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Exchange rate pass-through in emerging Asia and exposure to external shocks

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**EXCHANGE RATE PASS-THROUGH
IN EMERGING ASIA AND
EXPOSURE TO EXTERNAL SHOCKS**

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Abstract

Using a time-varying parameter SVAR model over the period 1994 to 2021, this paper provides estimates of exchange rate pass-through (ERPT) to both producer and consumer prices for nine emerging Asian economies. We also examine the role of four global shocks as propagation channels to both producer and consumer price ERPT, specifically via oil prices, global output, US monetary policy, and the VIX. Our main findings are: (i) ERPT is incomplete and mostly higher for ERPT to producer than consumer prices; (ii) longer-term ERPT to producer and consumer prices is mostly greater in magnitude than shorter-term ERPT; (iii) ERPT has been declining for most Asian EMEs since around 2010; (iv) oil price and global output shocks mostly affect longer-term producer price ERPT in emerging Asia; and (v) US monetary policy and VIX shocks mostly affect longer-term consumer price ERPT in emerging Asia.

Keywords: exchange rate pass-through, global shocks, structural VAR, time-varying parameter VAR

JEL Classification: E31, F31, F41

1 Introduction

This paper examines the extent of exchange rate pass-through (ERPT) to prices in emerging Asia over the past 25 years, across short and longer-term horizons. We also examine the susceptibility of ERPT in emerging Asia to four global shocks, namely global output, oil prices, US monetary policy, and global risk aversion. ERPT measures the relative change in the prices in the local economy due to changes in the exchange rate between an importing and exporting economy. We focus on emerging Asian economies given their rapid evolution since the Asian financial crisis in terms of the macroeconomic management of the economy, particularly in terms of monetary policy and foreign exchange reserve adequacy. This also motivates our selected time period from 1994 to 2021. Improved macroeconomic management factors have helped emerging Asian economies to become more resilient to external shocks. At the same time, while rising financial development and integration with global financial markets has been a feature of Asian economies over the sample period, there can be increased exposure to foreign financial shocks, thereby testing the strength of macro resilience.

The traditional literature suggests that key channels of ERPT to domestic producer prices are costs of production and the level of competition (Auer & Schoenle, 2016). Since most developing economies depend on foreign currency for engaging in international trade, their ERPT elasticity can be subject to significant variations related to the sectoral composition of the economy and exposure to external economic and financial developments (Burstein & Gopinath, 2014; Forbes et al., 2018). In addition, given rising levels of global financial integration, EMEs are vulnerable to global financial shocks and monetary spillovers, notably via the exchange rate channel (Han & Wei, 2018). For example, shifts in global risk sentiment have played a significant role in affecting financial conditions of EMEs in recent years (Lodge & Manu, 2022). Several papers have pointed out the factors affecting the elasticity and magnitude of ERPT through various macroeconomic models and empirical studies over time (see among others; Amiti et al., 2016; Bonadio et al., 2020; Devereux et al., 2015; Gopinath et al., 2010).

The more recent literature highlights that ERPT is driven strongly by exogenous global shocks (e.g., Forbes et al., 2018; Shambaugh, 2008). While there can be exposure

to global shocks, other work has shown that strong macroeconomic fundamentals and the credibility of the central bank are important shock absorbers (de Mendonça & Tiberto, 2017). Understanding the elasticity and magnitude of global drivers of ERPT to prices is key to the management of inflation and achieving the central bank's price stability mandate. This is a particularly important consideration for emerging economies, where there is a greater susceptibility of domestic inflation to external cost-push pressures and global financial market developments. High levels of ERPT indicate vulnerability of inflation to exchange rate developments which should be closely monitored by policymakers. Lower levels of ERPT can imply less exposure to external shocks and greater monetary policy autonomy. ERPT can affect domestic price stability via foreign spillovers while the role of the exchange rate as an adjustment lever to shocks is also underpinned by the magnitude of ERPT. Depending on the level, ERPT will have varying influences on monetary policy decisions.

While a few studies have examined shock-dependent ERPT in recent years (e.g., Ha et al. (2020) for monetary policy shocks; Ghosh and Rajan (2009a, 2009b); Ozkan and Erden (2015) for global output gap; Sek et al. (2015) for oil price shocks; de Mendonça and Tiberto (2017) for volatility shocks), there is less work carried out that examines a number of alternative global shocks for Asian economies in a consistent econometric set-up, thereby enabling comparative effects to be assessed. To meet this gap, focusing on nine emerging Asian economies over the period 1994 to 2021, this paper builds upon the strand of the ERPT literature that examines so-called "shock-dependent ERPT", by assessing how different types of global shocks can lead to different ERPT reactions for Asian economies. Moreover, our estimated ERPTs incorporate a time-varying component.

The paper has two main related contributions: (i) to construct time-varying estimates of ERPT for emerging Asian economies based on shorter (i.e. 3 months after an exchange rate shock) and longer terms (i.e. 12 months after an exchange rate shock), and (ii) to examine the responsiveness of the estimated ERPTs to different types of global financial and macroeconomic shocks. More specifically, our approach for the ERPT estimates uses a time-varying parameter SVAR model, which is superior to standard one-equation or VAR models in capturing changes in ERPT over time. The TVP-SVAR model also allows us to capture potential structural changes in ERPT (e.g., concerns about structural shifts

such as those related to exchange rate regimes) by allowing VAR coefficients to change over time. As the most policy-relevant concern, there is strong interest in understanding pass-through to consumer prices at short and longer horizons. However, we also examine the pass-through to producer prices, which is also important given the potential for spillovers to consumer prices, and its role as a leading indicator, i.e. central bankers pay close attention to the elasticity of producer prices to external shocks given that they could then spill over consumer prices.

Overall, we find that for our sample of Asian economies, ERPT is incomplete and mostly higher for producer than consumer prices. In addition, we find that longer-term ERPT to producer and consumer prices is mostly greater in magnitude than the shorter-term ERPT. We also find that ERPT has been declining for most Asian EMEs since around 2010, with many economies experiencing some upheaval in ERPT dynamics during the period before 2010. After 2010, and in particular, since the taper tantrum of 2013, these economies have developed significantly in terms of bolstering macroeconomic fundamentals and central bank credibility. A further key finding relates to the source of the exchange rate shock, whereby oil price and global output shocks mostly affect longer-term producer price ERPT in emerging Asia, while US monetary policy and VIX shocks mostly affect longer-term consumer price ERPT in emerging Asia.

The remainder of this paper is organized as follows. Section 2 reviews the literature. Section 3 describes the data, illustrates the methodology, and presents the estimates of time-varying ERPTs. Section 4 presents the results on the impact of global shocks on ERPTs. Finally, Section 5 concludes and provides policy implications. Some supplementary materials are provided in Appendix A.

2 Literature Review

This paper contributes to two main strands of the ERPT literature, that on estimating the extent of ERPT and that which disentangles its magnitude according to the sources of external shocks. Goldberg and Knetter (1997) refer to ERPT as the relative change in the local currency prices due to changes in the exchange rate between an importing and exporting economy. Since the collapse of the Bretton Woods system in 1973, and especially

due to financial globalization and rapidly changing dynamics of the cross-border flow of labor and capital through trade, investment, and financial integration, ERPT emerged as a critical research topic in the exchange rate literature over the past three decades (Beirne & Bijsterbosch, 2011). On the ERPT level, incomplete pass-through can be explained by industrial organization approaches to labor cost adjustment, product substitutability, and the competition of domestic and foreign firms (Dornbusch, 1987a, 1987b; Krugman, 1986). The price effects of the exchange rate are closely associated with wage rates, transportation and distribution costs, trade dependency, openness and trade barriers, and monetary policy framework of importing economies, as well as the extent of local and producer currency pricing (Anh et al., 2021; Barhoumi, 2006; Brun-Aguerre et al., 2012; Bussiere et al., 2014; Choudhri et al., 2005; Frankel et al., 2012; Mankiw, 1985; Mihaljek, Klau, et al., 2008; Obstfeld & Rogoff, 2000; Taylor, 1980). Sekine (2006) noted that ERPT effects have declined for import prices and consumer prices in major industrial countries (see also Anh et al., 2021; Ihrig et al., 2006). Other studies indicate that exchange rates have more pronounced effects on imports compared to consumer prices (McCarthy, 2007). Other papers have noted that higher exchange rate volatility can be related to higher ERPT, also stressing that there can be substantial variation in ERPT magnitudes depending upon the country sample, sample period, and exchange rate regime (Bache, 2007; Wolf & Ghosh, 2001). Several studies have estimated ERPT using time-varying structural vector autoregression (SVAR) models. For example, using a recursive identification method to identify exchange rate shocks for six industrial economies, Campa and Goldberg (2005) identified higher elasticity of ERPT in the short-run relative to the long-run, given the slow adjustment of prices by firms in response to exchange rate shocks. More recently, Leiva-Leon et al. (2022) combine an SVAR approach to model exogenous exchange rate shocks with dynamic factor models to understand ERPT in the euro area. In particular, they find a greater sensitivity in energy inflation to exogenous exchange rate shocks in the period since 2010.

The long-run and short-run elasticity and magnitude of ERPT to prices depends on numerous factors, in particular the sensitivity of firms to external factors and the overall sectoral composition of the economy. The time dimension can be significant as competitive forces can dampen ERPT magnitudes over time. Generally, and in line with economic

intuition, a higher magnitude can be expected on import prices followed by producer prices and then consumer prices. A theoretical understanding of these variations heavily depends on how economic agents manage risk against the cost of production of goods and services, while bearing in mind the level of competition in the importing economies (Auer & Schoenle, 2016).

In Asian economies, early work aligned with the wider ERPT literature that higher pass-through is evident for import prices compared to consumer prices (CaZorzi et al., 2007; Ito & Sato, 2007). Other work on Asia showed that the degree of ERPT is higher during periods of the financial crisis (Ghosh & Rajan, 2009a; Ito et al., 2005). Some studies have found that central bank credibility and the soundness of domestic financial and monetary policies are important factors, with high ERPT associated with a failure to absorb exchange rate shocks during crisis episodes (Baharumshah et al., 2017). High trade dependency has also been found to be an important determinant of ERPT in Asian economies (Copeland & Taylor, 1997; Ghosh & Rajan, 2007; Phuc & Duc, 2021). Asymmetric effects have also been found on prices according to whether the exchange rate is appreciating or depreciating. Delatte and López-Villavicencio (2012) found higher ERPT for exchange rate depreciations than appreciations (see also Kassi et al., 2019). For some economies, ERPT can approach 100% where consumer price volatility is high (Baharumshah et al., 2017; Toh & Ho, 2001). The nature of the exchange rate as the relative price of domestic and foreign prices implies an important role in global shocks (Corsetti et al., 2008; Ha et al., 2020; Nusair & Olson, 2019).

A more recent strand of the literature ascribes the extent and magnitude of ERPT to the nature of exogenous shocks that underpin exchange rate fluctuations (An et al., 2021; Forbes et al., 2018; Ha et al., 2020), generally finding that monetary policy shocks are associated with higher ERPT levels than demand shocks. The nature of the exogenous shock has been found to be an important consideration in a range of other related papers that focus on shock-dependent ERPT (e.g. Forbes et al. (2020) for 26 advanced and emerging economies; Comunale (2019) for the Baltic region; Comunale and Kunovac (2017) in the case of the euro area; and Borensztein, Queijo Von Heideken, et al. (2016) in the case of Latin America). Our paper builds on these works using a TVP-SVAR to examine the responsiveness of domestic prices against four different types of shocks. We follow while

constructing TVP-SVAR approaches. In particular, this paper focuses on understanding how external real and financial triggers of exchange rate fluctuations in emerging Asian economies can result in different effects on inflation.

3 Time-varying exchange rate pass-through

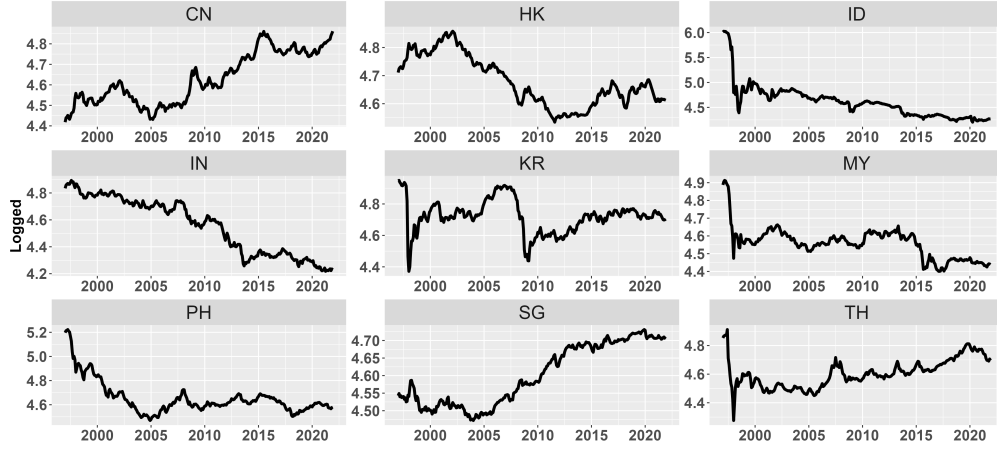
This section estimates time-varying pass-through coefficients, namely ERPT, for each economy in our sample using the time-varying parameter SVAR (TVP-SVAR) model. We first describe the sample and data used in this paper. We then introduce our TVP-SVAR framework as well as the ERPT Identification. Finally, we report the estimated time-varying ERPT for each economy.

3.1 Data

We estimate the ERPT with monthly time-series data from 1994:M1–2021:M12 for nine emerging Asian economies, including the People’s Republic of China (PRC); Hong Kong, China; India; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; and Thailand. The data period selected reflects the longest period possible to ensure a complete set of data for the set of Asian economies considered in the analysis. We analyze the ERPT with the following variables, reflecting the theoretical set-up of ERPT (e.g., Gagnon & Ihrig, 2004). As this paper examines ERPT to domestic prices, namely producer prices and consumer prices, we use the log of monthly seasonally adjusted producer price indices (PPI) and consumer price indices (CPI) as our objective variables. For the nominal exchange rate, we use the log of the average monthly nominal effective exchange rate (NEER) index series from BIS (see Figure 1). Note that, in this paper, an increase in NEER refers to a nominal appreciation. To control for the domestic business cycle, we include the output gap, measured as the deviation of the quarterly seasonally adjusted real GDP from its Hodrick-Prescott filtered trend. For the analysis, we transform the quarterly output gap series into monthly series by quadratic interpolation. Finally, we control for the domestic interest rates by including annualized monthly short-term rates. Table A.1 in Appendix A provides a detailed description of the data, including additional information

on data sources.

Figure 1: Exchange Rates in Emerging Asia



Notes: The figure plots the evolution of nominal effective exchange rate in emerging Asia. The indicators CN, HK, IN, ID, KR, MY, PH, SG, TH represent the People’s Republic of China; Hong Kong, China; India; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; and Thailand, respectively.

3.2 TVP-SVAR framework

The estimation of the ERPT to domestic prices rests on country-specific TVP-SVAR model, using the variables mentioned above, namely nominal exchange rate, output gap, domestic interest rate, producer prices, and consumer prices. We employ the TVP-SVAR approach to estimate the ERPT, instead of relying on a standard reduced-form specification (e.g., Forbes et al., 2018; Javsova et al., 2019) or standard VAR models (e.g., An et al., 2021; Ha et al., 2020; Ito & Sato, 2008; Jimenez-Rodriguez & Morales-Zumaquero, 2016). The advantage of the TVP-SVAR model lies on the possibility to capture the potential structural changes in the ERPT by allowing VAR coefficients to change over time.

Although concentrating on different objective variables, the setting of our TVP-SVAR model follows the specification described in Primiceri (2005) and Nakajima (2011). The reduced form of the TVP-SVAR model can be expressed as

$$X_t = A_{0,t} + A_{1,t}X_{t-1} + \dots + A_{p,t}X_{t-p} + u_t, \quad t = p + 1, \dots, T \quad (1)$$

where the vector of time-varying intercepts is represented by $A_{0,t}$, and $A_{i,t}$ are time-varying

parameter matrices for $i = 1, \dots, p$, and the disturbance vector u_t is white noise. Furthermore, we can obtain a linearized dynamic model as

$$X_t = Z_t \beta_t + S_t^{-1} \Sigma_t \varepsilon_t \quad (2)$$

where β_t is the stacked form of the rows of $S_t^{-1} A_{i,t}$, for $i = 0, \dots, p$, and in $Z_t = I_5 \otimes (X'_{t-1}, \dots, X'_{t-p})$, operator \otimes refers to the Kronecker product. S_t describes the strategy to identify structural shocks and is given in a time-varying lower-triangular matrix form:

$$S_t = \begin{bmatrix} s_{11,t} & 0 & \dots & 0 \\ s_{21,t} & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ s_{51,t} & \dots & s_{54,t} & s_{55,t} \end{bmatrix} \quad (3)$$

The time-varying covariance Ω_t can be decomposed into $\Omega_t = S_t^{-1} \Sigma_t \Sigma_t' (S_t^{-1})'$, where Σ_t is a diagonal time-varying covariance matrix:

$$\Sigma_t = \begin{bmatrix} \sigma_{1,t} & 0 & \dots & 0 \\ 0 & \sigma_{2,t} & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \dots & 0 & \sigma_{5,t} \end{bmatrix} \quad (4)$$

The process built for time-varying parameters follows Primiceri (2005). Let s_t be the assembled vector of the lower triangular coefficients of matrix S_t , and define σ_t to be the assembled vector of the diagonal coefficients of matrix Σ_t . Assume that β_t , S_t , and Σ_t in Equation 2 follow a random walk as follows:

$$\beta_{t+1} = \beta_t + \mu_t \quad (5)$$

$$s_{t+1} = a_t + \eta_t \quad (6)$$

$$\log \sigma_{t+1} = \log \sigma_t + \theta_t \quad (7)$$

for $t = p + 1, \dots, T$. The vectors of the disturbances are assumed to be in a joint normal

distribution with a matrix of variance-covariance:

$$\begin{pmatrix} \varepsilon_t \\ \mu_t \\ \eta_t \\ \theta_t \end{pmatrix} \sim N \left(0, \begin{pmatrix} I_{5,t} & 0 & \dots & 0 \\ 0 & Q & \ddots & \vdots \\ \vdots & \ddots & U & 0 \\ 0 & \dots & 0 & V \end{pmatrix} \right) \quad (8)$$

In the TVP-SVAR framework, we typically have to set up the prior distribution of the initial state of the time-varying parameters. The purpose of the estimation is to specify the joint posterior distribution of the model parameters. To accomplish this, instead of following Primiceri (2005), in which the mean and variance of the prior normal distribution are determined by estimating the baseline SVAR model using time series in the pre-sample period, we choose a flat prior specification based on Nakajima (2011)¹. Based on the Akaike Information Criterion (AIC), the model's lag length is set to two.

3.3 Identification

One standard way to estimate the ERPT is as the impulse responses of domestic prices to NEER shocks. Therefore, we encounter the usual reverse causation issue: economic activities respond to exchange rate movements, but exchange rates also react to changes in domestic macroeconomic fundamentals. The exchange rate shock series used for the estimation is required to identify unanticipated innovations in NEER. In this paper, the identification strategy for the ERPT is based on a block recursive restriction (e.g., Christiano et al., 1999; Ito & Sato, 2008), which results in the following matrix S to fit a just-identified model:

$$S_{m,n} = \begin{pmatrix} s_{1,1} & 0 & \dots & 0 \\ s_{2,1} & s_{2,2} & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ s_{m,1} & s_{m,2} & \dots & s_{m,n} \end{pmatrix} \quad (9)$$

The ordering of the variables imposed in the recursive form implies that the vari-

¹As mentioned in Nakajima (2011), using flat priors for the initial state of time-varying parameters, Markov chain Monte Carlo (MCMC) methodology can efficiently compute the posterior estimation.

ables at the top (such as $s_{1,1}$) will not be affected by the contemporaneous shocks to the lower variables (such as $s_{m,1}$) while the lower variables will be affected by the contemporaneous shocks to the upper variables Christiano et al. (1999). Usually, slower-moving variables are better candidates to be ordered before fast-moving variables (Bruno & Shin, 2015). It therefore follows that we place output gap at the top in the ordering, implying that it will only be affected by contemporaneous shock to itself. Following output gap, we place policy rate second in the ordering, which implies that policy rate will be affected by output gap and itself, based on the assumption that the central bank’s monetary policy will reflect economic conditions. Importantly, we place the nominal exchange rate variable after the policy rate but before two domestic price variables, which is based not only on the assumption that domestic business cycle and monetary policies will affect the state of nominal exchange rates, but also on the consideration of our goals to estimate the pass-through of exchange rate shocks to domestic prices. Finally, we put producer prices and consumer prices in last place in the ordering while letting consumer prices reflect the changes in producer prices, following the price chain from the producer level to the consumer level².

3.4 Time-varying ERPT

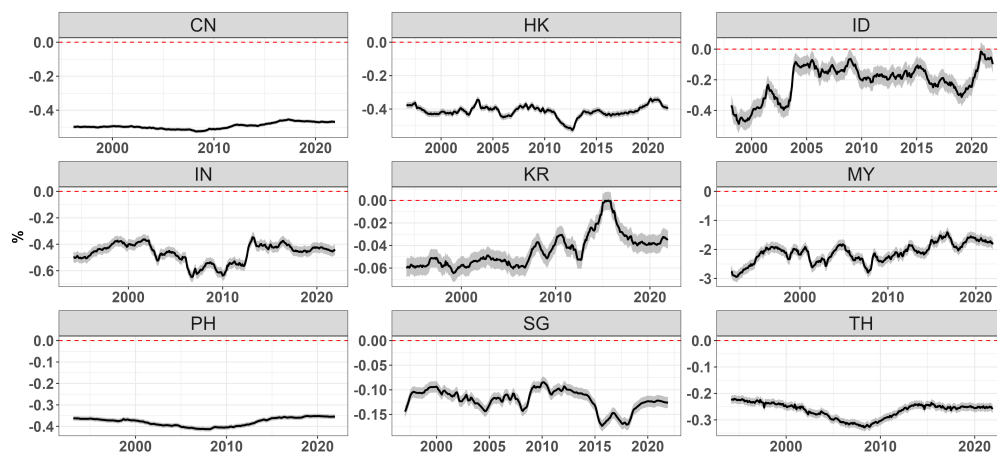
In this study, we define the ERPT as the ratio of the impulse responses of domestic prices to the impulse responses of NEER changes following the positive exchange rate shock, which is equal to time-varying impulse responses of domestic prices to a 1 percentage point appreciation shock to the NEER. Therefore, a negative ERPT refers to a situation in which a currency appreciation is accompanied by a decline in domestic prices.

One advantage of TVP-SVAR impulse response analysis is that we can estimate the time-varying ERPT across different horizons (the number of months after a given NEER shock). Figures A.1 and A.2 show the complete time series evolution of ERPTs to domestic prices, namely the producer and consumer prices, using three-dimensional graphs. Here, the vertical axis represents the magnitude of the response, of which the unit is one percentage point. The left horizontal axis represents the response period, of which the unit

²We also use alternative orderings as robustness tests, finding that our baselines results continue to hold. Further details are available from the authors upon request.

is one month. The right horizontal axis represents the year. Although the magnitude and volatility of the ERPTs vary across different economies, we find that positive exchange rate shocks dampen domestic prices. For a deeper insight on the time-varying results, we focus on two types of ERPTs, namely the short-term ERPT and yearly ERPT. The short-term ERPT is defined as the percentage change of domestic prices around three months after a given NEER shock and yearly ERPT is the percentage change of domestic prices around 12 months after a given NEER shock³.

Figure 2: Time-varying ERPT to Producer Prices: Short-term



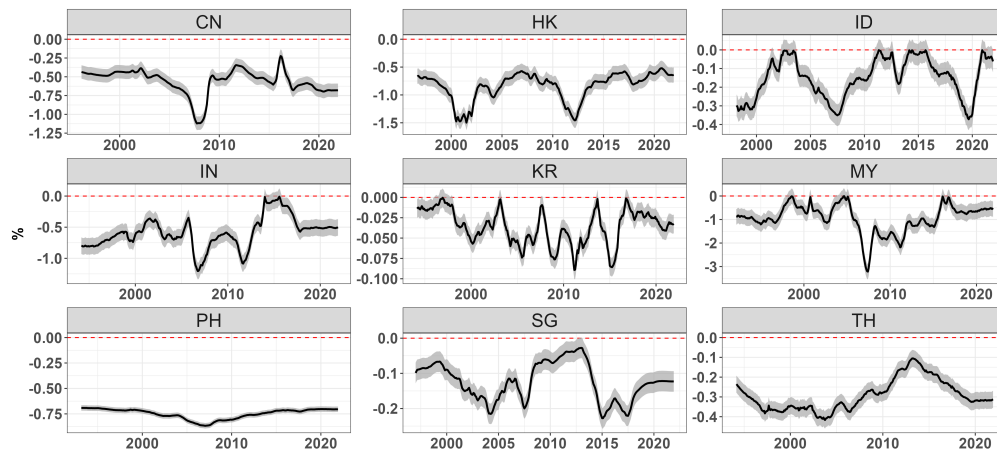
Notes: The figure plots short-term time-varying impulse responses of producer prices to a 1 percentage point appreciation shock of the exchange rate, with 90% confidence intervals. The vertical axis unit is percentage points, and the unit of the horizontal axis refers to months. The indicators CN, HK, IN, ID, KR, MY, PH, SG, TH represent the People’s Republic of China; Hong Kong, China; India; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; and Thailand, respectively.

Figures 2 to 3 plot the estimated short-term and yearly time-varying ERPT to producer prices for nine emerging Asian economies, respectively. The results indicate that both short-term and yearly ERPT to producer prices vary substantially across economies. For the short-term ERPT, the results show that there is a gradual decline at some point in the ERPT for the PRC, Malaysia, India, and Indonesia over the sample period. On the other hand, for other economies, the ERPT spikes in one period and then dampens. In-

³ERPT estimates at three months after a shock and 12 months after a shock are important for policymakers, particularly central bankers, in order to understand the magnitude of pass-through over different time horizons. For example, a monetary policy reaction may be more pertinent for excessive vulnerabilities to shocks for the 12-month case, given the usual lags associated with the monetary policy impact. That said, monetary policy can still have a significant effect on financial markets at the shorter end. Shocks at the shorter end may also be the most concerning from a financial stability perspective.

terestingly, we find that the yearly ERPT estimates are more volatile and with a larger magnitude compared to the short-term ones. Our estimates also suggest that traditional VAR estimates in previous studies can miss meaningful changes in ERPT over time for individual economies.

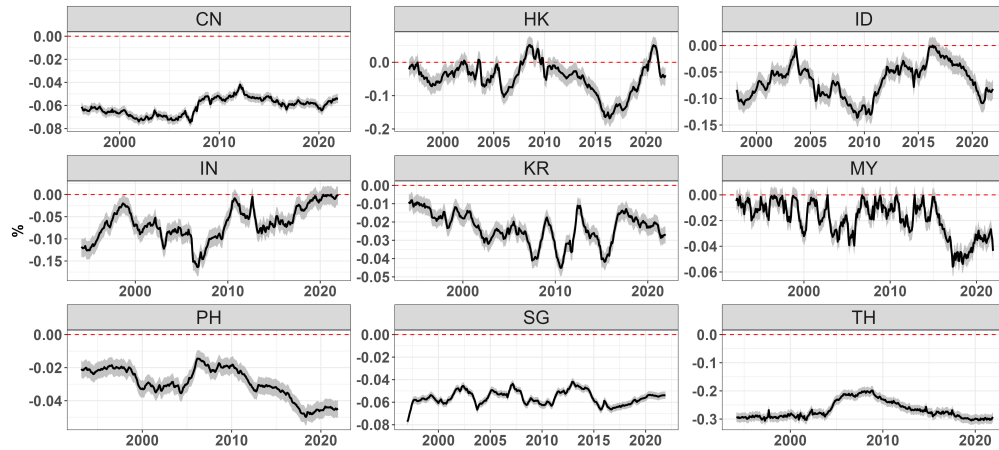
Figure 3: Time-varying ERPT to Producer Prices: Yearly



Notes: The figure plots yearly time-varying impulse responses of producer prices to a 1 percentage point appreciation shock of the exchange rate, with 90% confidence intervals. The vertical axis unit is percentage points, and the unit of the horizontal axis refers to months. The indicators CN, HK, IN, ID, KR, MY, PH, SG, TH represent the People’s Republic of China; Hong Kong, China; India; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; and Thailand, respectively.

Figures 4 to 5 plot the estimated short-term and yearly time-varying ERPT to consumer prices, respectively. The results also suggest that both short-term and yearly ERPT to consumer prices have different patterns over time across economies. Figure 4 suggests that there is a gradual decline in the short-term ERPT from the 2010s onwards in Indonesia. There is a strong increase in the short-term ERPT for the Philippines and Thailand from 2009 onwards, with ERPT remaining relatively more stable in recent periods. For the other emerging Asian economies, the pattern of short-term ERPT is unclear, with evidence of volatile fluctuations. For the yearly ERPT (Figure 5), similar to the case of producer prices, the magnitude of the pass-through is larger compared to the short-term. Importantly, we find that the ERPT to consumer prices is smaller than that to producer prices, supporting the intuition of the price chain running from the producer level to the consumer level. It is also notable, and in line with the wider literature and economic intuition, that ERPT to prices is generally lower in magnitude for economies with flexible

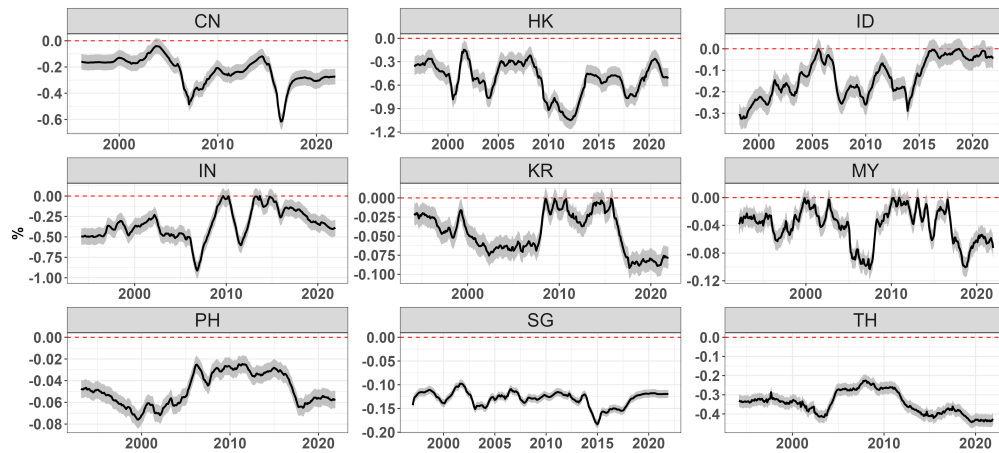
Figure 4: Time-varying ERPT to Consumer Prices: Short-term



Notes: The figure plots short-term time-varying impulse responses of consumer prices to a 1 percentage point appreciation shock of the exchange rate, with 90% confidence intervals. The vertical axis unit is percentage points, and the unit of the horizontal axis refers to months. The indicators CN, HK, IN, ID, KR, MY, PH, SG, TH represent the People’s Republic of China; Hong Kong, China; India; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; and Thailand, respectively.

exchange rates and inflation targeting central bank mandates.

Figure 5: Time-varying ERPT to Consumer Prices: Yearly



Notes: The figure plots yearly time-varying impulse responses of consumer prices to a 1 percentage point appreciation shock of the exchange rate, with 90% confidence intervals. The vertical axis unit is percentage points, and the unit of the horizontal axis refers to months. The indicators CN, HK, IN, ID, KR, MY, PH, SG, TH represent the People’s Republic of China; Hong Kong, China; India; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; and Thailand, respectively.

4 Global shocks and ERPT

In the previous section, we estimated ERPTs to producer prices and consumer prices based on a TVP-SVAR approach for economies in emerging Asia, showing that ERPTs not only vary substantially across economies but also evolve significantly over time within economies. As ERPT can affect domestic price stability via foreign spillovers, it is important to explicitly to investigate how ERPT depends on global financial and macroeconomic movements (i.e., the shocks). Therefore, this section analyzes the effects of global shocks on ERPTs by incorporating a set of global factor variables and an identified SVAR framework.

4.1 Global factors

The previous literature highlighted a large number of global factors that can affect exchange rates. In this paper, we focus on the following variables to capture global financial and macroeconomic movements: oil prices, the global output gap, the VIX index, and the US short-term rate. For oil prices, we use the monthly average spot price of Brent, Dubai and West Texas Intermediate in the log form. The global output gap is calculated according to the methodology for the domestic output gap, as the deviation of the monthly seasonally adjusted real global industrial production from its Hodrick-Prescott filtered trend. The global industrial production index is attained by CPB Netherlands Bureau for Economic Policy Analysis. We use the VIX index that stands for the Chicago Board Options Exchange (CBOE) Volatility Index, as a measure of global financial market uncertainty. For the indicator of US monetary policy stance, we use the shadow policy rate proposed by Wu and Xia (2016), which reasonably reflects both conventional and unconventional monetary policy regimes.

4.2 SVAR framework

Based on the estimated ERPTs together with the global factors described above, we investigate the dynamic impact of global shocks on country-specific ERPTs by estimating the SVAR model in the following reduced form:

$$A(L)X_t = \varepsilon_t \tag{10}$$

where X_t is the endogenous variable vector, including our global factors and ERPT estimates, $A(L) = A_0 - A_1L - \dots - A_pL^p$ is the p th polynomial matrix with lag operator L , and ε_t is the structural shock vector.

Similar to the previous section, the identification strategy for global shocks also relies on a block recursive restriction. We place oil prices at the top in the ordering, implying that it will only be affected by contemporaneous shock to itself. Following oil prices, we place the global output gap second in the ordering, which implies that the global output gap is affected by oil price shocks and itself. The US shadow policy rate is ordered third, based on the assumption that the Fed’s monetary policy reflects the global business cycle and changes in US monetary policy affect the global financial market uncertainty (e.g., Miranda-Agrippino & Rey, 2020; Obstfeld, 2019). The VIX index is placed fourth, indicating that global financial market uncertainty will be affected by other global shocks and itself except domestic ERPTs. As the ERPT is our target variable, we place the ERPT estimates at the bottom of the SVAR ordering, implying the ERPT is contemporaneously affected by all global shocks while the ERPT innovations have no contemporaneous impact on global factors⁴.

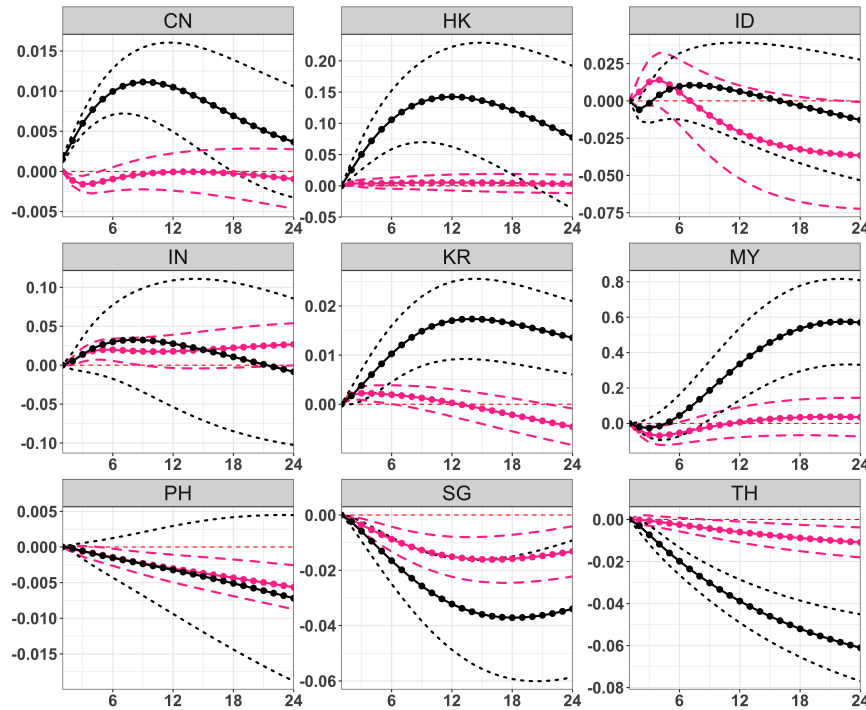
4.3 Results

The estimation is based on monthly time series spanning from 1994:M1 to 2022:M1. Based on the Akaike Information Criterion (AIC), the SVAR model’s lag length is set to two.

Oil price shocks Figure 6 plots impulse responses of the short-term (red lines) and yearly (black lines) ERPT to producer prices to for a positive oil price shock. The impulse responses are plotted with 95% confidence bands. The shock refers to a one-unit shock, which can be interpreted as a one percentage point change in oil prices.

⁴We also examine alternative orderings as a robustness check. These sensitivity tests, available from the authors upon request, are consistent with our baseline.

Figure 6: Response of ERPT to Producer Prices: Oil Price Shocks



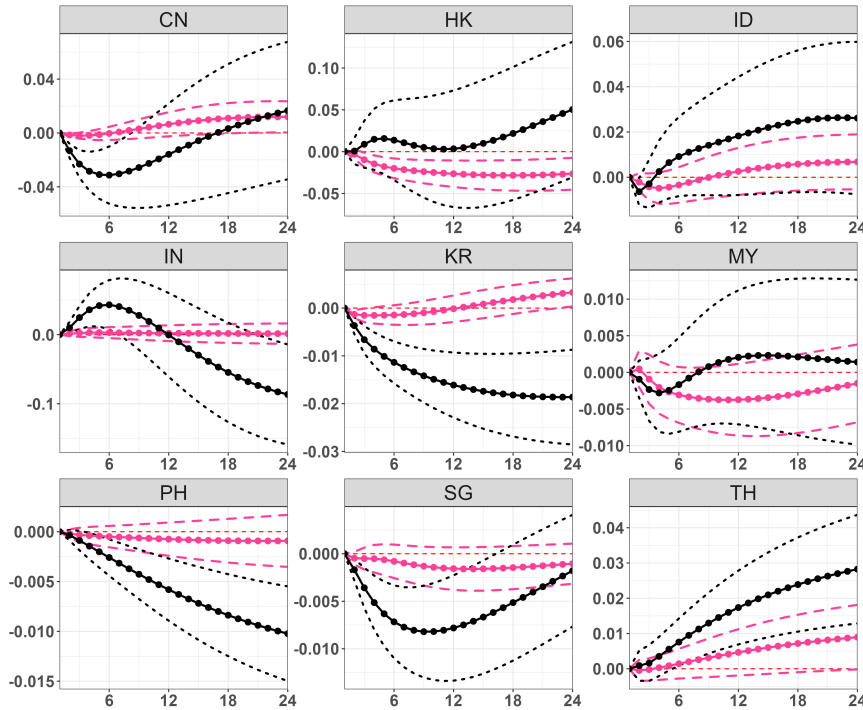
Notes: Impulse responses with 95% confidence bands are reported. Red lines refer to the short-term ERPT and black lines refer to the yearly ERPT. The vertical axis unit is percentage points, and the unit of the horizontal axis refers to months. The indicators CN, HK, IN, ID, KR, MY, PH, SG, TH represent the People’s Republic of China; Hong Kong, China; India; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; and Thailand, respectively.

The results indicate that the impacts of oil price shocks on producer price ERPTs vary substantially for short-term and yearly estimates as well as across economies. For longer-term ERPT, the oil price shock amplifies the extent of the pass-through to producer prices, with a positive response found in the cases of the PRC; Hong Kong, China; the Republic of Korea; and Malaysia. On the other hand, for Singapore, the Philippines, and Thailand, the oil price shock is associated with a negative response in ERPT to producer prices, although the results are not always significant. In addition, we do not observe a significant impact of oil price shocks on Indonesia’s ERPT to producer prices for both short-term and yearly estimates. In general, the results are in line with the recent findings (e.g., Ha et al., 2020), showing that oil price shocks can be associated with different ERPTs, which is also related to the extent to which economies are net exporters or net importers of oil. For short-term ERPT to producer prices, the response to oil price shocks is much more muted than that

for longer-term ERPT.

Figure 7 plots impulse responses of the short-term (red lines) and yearly (black lines) ERPT to consumer prices to a positive oil price shock.

Figure 7: Response of ERPT to Consumer Prices: Oil Price Shocks

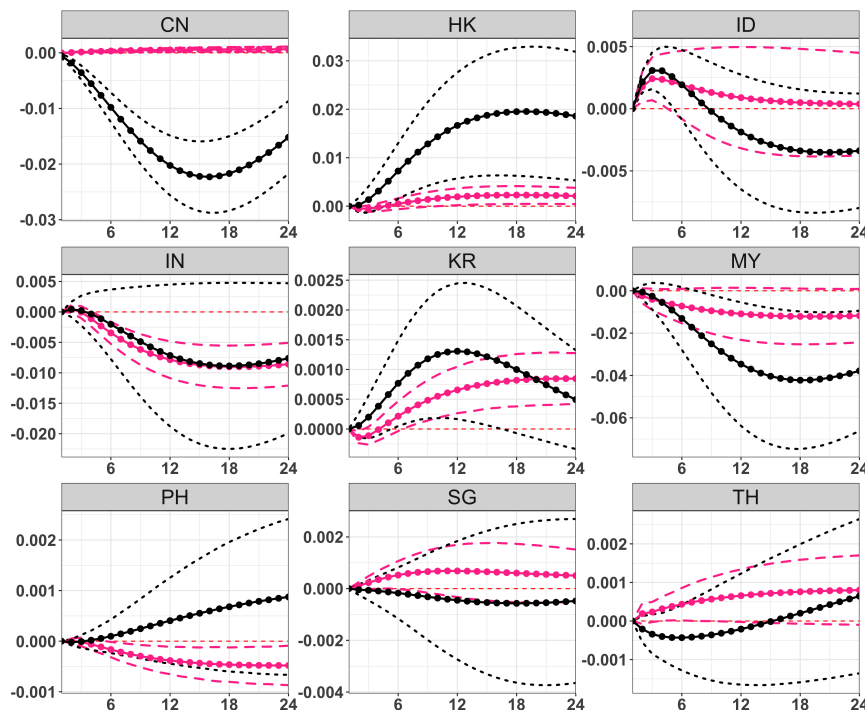


Notes: Impulse responses with 95% confidence bands are reported. Red lines refer to the short-term ERPT and black lines refer to the yearly ERPT. The vertical axis unit is percentage points, and the unit of the horizontal axis refers to months. The indicators CN, HK, IN, ID, KR, MY, PH, SG, TH represent the People's Republic of China; Hong Kong, China; India; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; and Thailand, respectively.

Similar to the case of ERPT to producer prices, the impacts of oil price shocks on ERPT to consumer prices reveal some variation across economies. The responses are much larger in magnitude and more statistically significant in the case of longer-term ERPT estimates. The rise in oil prices has a negative effect on the ERPT's magnitude (in the cases of either short or longer-term ERPT) for the PRC; the Republic of Korea; the Philippines; and Singapore. A positive effect is found in the case of Thailand. For other economies, the responses are mostly not significant. The responses to shocks are much lower in magnitude and less significant overall in the case of shorter-term ERPT to consumer prices.

Global output shocks Figure 8 plots impulse responses of the short-term (red lines) and yearly (black lines) ERPT to producer prices for a positive global output shock.

Figure 8: Response of ERPT to Producer Prices: Global Output Shocks



Notes: Impulse responses with 95% confidence bands are reported. Red lines refer to the short-term ERPT and black lines refer to the yearly ERPT. The vertical axis unit is percentage points, and the unit of the horizontal axis refers to months. The indicators CN, HK, IN, ID, KR, MY, PH, SG, TH represent the People’s Republic of China; Hong Kong, China; India; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; and Thailand, respectively.

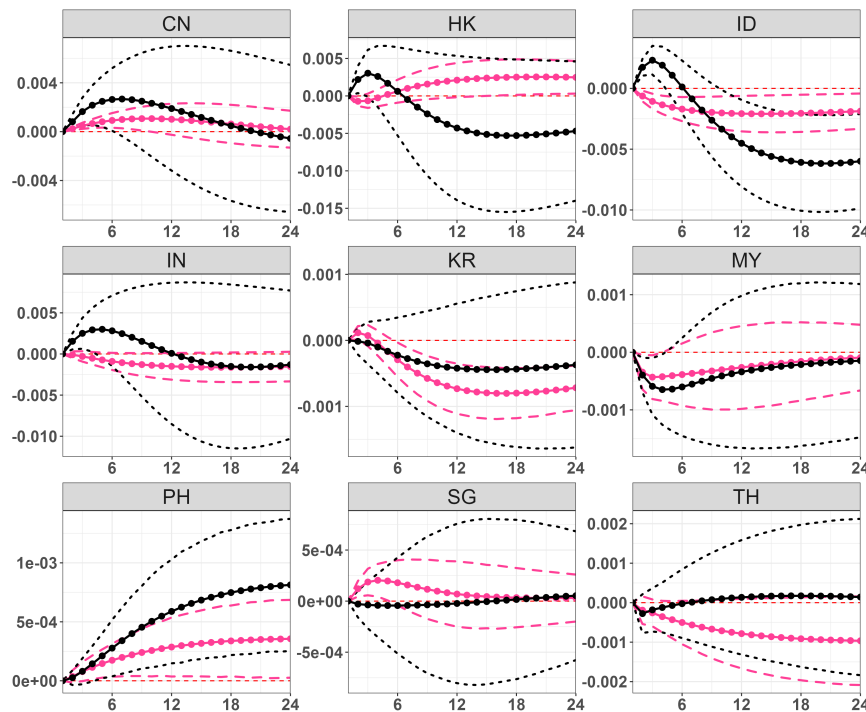
As can be seen, a positive global output shock increases the ERPT to producer prices for Hong Kong, China; Indonesia; and the Republic of Korea, in the case of the longer-term estimate. Negative responses are found for the PRC and Malaysia on longer-term ERPT. For short-term ERPT to producer prices, the responses to shocks are mostly lower in magnitude and less significant, while there are significant effects in the cases of India and the Philippines. We do not observe a significant impact of global output shocks on Singapore’s ERPT to producer prices for both short-term and yearly estimates.

Figure 9 plots impulse responses of the short-term (red lines) and yearly (black lines) ERPT to consumer prices to a positive global output shock.

While some variation is found in the estimates, the significant responses in ERPT

to are mostly found at the shorter time horizon, with statistical significance dissipating within the first 6 months after the shock. The positive shock to global output decreases the ERPT's magnitude for Indonesia and the Republic of Korea, at some points. The effect of global output shocks on ERPT to either producer or consumer prices is closely linked to country-specific trade integration at the global level and the extent of the impact of a more positive global growth outlook on global exchange rate configurations. Differences across economies as regards their exposure to shifts in global output, notably via the exchange rate channel, provides some insight on the heterogeneity found in the ERPT responses to shocks across economies.

Figure 9: Response of ERPT to Consumer Prices: Global Output Shocks

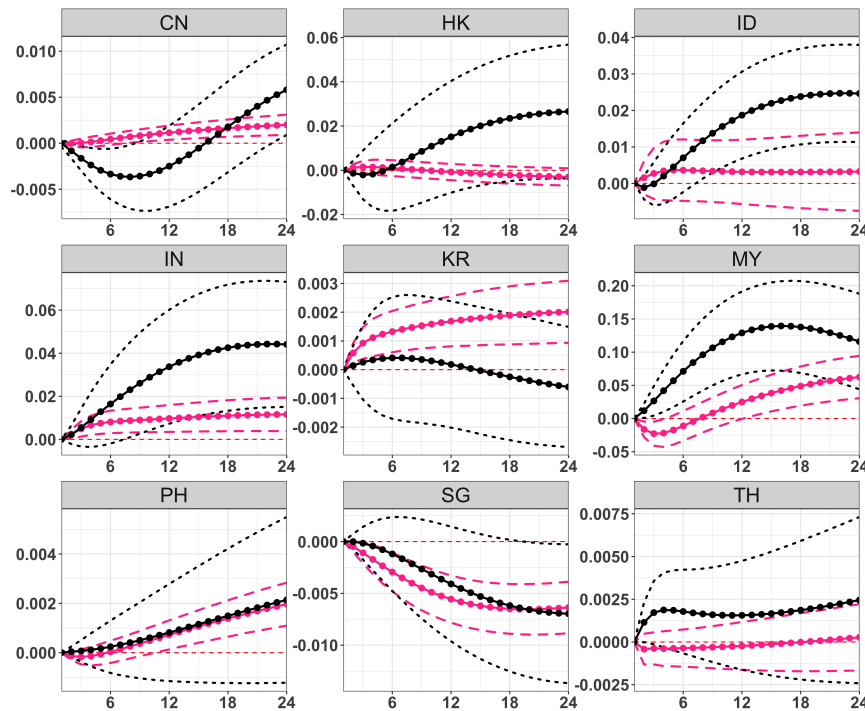


Notes: Impulse responses with 95% confidence bands are reported. Red lines refer to the short-term ERPT and black lines refer to the yearly ERPT. The vertical axis unit is percentage points, and the unit of the horizontal axis refers to months. The indicators CN, HK, IN, ID, KR, MY, PH, SG, TH represent the People's Republic of China; Hong Kong, China; India; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; and Thailand, respectively.

US monetary policy shocks Figure 10 plots the impulse responses of the short-term (red lines) and yearly (black lines) ERPT to producer prices to a contractionary US monetary

policy shock.

Figure 10: Response of ERPT to Producer Prices: US Monetary Policy Shocks



Notes: Impulse responses with 95% confidence bands are reported. Red lines refer to the short-term ERPT and black lines refer to the yearly ERPT. The vertical axis unit is percentage points, and the unit of the horizontal axis refers to months. The indicators CN, HK, IN, ID, KR, MY, PH, SG, TH represent the People’s Republic of China; Hong Kong, China; India; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; and Thailand, respectively.

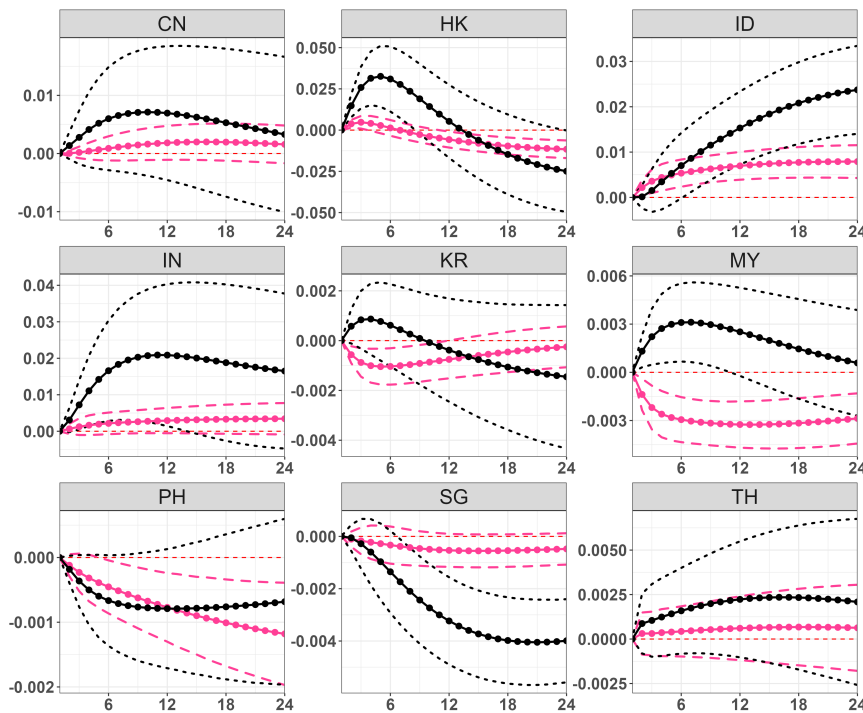
A tightening US monetary policy scenario and US dollar appreciation would be expected to lead to imported inflation abroad. As can be seen, US monetary tightening shocks increase the magnitude of ERPT to producer prices for most economies (such as the PRC; Hong Kong, China; Indonesia; India; the Republic of Korea; Malaysia; the Philippines; and Thailand), at least for the short term. On the other hand, US monetary tightening shocks lead to weaker ERPT for Singapore. The longer-term estimates are significant in only a few cases (India, Indonesia, and Malaysia). The findings imply that a US monetary policy shock is more likely to affect ERPT to producer prices in the short-term estimate, with a more rapid transmission of shocks emanating in financial markets as opposed to real economy shocks.

Figure 11 plots impulse responses of the short-term (red lines) and yearly (black lines)

ERPT to consumer prices to a contractionary US monetary policy shock.

The results show that contractionary US monetary policy shocks increase the ERPT's magnitude for Hong Kong, China; Indonesia; and India, while they decrease the ERPT of the Philippines and Singapore. This holds across both longer-term and shorter-term estimates, with the magnitude of the effects larger for the former overall. For the Republic of Korea and Malaysia, the short-term ERPT responds negatively while the yearly one reacts positively, following a US monetary tightening. On the other hand, for the PRC and Thailand, the US monetary tightening has no significant impact on ERPTs. Unlike the case of the responses of producer price ERPT to US monetary policy shocks, the responses of consumer price ERPT show much more heterogeneity across economies in terms of both magnitude and significance.

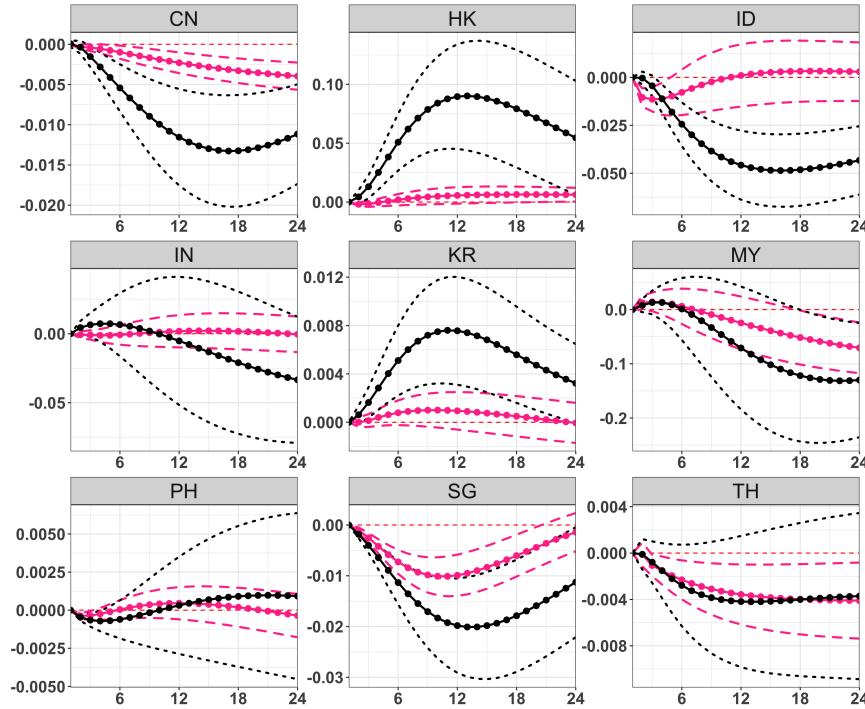
Figure 11: Response of ERPT to Consumer Prices: US Monetary Policy Shocks



Notes: Impulse responses with 95% confidence bands are reported. Red lines refer to the short-term ERPT and black lines refer to the yearly ERPT. The vertical axis unit is percentage points, and the unit of the horizontal axis refers to months. The indicators CN, HK, IN, ID, KR, MY, PH, SG, TH represent the People's Republic of China; Hong Kong, China; India; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; and Thailand, respectively.

VIX shocks Figure 12 plots impulse responses of the short-term (red lines) and yearly (black lines) ERPT to producer prices to a positive VIX shock.

Figure 12: Response of ERPT to Producer Prices: VIX Shocks



Notes: Impulse responses with 95% confidence bands are reported. Red lines refer to the short-term ERPT and black lines refer to the yearly ERPT. The vertical axis unit is percentage points, and the unit of the horizontal axis refers to months. The indicators CN, HK, IN, ID, KR, MY, PH, SG, TH represent the People’s Republic of China; Hong Kong, China; India; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; and Thailand, respectively.

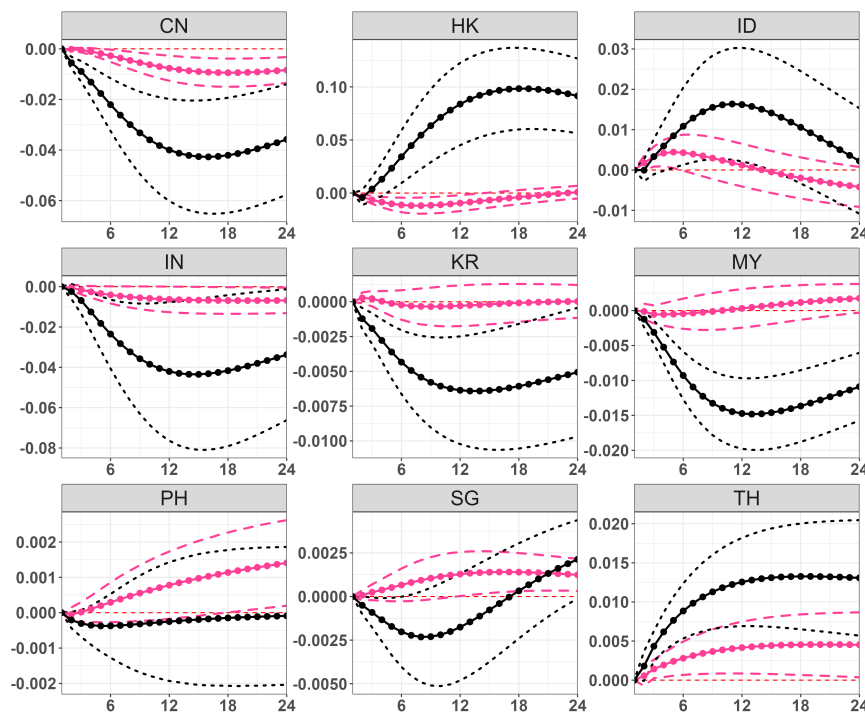
A positive VIX shock can signify amplified global financial market uncertainty and net capital outflows from EMEs. Our results show that VIX shocks dampen producer price ERPT for the PRC, Indonesia, Malaysia, Singapore, and Thailand, while a positive impact is found for Hong Kong, China and the Republic of Korea. On the other hand, VIX shocks have little effect on ERPTs in India and the Philippines.

Figure 13 plots impulse responses of the short-term (red lines) and yearly (black lines) ERPT to consumer prices to a positive VIX shock.

VIX shocks dampen the magnitude of consumer price ERPT for the PRC, India, the Republic of Korea, and Malaysia while increasing the ERPT for Hong Kong, China; Indonesia; and Thailand. On the other hand, VIX shocks have little effect on ERPTs in the

Philippines and Singapore.

Figure 13: Response of ERPT to Consumer Prices: VIX Shocks



Notes: Impulse responses with 95% confidence bands are reported. Red lines refer to the short-term ERPT and black lines refer to the yearly ERPT. The vertical axis unit is percentage points, and the unit of the horizontal axis refers to months. The indicators CN, HK, IN, ID, KR, MY, PH, SG, TH represent the People's Republic of China; Hong Kong, China; India; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; and Thailand, respectively.

Overall, it is clear that the magnitude of producer and consumer price ERPT in emerging Asian economies varies considerably depending on the nature of the shock. There are also notable differences across economies according to the elasticity of ERPTs to global shocks for shorter-term and longer-term estimates. Global shocks overall seem to have the greatest effects on the longer-term estimates for both producer and consumer price ERPT. For oil price and global output shocks, as regards statistical significance, producer price ERPT is more affected overall than consumer price ERPT. For financial market shocks emanating from US monetary policy and the VIX, consumer price ERPT seems to be more responsive overall than producer price ERPT.

5 Conclusion and policy implications

This paper provides ERPT estimates for nine emerging Asian economies based on a time-varying SVAR model over the period 1994 to 2021. In addition, the paper uncovers external vulnerabilities that evoke alternative relative ERPT responses in terms of magnitude and persistence. Overall, we find that ERPT is incomplete and mostly higher for producer than consumer prices. The elasticity of producer prices and consumer prices to exchange rate shocks is largely greater in magnitude in the longer-term compared to the shorter-term ERPT. We also find that ERPT has been declining for most Asian EMEs since around 2010, with many economies experiencing some upheaval in ERPT dynamics during the period prior to 2010. During the early 2010s, notably in the aftermath of the taper tantrum in 2013, these economies developed significantly in terms of bolstering macroeconomic fundamentals and central bank credibility. As regards the significance of global shocks, we find that oil price and global output shocks mostly affect longer-term producer price ERPT in emerging Asia, while US monetary policy and VIX shocks mostly affect longer-term consumer price ERPT in emerging Asia.

Our results have implications for monetary policy and central banks in emerging Asia. While ERPT has in general trended downwards and varies somewhat across economies in terms of the size of the elasticity, it remains materially and statistically significantly affecting inflation, also with evidence of persistence. This implies that exchange rate developments are important considerations for central banks in the sense that it can affect their core mandate on price stability. While recognizing the shock-absorbing capacity of exchange rates in flexible exchange rate regime settings, a persistently high rate of ERPT could trigger an assessment of the appropriateness of the monetary policy framework. Our results also have implications for policy makers and central banks in shielding their economies from the ERPT effects of global economic and financial shocks. For example, amplified ERPT to producer prices from oil price shocks could trigger an acceleration in efforts aimed at reducing concentration risks through diversification of the energy supply networks. For central banks, the dominant role of US monetary policy in driving the global financial cycle makes it a difficult proposition for emerging Asian economies to have buffers in place against US monetary policy shocks. However, strong macroe-

conomic fundamentals are important considerations in this regard, including adequate foreign exchange reserve accumulation.

Finally, our paper can also help central banks to improve forecasts of inflation that derive from exchange rate movements. While fraught with difficulty and notoriously bound by wide margins of error, the lags in monetary policy in affecting inflation mean that accuracy in inflation forecasting is central to effective monetary policy. The incorporation of time-varying ERPT estimates into inflation forecasting models may be an area worth further examination.

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A Appendix

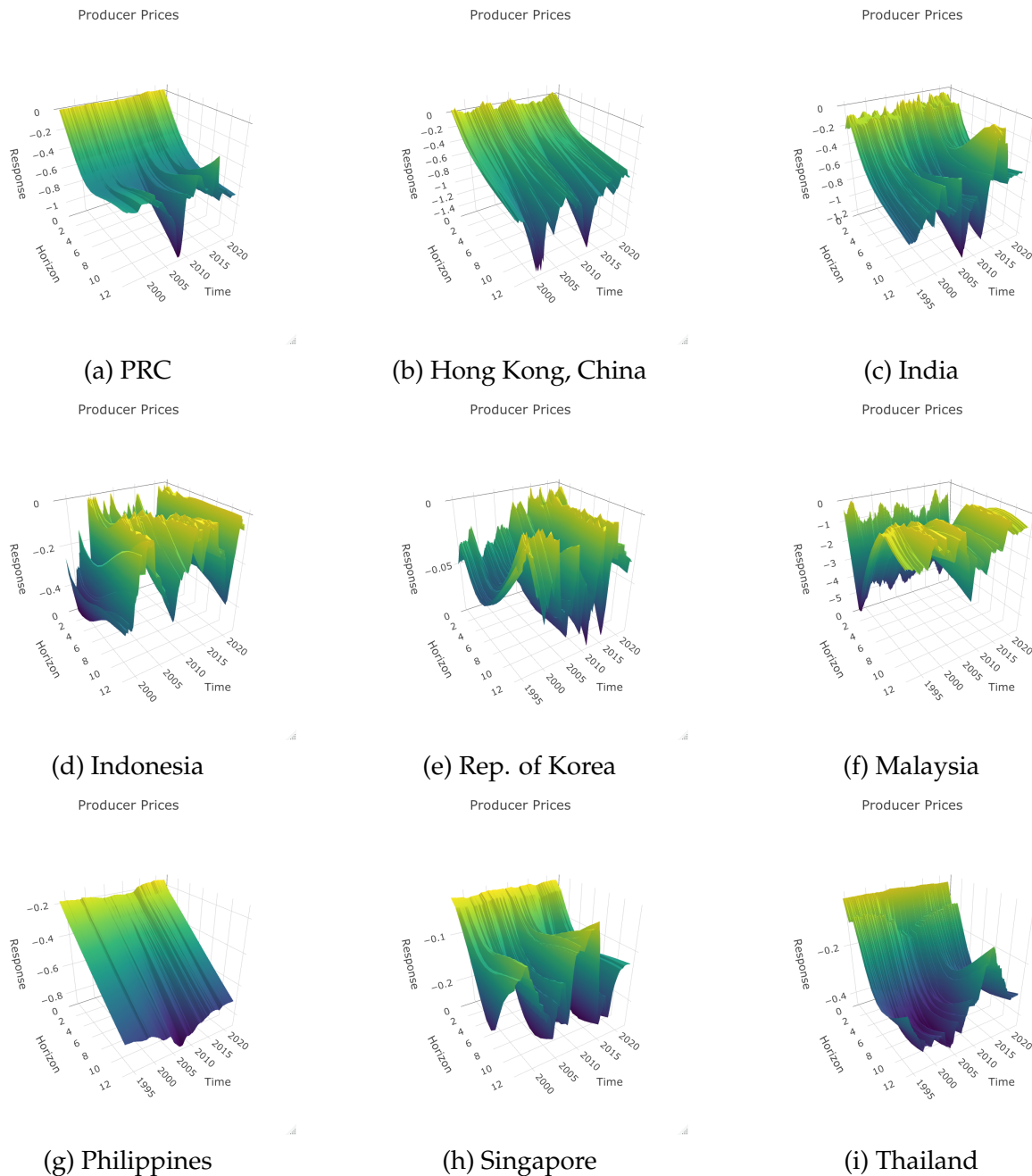
A.1 Data Sources

Table A.1: Overview of Variables Used in the Empirical Analysis

Variable	Data Source	Definition
Nominal effective exchange rate	BIS and IMF	The log of the nominal effective exchange rate (NEER) indices.
Consumer prices	IMF and national statistics	The log of seasonally adjusted monthly consumer price indices (CPI)
Producer prices	IMF and national statistics	The log of seasonally adjusted monthly producer price indices (PPI)
Output gap	IMF, national statistics, and authors' calculation	The deviation of the quarterly seasonally adjusted real GDP from its Hodrick-Prescott filtered trend. Quadratic interpolation is implemented to generate monthly time series.
Domestic interest rates	IMF and national statistics	Annualized monthly policy rates.
Oil prices	World Bank	Monthly average spot price of Brent, Dubai and West Texas Intermediate
Global output gap	CPB Netherlands Bureau for Economic Policy Analysis and authors' calculation	Monthly seasonally adjusted
VIX index	Bloomberg	Real global industrial production from its Hodrick-Prescott filtered trend
US monetary policy rate	Wu and Xia (2016)	the Chicago Board Options Exchange (CBOE) Volatility Index, Measure of global financial market uncertainty. Monthly shadow policy rate

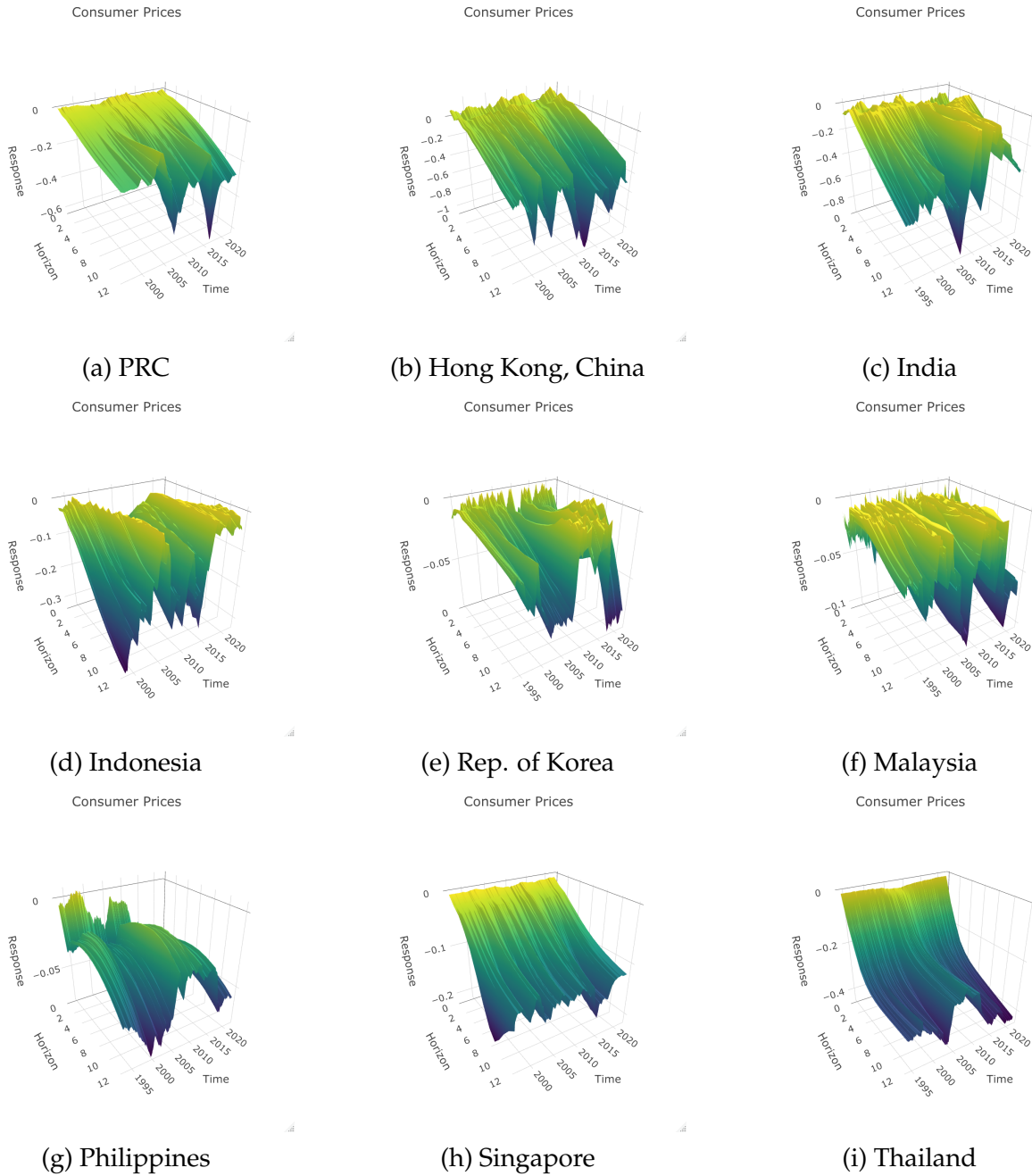
A.2 Supplementary Figures

Figure A.1: Time-varying ERPT to Producer Prices



Notes: The figure plots time-varying impulse responses of producer prices to a one percentage point appreciation shock of the exchange rate. The vertical axis represents the magnitude of the response, of which the unit is percentage points. The left horizontal axis represents the response period, of which the unit is months. The right horizontal axis represents the year.

Figure A.2: Time-varying ERPT to Consumer Prices



Notes: The figure plots time-varying impulse responses of consumer prices to a one percentage point appreciation shock of the exchange rate. The vertical axis represents the magnitude of the response, of which the unit is percentage points. The left horizontal axis represents the response period, of which the unit is months. The right horizontal axis represents the year.