 10,000	
I'm not ready to **buy**	❑
I'm ready to **buy** if the price is 17,000	❑
I'm ready to **buy** if the price is 18,000	❑
I'm ready to **buy** if the price is 19,000	❑
I'm ready to **buy** if the price is 20,000	❑
I'm ready to **buy** if the price is 21,000	❑
I'm ready to **buy** if the price is 22,000	❑
I'm ready to **buy** if the price is 23,000	❑
Reference price is 30,000	

Source: Adapted from Gachter et al. (2007)

The results of loss aversion coefficient in increasing prices and decreasing prices

Cases	Coefficient	No. Obs.	Average coefficient	Percentage
If the price increases 10,000				
I'm ready to **buy** if the price is 43,000	1.30	23	30	2.01%
I'm ready to **buy** if the price is 42,000	1.20	32	38	2.80%
I'm ready to **buy** if the price is 41,000	1.10	351	386	30.74%
I'm ready to **buy** if the price is 40,000	1.00	109		9.54%
I'm ready to **buy** if the price is 39,000	0.90	76		6.65%
I'm ready to **buy** if the price is 38,000	0.80	89		7.79%
I'm ready to **buy** if the price is 37,000	0.70	165		14.45%
I'm not ready to **buy**		297		26.01%
Total		**1,142**	**1.12**	**100.00%**
If the price increases 5,000				
I'm ready to **buy** if the price is 38,000	1.60	80	128	7.01%
I'm ready to **buy** if the price is 37,000	1.40	72	101	6.30%
I'm ready to **buy** if the price is 36,000	1.20	521	625	45.62%
I'm ready to **buy** if the price is 35,000	1.00	232		20.32%
I'm ready to **buy** if the price is 34,000	0.80	72		6.30%
I'm ready to **buy** if the price is 33,000	0.60	61		5.34%
I'm ready to **buy** if the price is 32,000	0.40	36		3.15%
I'm not ready to **buy**		77		6.74%
Total		**1,151**	**1.27**	**100.79%**
Loss aversion in increasing prices (l_{In})			**1.21**	
Reference price (P^*) is 30,000				
If the price decrease 5,000				
I'm not ready to **buy**		21		1.84%
I'm ready to **buy** if the price is 22,000	1.60	24		2.10%
I'm ready to **buy** if the price is 23,000	1.40	42		3.68%
I'm ready to **buy** if the price is 24,000	1.20	57		4.99%
I'm ready to **buy** if the price is 25,000	1.00	117		10.25%
I'm ready to **buy** if the price is 26,000	0.80	255	204	22.33%
I'm ready to **buy** if the price is 27,000	0.60	323	194	28.28%
I'm ready to **buy** if the price is 28,000	0.40	304	122	26.62%
Total		**1,143**	**0.59**	**100.09%**
If the price decrease 10,000				
I'm not ready to **buy**		22		1.93%
I'm ready to **buy** if the price is 17,000	1.30	14		1.23%
I'm ready to **buy** if the price is 18,000	1.20	17		1.49%
I'm ready to **buy** if the price is 19,000	1.10	84		7.36%
I'm ready to **buy** if the price is 20,000	1.00	312		27.32%
I'm ready to **buy** if the price is 21,000	0.90	184	166	16.11%
I'm ready to **buy** if the price is 22,000	0.80	221	177	19.35%
I'm ready to **buy** if the price is 23,000	0.70	286	200	25.04%
Total		1,140	0.79	99.82%
Loss aversion in increasing prices (l_{De})			**0.68**	
Reference price (P^*) is 30,000				

Source: Authors' calculations

in which,

- Coefficient: $\frac{P_{WTP\ (i)}-P^*}{P_{Increase}}$
- Average coefficient: $\frac{P_{WTP\ (i)}-P^*}{P_{Increase}} \times Obs.$

As mentioned before, "loss aversion" appears when people have to choose among several alternatives; they tend to avoid losses and optimize for sure wins because the pain of losing is greater than the satisfaction of an equivalent gain. For example, in the pricing setting process, consumers expect to buy the product; given that the reference price of a cup of coffee is 30,000 VND, and the price is expected to increase 10,000 VND (pushing the price from 30,000 VND to 40,000 VND), consumers will perceive more seriously because it is LOSS. Hence, this fact pushes increasing their willingness to pay for this product higher than the increase (i.e., 10,000 VND). In this case, those willing to pay a price higher than 40,000 VND (i.e., 41,000 VND; 42,000 VND; 43,000 VND) have a loss aversion perception. Similarly, the case of decreasing prices is explained in the same way.

The dataset in this study was collected through the website for measuring and publicizing psychological inflation, a product of the authors and has already been transferred to SBV. The website address is

https://lamphatkyvong.uel.edu.vn/.