How is Inflation Priced in Global Markets ?

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Abstract

We examine how inflation risk is priced in 34 equity markets from 1989 to 2022. International markets feature distinct persistence and volatility of their inflation components. Also, the shares of core, energy, and food in the consumer basket differ significantly across countries. We model separately the inflation components in partially segmented markets allowing for time variation in the risk factors and their prices. We find shocks to core inflation command global and local risk premiums, while shocks to food and energy inflation are only priced locally in some countries, especially in emerging markets. Our study provides new insights into the dynamics of different inflation components and highlights the importance of distinguishing between global and local inflationary forces.

JEL Classification: G15, F30, G30

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1 Introduction

We examine the pricing of inflation risk in international equity markets. When inflation is stochastic and purchasing power parity does not hold, international assets are priced by the global market and global inflation risks as demonstrated by Adler and Dumas (1983). Under partial segmentation due to barriers to portfolio flows, local market, and local inflation risk factors are priced in addition to global market and global inflation risks as shown by Chaieb and Errunza (2007)(hereafter, CE). Since international markets feature distinct persistence and volatility of their inflation components, and the shares of core, energy, and food in the consumer's basket differ significantly across countries, we study how inflation risk is priced in international equity markets by extending the CE model for a sample of 34 countries.

Specifically, we extend the two-country CE model to N countries and allow currency and inflation risks to be priced separately. A security that can only be held by local investors commands a world market risk premium, N foreign inflation and exchange risk premiums, an unspanned local market risk premium, an unspanned local inflation risk premium, and an unspanned local currency risk premium. The unspanned risk is the country-specific risk that cannot be spanned by the set of assets that are traded in markets that are open to all investors. The model implies the estimation of a large number of risk premiums. We show that assuming the same risk tolerance among DMs allows us to collapse the N currency and inflation risk premiums in a dollar factor risk premium and a global inflation risk premium.[1] This simplified version of the model minimizes the number of currency and inflation risk premiums that need to be estimated. Interestingly, assuming the same risk tolerance across countries shows that the dollar factor, which is a wealth-weighted average of excess returns on all non-US dollar currencies, should be globally priced in international equity markets.[2] In the model estimation, we allow for time-variation in quantities and prices of risks and differentiate between core, energy, and food inflation shocks.

In addition to the development of the new international asset pricing model (IAPM), our work makes three contributions. First, we document a large comovement in unexpected headline inflation across countries, more so in developed markets (DMs) than in emerging markets (EMs). We

[1] Other empirical studies on currency risk use an aggregate exchange rate index, see, for example, Ferson and Harvey (1994), Vassalou (2000), Carrieri, Errunza, and Majerbi (2006), **?**.

[2] Lustig, Roussanov, and Verdelhan (2011, 2014) and Verdelhan (2018) find that two factors, dollar and carry, explain a significant share of the systematic variation in exchange rates.

estimate global inflation with a GDP-weighted average of 18 developed market inflation series. The global inflation risk is priced in equity markets. The commonalities across countries are present in all three core, energy, and food inflation components. Although the commonality in headline inflation across countries has been documented in the previous literature (see, for example, Ciccarelli and Mojon (2010), Neely and Rapach (2011), Parker (2018), Mumtaz and Surico (2012), Lane (2022))[3], our paper is the first to show how global inflation risk is priced in international equity markets. Global core inflation risk is priced but we find no evidence of pricing of global energy and food inflation risks. The premium for bearing global core inflation risk represents, on average, about 3% of the total risk premium for DMs and EMs.

Second, we show that the exposure to global core inflation risk varies substantially over time, and has become more synchronized after the Global Financial Crisis (hereafter, GFC). We observe commonality in the exposure to global core inflation among DMs and EMs, with the average cross-country correlation of 0.70. However, we observe more time series variation in the exposures to global core inflation risk for EMs, approximately twice as much as that of DMs.

Third, we document large heterogeneity in the exposures to local inflation risks which includes not only core but also energy and food. Local inflation risk is priced in more than half of our sample of DMs and EMs. Local inflation risk premium includes not only core but also energy and food. Local inflation risk is small for some countries but on average it represents about 10% of the total premium in absolute value across all assets. Core and non-core shocks are relevant and are locally priced in partially segmented markets. These results are new to the literature and important for further understanding how inflation risk is priced in a global context.

To test the model, we need a measure of global inflation risk, estimation of the diversification portfolios that are the most highly correlated with the country market portfolios, a specification of the dynamics of risk exposures, and a specification of the time-variation in prices of risk.

To construct the global inflation risk, we first filter out the innovations in inflation using the ARMA(1,1)-model. We obtain innovations of total headline inflation for each country. We use GDP as a proxy for a country's wealth and construct the global unexpected inflation factor as the GDP-weighted average of the unexpected inflation in DMs. Next, we assume that the total

[3] A growing empirical literature shows how globalization affects the domestic inflation dynamics and that domestic inflation rates contain a large global component (see, among others, Forbes (2019), Henriksen, Kydland, and Šustek (2013). See Rogoff et al. (2003) for a discussion of the sources of international comovements in inflation.

inflation rate for a given country is a weighted sum of three inflation components; core, energy, and food, which have different properties across DMs and EMs. Core inflation accounts for most of the headline inflation and comprises essentially non-tradeable goods. Energy inflation represents a smaller fraction of headline inflation and is the most volatile for most countries. Food is an important component of consumption baskets for EMs.

We model the covariance matrix of all shocks as multivariate GARCH process to obtain the time-varying risk exposures. We estimate a diversification portfolio (DP) for each country following Chaieb, Errunza, and Langlois (2021a). The DP dynamically replicates the country market portfolio using substitute assets that are actively traded in markets that are fully open to global investors. The global inflation risk is measured as the covariance between the DP and the GDP-weighted unexpected inflation. The local inflation risk is measured as the covariance between the country hedge portfolio and the local unexpected inflation. The hedge portfolio return is the difference between the country market return and the DP return.

We parametrize the prices of global covariance risks as functions of global instruments (World dividend yield, US term spread, and US default spread), and the price of unspanned local covariance risks as functions of local instruments (country market excess return, country dividend yield, country headline inflation). Our findings are robust to alternative specifications of instruments.

We test the asset pricing implications of our model using monthly returns on 18 DMs and 20 EMs. Our key empirical findings can be summarized as follows. The first finding relates to the global and local pricing of inflation risk. We find that global core inflation is significantly priced and varies over time. We estimate an annualized average price of -0.46%.[4] In other words, investors require compensation of 0.46% of expected excess return per annum for each unit of negative exposure of an asset to global core inflation shocks. The price of core inflation covariance risk retains its size and significance after we control for the carry factor. Local core inflation risk is priced in about 60% of our sample of 34 countries, exhibiting substantial heterogeneity across countries. Similarly, local energy and food inflation risks are priced in about 50% of the sample. The second finding relates to the exposure to global and local inflation risk. We document significant time variation and switch in sign of exposures. Both EMs and DMs show positive exposure to global core risk on average for

[4]The price of covariance risk is standardized by the time-varying covariance matrix, to facilitate economic interpretation and to enable comparisons with other studies on beta risk.

40% of the time series, and around 50% for local core, energy, and food. The third finding relates to the equity risk premium contribution of global and local inflation risks. The contribution of the global core inflation risk premium to the total equity risk premium is comparable in DMs and EMs (on average, 3.13% and 3.45%, respectively). Local inflation risks instead contribute to a larger extent to the equity risk premium in EMs than DMs (on average, 14.29% and 12.52%, respectively). Our results show that despite the increasing financial market integration of economies over time, equity returns continue to be significantly influenced by local factors, particularly in EMs.

Our work adds to the empirical literature on inflation risk exposure and pricing in the US equity market. For unconditional asset pricing models, Chen, Roll, and Ross (1986), Ferson and Harvey (1991), and Ang, Brière, and Signori (2012) uncover a negative but insignificant inflation risk premium in the cross-section of US stocks. Boons, Duarte, de Roon, and Szymanowska (2020) show that inflation risk is priced in US stock returns and that both the price and quantities of inflation risk are strongly time-varying.[5] Our results highlight the significant time variation in exposure and prices of inflation risk in international stock markets.

Several empirical papers investigate inflation risk pricing in international markets. Vassalou (2000) shows that US inflation risk is priced in ten major DMs. Cooper, Mitrache, and Priestley (2022) examine how global macroeconomic risk is priced in value and momentum portfolios from major DMs and find shocks to expected inflation are negatively significantly priced. Fang, Liu, and Roussanov (2021) examine the pricing of core and energy inflation across different asset classes in the US and some major DMs and find core inflation is negatively and significantly priced while the coefficient for the price of energy inflation risk is insignificant. These studies focus exclusively on major DMs. Our paper shows how inflation risk is priced not only in DMs but also in EMs.

Our work also contributes to currency risk pricing in international equity markets (see, for example, Dumas and Solnik (1995), De Santis and Gerard (1998), Vassalou (2000), Carrieri et al. (2006), Brusa, Ramadorai, and Verdelhan (2014), Karolyi and Wu (2021)). Our results on the pricing, size, and significance of the dollar and carry factors for our sample of open major DMs are consistent with Karolyi and Wu (2021). We estimate a negative price for the dollar risk factor but the significance of its coefficient depends on the model specification. Also, in our robustness tests, we uncover a positive albeit insignificant price of the carry factor. When their test assets include only DMs,

[5] Cieslak and Pflueger (2023) discuss the economic channels linking inflation and asset prices.

Karolyi and Wu (2021) also uncover insignificant price for the carry factor. Our model implies that local unspnanned currency risk should be priced in partially segmented markets. The coefficient estimate for the price of local currency risk is significant in half of our sample of EMs and about 30% of our sample of DMs. The local currency risk premium contributes about 10% of the total risk premium in EMs and 5% in DMs.

Our work extends an important strand of literature that studies market segmentation and the role of global and local risk factors in international equity markets. Carrieri, Chaieb, and Errunza (2013) show that local market risk is priced in emerging markets even after accounting for investability. Hou, Karolyi, and Kho (2011) show that a multifactor model of global and local factors based on momentum and the ratio of cash flow to price explains time series and cross-sectional variation of global stock returns. Fama and French (2017) show that an international version of the Fama and French (2015) 5-factor model performs well for developed markets. Karolyi and Wu (2018) propose a partial- segmentation model that includes style factor portfolios based on size, value, and momentum and that specifically distinguishes global and local factors arising through the emergence of globally accessible stocks. Their results stress the role of local factors in achieving lower pricing errors. Choi and Kim (2018), Chaieb, Langlois, and Scaillet (2021b), and Patton and Weller (2022) test whether the same risk factors command the same risk premia in different markets. Bryzgalova, Huang, and Julliard (2024) test heterogeneous risk premia in the entire term structure. Our work shows that local inflation risk is important in pricing partially segmented equity markets.

The remainder of the paper is organized as follows. The next section outlines our estimation framework. Section 3 details the data. Section 4 presents our empirical findings. Section 5 reports some robustness checks, and Section 6 concludes. Additional results, and a detailed description of the data sources, are reported in the Internet Appendix.

2 Methodology

2.1 International Asset Pricing Model

To conduct our analysis, we build on the IAPM of Chaieb and Errunza (2007). CE models partially segmented international capital markets where residents use different purchasing power indices.

They assume a two-country world, with a domestic country (e.g., the US), and a foreign country (e.g., EM). There are two sets of securities, the eligible and the ineligible securities. The domestic market consists of eligible securities that are accessible to all investors, whereas the foreign market consists of ineligible securities that are accessible only to local investors. Eligible securities command the world market premium and global inflation risk premiums. The ineligible securities command two additional risk premiums: the unspanned local market risk premium and the local inflation risk premium. In equilibrium, foreign investors, who hold the ineligible foreign securities, can reduce their local risk exposure by short-selling the portfolio of eligible securities that mimic the market portfolio of ineligible securities, called diversification portfolio (DP). Domestic investors are willing to take a long position in the DP portfolio as the best substitute for the market portfolio of ineligible securities. Unless the DP portfolio is a perfect substitute for the market portfolio of ineligible securities, foreign investors are exposed to unspanned local risk and require an extra local market risk premium. Also, barriers to portfolio flows limit inflation-hedging benefits because of incomplete risk sharing. Hence, the expected return on ineligible securities also commands an extra local inflation risk premium. The equilibrium expected return on the ineligible market portfolio of country I can be written as,

$$\begin{aligned} E_t\left[r_{I,t+1}\right] &= \gamma_{W,t}\mathrm{cov}_t\left[r_{I,t+1}, r_{W,t+1}\right] + \sum_j \gamma_{j,t}\mathrm{cov}_t\left[r_{DP_I,t+1}, \pi^{\$}_{j,t+1}\right] \\ &+ \lambda_{I,t-1}\mathrm{var}_t\left[r_{I,t+1}|r_{DP_I,t+1}\right] + \lambda_{\pi,t}\mathrm{cov}_t\left[r_{HP_I,t+1}, \pi^{\$}_{I,t+1}\right], \end{aligned} \tag{1}$$

where $r_{I,t+1}$ is the excess returns on the country I market index, $r_{W,t+1}$ is the excess return on the world index, $r_{DP_I,t+1}$ is the excess return on country I diversification portfolio (DP), $r_{HP_I,t+1}$ is the excess return on country I hedge portfolio (HP). All returns are in USD terms. The return on the diversification portfolio r_{DP_I} is the fitted value from the regression,

$$r_{I,t+1} = \widehat{w}'_{t+1} r_{S,t+1} + u_{I,t+1},$$

where $w_{t+1} \equiv \Sigma^{-1}_{S,S,t+1}\Sigma_{I,S,t+1}$ is the vector of time-varying weights of DP, $\Sigma_{S,S,t+1}$ is the conditional covariance matrix of substitute assets, and $\Sigma_{I,S,t+1}$ is the vector of conditional covariance between the return on the equity index I and the vector of substitute assets $r_{S,t+1}$. $\pi^{\$}_{j,t+1} = \pi_{j,t+1} + \Delta s_{j,t+1}$ is the rate of inflation of country j expressed in US dollars and is the sum of local inflation expressed in local currency $\pi_{j,t+1}$ and the change in bilateral exchange rate vis-a-vis the dollar $\Delta s_{j,t+1}$. $\gamma_{W,t}$ and $\gamma_{j,t}$ are respectively the price of global market risk and country j's inflation risk. $\lambda_{I,t}$ is the price of local market risk and $\lambda_{\pi,t}$ is the price of local inflation risk.

The price of country j's inflation risk is,

$$\gamma_j = (1-\theta_m)\frac{(1-\alpha_j)W_j}{\sum_j(1-\alpha_j)W_j} \tag{2}$$

where $\theta_m = AW_m$ is the aggregate relative risk aversion, A is the aggregate absolute risk aversion, W_m is the aggregate world wealth, $\alpha_j = 1/A_j$ is country j absolute risk tolerance, A_j is country j absolute risk aversion, W_j is the wealth of country j. Assuming same absolute risk tolerance among investors worldwide, that is $\alpha_j = \alpha$, we can write γ_j as,

$$\gamma_j = (1-\theta_m)\frac{W_j}{\sum_j W_j} = (1-\theta_m)\frac{W_j}{W_m} \tag{3}$$

The sum of country j,$j = 1...N$, inflation risk premia simplifies to,

$$\sum_j \gamma_{j,t}\mathrm{cov}_t[r_{DP_I,t+1}, \pi^{\$}_{j,t+1}] = (1-\theta_m)cov\left(r_{DP_I,t+1}, \frac{\sum_j W_j\pi^{\$}_{j,t+1}}{W_m}\right) \tag{4}$$

Let $\pi^{\$}_{global,t+1} \equiv \frac{\sum_j W_j\pi^{\$}_{j,t+1}}{W_m}$. Assuming the same risk tolerance across countries alleviates the curse of dimensionality arising from summing over the N covariances between r_{DP_I} and country j's inflation rate $\pi^{\$}_j$. Further, we can write $\pi^{\$}_{global,t+1}$ as the sum of two terms. The first, $\pi_{global,t+1} \equiv \frac{\sum_j W_{j,t+1}\pi_j}{W^m_{t+1}}$, is the weighted average global inflation where each inflation rate π_j is expressed in country j currency. The second, $\Delta s_{dollar,t+1} \equiv \frac{\sum_j W_{j,t+1}s_{j,t+1}}{W^m_{t+1}}$, is the weighted average change in bilateral exchange rates across countries also termed the dollar factor (see, for example, Verdelhan (2018)[6]),

$$\pi^{\$}_{global,t+1} = \pi_{global,t+1} + \Delta s_{dollar,t+1}. \tag{5}$$

[6]Note that in Verdelhan (2018), the exchange rate is defined in units of foreign currency per USD so an increase in the dollar factor corresponds to an appreciation of the dollar. We define the exchange rate in units of USD per foreign currency, so an increase in the dollar factor reflects a dollar depreciation. Thus, there is a strong negative correlation between our dollar factor and the one defined in Verdelhan (2018).

Total realized inflation is the sum of expected and unexpected inflation. We extract unexpected shocks to inflation using an ARMA(1,1) model which fits the slowly decaying autocorrelogram of inflation,[7]

$$\pi_{j,t+1} = c + \phi_1 \pi_{j,t} + \theta_1 \varepsilon_{\pi,t} + \varepsilon_{\pi,t+1}. \tag{6}$$

We filter the unexpected headline inflation of each country from the univariate ARMA(1,1) model. We use GDP as a proxy for a country's wealth and construct the global unexpected inflation factor, $\widehat{\epsilon}^{G}_{\pi,t+1}$, as the GDP-weighted average of the unexpected inflation in DMs. We use DMs instead of all the countries of the sample to construct the global inflation factor. This allows us to overcome the issue of missing data in EMs inflation series. We don't expect results to change since we use a GDP-weighted average. In addition, to the extent country-level differences in financial development proxy for differences in risk aversion, we could assume similar risk tolerance for DMs. Assuming the same risk tolerance among DMs seems more plausible than among DMs and EMs. The DMs utilized to construct the global inflation factor include Austria, Belgium, Canada, Denmark, France, Finland, Germany, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the UK, and the US. We construct the GDP-weighted cross-sectional average of bilateral exchange rate changes, $\Delta s_{dollar,t+1}$.

Next, we assume that the total inflation rate of country j is a weighted sum of the inflation components. That is, $\pi_{j,t} = \sum_{k=1}^{K} w^k \pi^k_{j,t}$, where the weights w^k, $k = 1, ..., K$ represent the relative importance of the different inflation series in the total headline inflation. Our main specification sets $K = 3$ and uses core, food, and energy. These sub-components have different properties across developed and emerging markets. Core inflation accounts for most of headline inflation and comprises essentially non-tradeable goods. Energy inflation represents a smaller fraction of headline inflation and is the most volatile for most countries. Food is also an important component of consumption baskets, especially for EMs (see Peersman (2022), and Kohlscheen (2022)). We use the univariate ARMA(1,1) filtering process (see Eq. 6). In robustness, we also use multivariate inflation vector autoregression (VAR) estimated on core, food, and energy inflation.

[7] See, for example, Fama and Gibbons (1984), Vassalou (2000), Campbell and Viceira (2002), and Boons et al. (2020).

We specify the local market risk and the local inflation risk as follows:

$$var_t[r_{I,t+1}|r_{DP_I,t+1}] = var_t(r_{I,t+1}) - cov_t(r_{I,t+1}, r_{DP_I,t+1})$$
$$cov_t[r_{HP_I,t+1}, \pi^{\$}_{I,t+1}] = cov(r_{I,t+1}, \pi^{\$}_{I,t+1}) - cov(r_{DP_I,t+1}, \pi^{\$}_{I,t+1})$$

We implement a conditional version of the model allowing for time-varying risk exposure and price of risk.

2.2 Empirical Implementation

In this section, we lay out the empirical methodology to test the asset-pricing model given by Equation 1. First, we analyze global and local pricing of headline inflation shocks. Next, we separate total headline inflation into core, energy, and food inflation.

Since the theory predicts the global risk factors should command the same price for each country, we follow Bekaert and Harvey (1995) and use a two-stage estimation procedure. In the first stage, we estimate the following system of equations for the world market and all open markets:

$$\begin{cases} r_{w,t+1} = \alpha_w + \gamma_{w,t}\, var_t(r_{w,t+1}) \\ \quad +\gamma_{\pi,t} cov_t\, (r_{w,t+1}, \widehat{\epsilon}^G_{\pi,t+1}) + \gamma_{dollar,t} cov_t\, (r_{w,t+1}, \Delta s_{dollar,t+1}) + \epsilon_{w,t} \\ \\ r_{k,t+1} = \alpha_k + \gamma_{w,t}\, cov_t(r_{k,t+1}, r_{w,t+1}) \\ \quad +\gamma_{\pi,t} cov_t\, (r_{k,t+1}, \widehat{\epsilon}^G_{\pi,t+1}) + \gamma_{dollar,t} cov_t\, (r_{k,t+1}, \Delta s_{dollar,t+1}) + \epsilon_{k,t+1} \\ \\ \Delta s_{dollar,t+1} = \alpha_s + \gamma_{w,t}\, cov_t(\Delta s_{dollar,t+1}, r_{w,t+1}) \\ \quad +\gamma_{\pi,t} cov_t\, (\Delta s_{dollar,t+1}, \widehat{\epsilon}^G_{\pi,t+1}) + \gamma_{dollar,t} var_t\, (\Delta s_{dollar,t+1}) + \epsilon_{\Delta s_{dollar},t+1} \end{cases} \tag{7}$$

$$\boldsymbol{\epsilon}_{\mathbf{t+1}}|\Omega_t \sim \mathcal{N}(0, H_{t+1}),$$

where $r_{w,\,t+1}$, $r_{k,\,t+1}$, and $\Delta s_{dollar,\,t+1}$ represent the world return, the return on the k open markets, and the return on the dollar factor, respectively. We use six open markets ($k = 6$) to increase the precision of the estimation. Specifically, we select a subset of developed markets (DMs) that are fully open, as identified by Karolyi and Wu (2018): Belgium, France, Germany, the Netherlands, the UK, and the US. The variable $\widehat{\epsilon}^G_{\pi,t+1}$ denotes the shock to the global inflation extracted from the ARMA(1,1) process. In our first specification, $\widehat{\epsilon}^{G}_{\pi,t+1}$ is the global unexpected headline inflation. In our second specification, we include global shocks of the three subcomponents, core, energy, and food inflation, allowing a different price of risk for each. We denote by $\gamma_{w,t}$, $\gamma_{dollar,t}$, and $\gamma_{\pi,t}$ the prices of risk associated with the global market, the dollar factor, and global inflation, respectively. Note that the CE model implies the same price of risk for the dollar factor and global unexpected inflation, whereas we allow for different prices of the dollar factor and global unexpected inflation. This specification has two advantages: First, it allows us to test separately global inflation risk, and second, it resolves the multicollinearity problem that arises from the decomposition of the headline inflation into its subcomponents and the inclusion of the dollar factor across all inflation sub-components. Finally, Ω_t is the set of information available at time t and H_{t+1} is the (9×9) conditional covariance matrix of the assets in the system conditional on time t+1.[8]

In the second stage, we estimate the following system of equations:

$$\begin{cases} r_{I,t+1} = \alpha_I + \widehat{\gamma}_{w,t}\, cov_t(r_{I,t+1}, r_{w,t+1}) \\ \quad +\widehat{\gamma}_{\pi,t} cov_t\,(r_{DP,t+1}, \widehat{\epsilon}^{G}_{\pi,t+1}) + \widehat{\gamma}_{dollar,t} cov_t\,(r_{DP,t+1}, \Delta s_{dollar,t+1}) \\ \quad +\lambda_{I,t}(var_t(r_{I,t+1}) - cov_t(r_{I,t+1}, r_{DP,t+1})) \\ \quad +\lambda_{\pi,t}(cov(r_{I,t+1}, \widehat{\epsilon}^{L}_{\pi,t+1}) - cov_t(r_{DP}, \widehat{\epsilon}^{L}_{\pi,t+1})) \\ +\lambda_{\Delta s,t}(cov(r_{I,t+1}, \Delta s_{I,t+1}) - cov_t(r_{DP}, \Delta s_{I,t+1})) + \epsilon_{I,t+1} \\ \\ r_{DP,t+1} = \alpha_{DP} + \widehat{\gamma}_{w,t}\, cov_t(r_{DP,t+1}, r_{w,t+1}) \\ \quad +\widehat{\gamma}_{\pi,t} cov_t\,(r_{DP,t+1}, \widehat{\epsilon}^{G}_{\pi,t+1}) + \widehat{\gamma}_{dollar,t} cov_t\,(r_{DP,t+1}, \Delta s_{dollar,t+1}) + \epsilon_{DP,t+1} \\ \\ \Delta s_{I,t+1} = \alpha_s + \widehat{\gamma}_{w,t}\, cov_t(\Delta s_{I,t+1}, r_{w,t+1}) \\ \quad +\widehat{\gamma}_{\pi,t} cov_t\,(\Delta s_{I,t+1}, \widehat{\epsilon}^{G}_{\pi,t+1}) + \widehat{\gamma}_{dollar,t} cov_t\,(\Delta s_{I,t+1}, \Delta s_{dollar,t+1}) + \epsilon_{\Delta s_I,t+1} \end{cases} \tag{8}$$

$$\epsilon_{\mathbf{t+1}}|\Omega_t \sim \mathcal{N}(0, H_{t+1})$$

where $r_{I,\,t+1}$, $r_{DP,\,t+1}$, and $\Delta s_{I,\,t+1}$ represent the return on the local equity index, the return on the diversification portfolio, and the return on the local exchange rate, respectively. The term $\widehat{\epsilon}^{L}_{\pi,t+1}$ denotes the shock to local inflation. Similarly to the first-stage estimation, we use local unexpected

[8]The (9x9) matrix is obtained with the following assets: world market return, six open markets return, dollar factor return, global inflation shocks.

headline inflation in one specification. In the second specification, we use local unexpected core inflation, energy inflation, and food inflation jointly. $\widehat{\gamma}_{w,\,t}$, $\widehat{\gamma}_{dollar,\,t}$, and $\widehat{\gamma}_{\pi,\,t}$ are the first-stage estimates of the prices of the global market risk, the dollar risk factor, and the global inflation risk, respectively. $\lambda_{I,t}$, $\lambda_{\Delta s,t}$, $\lambda_{\pi,t}$ correspond to the price of risk associated with local market, local currency, and local inflation. As in the first- stage we estimate price of currency risk and inflation separately. We assume $\epsilon_{t+1}|\Omega_t \sim \mathcal{N}(0, H_{t+1})$, where H_{t+1} is the (7x7) conditional covariance matrix of the assets conditional on time t+1 and on the estimated residuals from first stage.[9] The vector of residuals ϵ_{t+1} is obtained by stacking the residuals of the three equations of the second stage system, and the first-stage estimated residuals from the world and dollar equations, $\epsilon_{W,t+1}$ and $\epsilon_{\Delta s_{dollar},t+1}$.

The CE model predicts that the prices of global and local market risk are positive. Therefore, we use a square function to model the dynamics of the global and local market risk prices.

$$\gamma_{W,t} = \left(k_{W,0} + k'_W Z_{G,t}\right)^2$$
$$\lambda_{I,t} = \left(y_{I,0} + y'_I Z_{L,t}\right)^2$$

Where $Z_{G,t}$ the vector of time-varying global information and $Z_{L,t}$ is the vector of the time-varying local information. If the global market risk is priced, we should reject the null hypothesis that $k_{W,0} = 0$ for $j \geq 0$ and if it is time-varying we should reject the null that $k_{W,0} = 0$ for $j > 0$. If the local market risk is priced, we should reject the null hypothesis that $y_{I,0} = 0$ for $j \geq 0$ and if it is time-varying we should reject the null that $y_{I,0} = 0$ for $j > 0$.

The price of dollar factor, global inflation, local currency, and local inflation can be positive or negative. Therefore, we use a linear function to model the dynamics for their prices.

$$\gamma_{dollar,t} = \left(k_{dollar,0} + k'_{dollar} Z_{G,t}\right)$$
$$\gamma_{\pi,t} = \left(k_{\pi,0} + k'_{\pi} Z_{G,t}\right)$$
$$\lambda_{\Delta_s,t} = \left(y_{\Delta_s,0} + y'_{\Delta_s} Z_{L,t}\right)$$
$$\lambda_{\pi,t} = \left(y_{\pi,0} + y'_{\pi} Z_{L,t}\right)$$

[9]The (7x7) matrix is obtained with the following assets: world market return, local market return, DP return, local exchange rate change, local inflation shocks, dollar factor, and global inflation shocks.

If the dollar risk factor is priced, we reject the null that $k_{dollar,0} = 0$ for $j \geq 0$ and if it is time-varying we should reject that $k_{dollar,0} = 0$ for $j > 0$. If global inflation risk is priced, we reject the null that $k_{\pi,0} = 0$ for $j \geq 0$ and if it is time-varying we should reject that $k_{\pi,0} = 0$ for $j > 0$. Similarly, if local currency risk is priced, we reject the null that $y_{\Delta_s,0} = 0$ for $j \geq 0$ and if it is time-varying we should reject that $y_{\Delta_s,0} = 0$ for $j > 0$. If local inflation risk is priced, we reject the null that $y_{\pi,0} = 0$ for $j \geq 0$ and if it is time-varying we should reject that $y_{\pi,0} = 0$ for $j > 0$. Note that the prices of global risk factors are functions of global instruments, while the prices of unspanned local market, local currency, and local inflation risk factors are functions of local instruments.

We model the covariance matrix $\boldsymbol{H_t}$ of all shocks $\boldsymbol{\epsilon_t}$ as multivariate GARCH (MGARCH) process in which the variances depend only on past squared residuals and an autoregressive component while the covariances depend on the past cross-product of residuals and an autoregressive component as in Chaieb et al. (2021a).

$$\boldsymbol{H_t} = \boldsymbol{H_0} \circ \left(\boldsymbol{\iota\iota}^\top - B - A\right) + B \circ \boldsymbol{H_{t-1}} + A \circ \boldsymbol{\epsilon_{t-1}\epsilon_{t-1}^\top}, \tag{9}$$

where $\circ$ is the Hamarald product, $\boldsymbol{H_0}$ is a $(N \times N)$ unconditional covariance matrix of residuals $\boldsymbol{\epsilon}$, $\boldsymbol{\iota}$ is a $(N \times 1)$ vector of ones, $B = \left(\bar{B}\bar{B}^\top\right)$, $A = \left(\bar{A}\bar{A}^\top\right)$, $\bar{A}$ and $\bar{B}$ each contain one parameter. The advantage of this MGARCH parameterization is that it ensures positive definiteness of the covariance matrix while reducing the number of parameters to be estimated.[10]

3 Data

The analysis requires four sets of data detailed in the next subsections. The first presents the asset return data that comprises the test assets and the substitute assets used to construct the diversification portfolios. The second discusses inflation data. The third explains how we construct diversification portfolios. The fourth discusses construction of the global unexpected inflation. The fifth presents the set of instrumental variables.

[10]We do not report the parameter estimates (A and B) for the conditional covariance processes, but these are significant and satisfy the stationarity condition, i.e., A + B $\leq$ 1. This value approaches one, indicating that the variance and covariance processes in $\boldsymbol{H_t}$ are highly persistent.

3.1 Asset Return Data

Our dataset includes data from 18 developed markets (DMs) and 20 emerging markets (EMs). The DMs are Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. The EMs are Brazil, Chile, China, Colombia, the Czech Republic, Greece[11], Hungary, India, Indonesia, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, South Africa, South Korea, Taiwan, Thailand, and Turkey. These data span the period from January 1989 to October 2022, with a monthly frequency.

Equity returns are obtained from Datastream. The MSCI country indices reflect market value-weighted total returns in U.S. dollars. The risk-free rate is provided by the Kenneth R. French data library. The bilateral exchange rates are retrieved from Datastream.

The substitute assets used to construct the DPs include the MSCI World Index, thirty-four global market industries classified according to FTSE, seventeen closed-end country funds (CFs), eighty-four cross-listings (including direct placements), and eleven country exchange-traded funds (ETFs). Monthly returns are adjusted for dividends. CFs and ETFs are from the Center for Research in Security Prices (CRSP) database, covering global, regional, and country-specific funds.

3.2 Inflation data

To carry out our analysis, we need four types of Consumer Price Index (CPI) series for each country: headline, core, food, and energy. CPI data is sourced from the OECD through Datastream. The Classification of Individual Consumption According to Purpose (COICOP) serves as the international standard for household expenditure classification. Headline CPI represents overall inflation, while core inflation excludes the more volatile components of food and energy. Food inflation is typically derived from COICOP 01.1, which covers food purchased for consumption at home. Energy inflation is captured by COICOP 04.5, which includes electricity, gas, and other fuels.

One of the main challenges in building an international CPI dataset is the difficulty of making cross-country comparisons due to differences in how CPI data is defined, constructed and reported. Developed markets typically provide detailed and standardized CPI data, which facilitates the

[11] As per MSCI classification 2023

analysis. However, many emerging markets use different consumer baskets, particularly for energy inflation. For instance, in EMs, energy inflation is often reported under COICOP 04 (Housing, water, electricity, gas, and other fuels), which combines both housing and energy components, making it difficult to isolate energy inflation data. As a result, we rely on COICOP 04 as a combined measure of housing and energy. Additionally, certain emerging countries, like India and Malaysia, do not provide core CPI data, limiting the analysis of core inflation in these regions. Therefore, these countries are included only in models based on headline inflation. Another challenge involves the length of the time series. While developed markets have extensive historical data, for emerging markets data often start late or is even missing for certain inflation categories.

Furthermore, national statistical agencies periodically rebase or re-reference their CPI series, requiring us to merge overlapping periods from older and newer series to extend the historical data.

We compute the inflation rate as the log change relative to the previous month. Our dataset reveals a distinct contrast in inflation trends between DMs and EMs. Figure 1 illustrates inflation rates across various markets and categories. The black line represents the median inflation rate. The green and blue shaded areas represent the 25th to 75th percentiles and the 10th to 90th percentiles, respectively. Several differences emerge between DMs and EMs. For EMs, inflation rates are more dispersed compared to DMs. This higher dispersion in EMs is particularly pronounced in the earlier part of the time series, before the 2000s, but becomes more stable after that period. Table 1 and Table 2 provide summary statistics for our data. On average, inflation in EMs tends to have both a higher mean and greater volatility than in DMs. For example, core inflation has, on average, been more than twice as volatile in EMs compared to DMs. These tables also underscore the critical role of food prices in EMs. Food inflation not only exhibits high volatility (Panel A) but also carries a larger weight β in the total inflation index, around 27% (Panel B). As a result, headline inflation in EMs closely tracks food inflation as displayed in Figure 1. The measures of inflation also exhibit a high degree of persistence especially in EMs.

3.3 Diversification portfolios

We estimate a diversification portfolio (DP) for each country. The DP dynamically replicates the equity indexes using substitute assets and is held long by the domestic investor to gain exposure to the foreign market. The DP weights are time-varying and computed from the conditional covariance matrices. To estimate the conditional covariance matrices we proceed in two steps. In the first step, we fit an AR-NGARCH on equity indexes and all substitute assets to estimate time-varying variances. In the second step, we estimate a dynamic normal copula by using all available assets at each point in time (See Christoffersen et al. (2018)). We then use the dynamic variances from the first step estimations and correlations[12] from the second step estimation to compute the DP weights (See Chaieb et al. (2021a)). The conditional covariance dynamics are the same as those used in the tests of the IAPM, and hence, the construction of the DPs is consistent with the asset pricing framework. The main advantage of our approach is that as barriers to investment fall, our dynamic approach captures the changing nature of the diversification portfolio. Also, our approach allows for a large number of replicating assets. In fact, we estimate the weights directly over the full set of substitute assets instead of using a sequential regression approach over a selected number of assets. The CE model suggests we use the largest set possible of substitute assets to hedge local market risks. In the appendix, we report the distribution of the funds by asset class (equity, sovereign bond, corporate bond), by type (CEF, ETF, OEF), and geographical focus (country, region, global). In total and after screening for data quality and time series length, we have more than a thousand funds. We also report the filtering used in the Appendix.

3.4 Global unexpected inflation

We construct four measures of global unexpected inflation: global headline, global core, global energy, and global food. Each of these is calculated using a GDP-weighted average of inflation shocks from developed markets (DMs). GDP data is retrieved from the OECD, expressed in U.S. dollars, and available at an annual frequency. This methodology effectively addresses several key challenges. First, it overcomes issues of comparability due to variations in consumer baskets across emerging markets (EMs). Second, it mitigates the problem of missing data by using DMs, which have more extensive historical data series. Third, the use of a GDP-weighted average reduces the issue of high data dispersion, which can undermine the reliability of equally weighted averages. Our measures display a correlation of 0.83, 0.70, 0.96, and 0.80 with US unexpected headline, core, energy, and food inflation, respectively. In DMs, the global unexpected headline inflation accounts, on average, for approximately 26% of the variation in national unexpected headline

[12] The conditional correlations follow the same dynamic of equation 9.

inflation. Meanwhile, the global unexpected core, energy, and food measures explain between 25%, 40%, and 17% of the variation in their respective national sub-component shocks. In contrast, in EMs, these measures explain only 4% of the variation in national inflation rates, with sub-component shocks accounting for 2%, 8%, and 6%. Incorporating EMs into the global unexpected inflation measure or using alternative methods to calculate unexpected global inflation does not significantly improve explanatory power. The level of commonality we uncover in the headline and subcomponent inflation series across countries is in line with previous studies. Parker (2018) finds global inflation comovements are more pronounced in higher-income economies, particularly for energy sub-components but EMs exhibit less commonality in inflation. Using a dynamic latent factor model that decomposes 64 national inflation rates into world, regional, and idiosyncratic components, Neely and Rapach (2011) show that the world factor explains 35% of annual inflation variability on average. As a robustness exercise, we explore alternative measures of global inflation, such as the median and equally weighted average, and demonstrate that our main result remains consistent across these measures.

3.5 Instrumental variables

We use global instrumental variables to parameterized the price of global risk factors and local instrumental variables for the unspanned local risk factors. The global information variables include the world dividend yield in excess of the risk-free rate, the change in the U.S. term premium—measured as the yield difference between the three-month T-bill and the 10-year T-bond—and the U.S. default premium, determined by the yield difference between Moody's Baa- and Aaa-rated bonds. Data for these variables are sourced from Datastream and FRED. The local information variables include the local equity return in excess of the risk-free rate, local excess dividend yield, and local headline inflation. The local instruments are obtained from Datastream. All instrumental variables are lagged by one month and standardized. We omit a detailed description of these variables because of their extensive use in prior research.

4 Results

4.1 Price of global inflation risk in open markets

Table 4 presents the results from the first-stage estimation of the prices of global risk factors (see system of Equation 7). Column (1) reports on the model specification that includes global headline inflation. Column (2) reports on the specification with global core, energy, and food inflation. The table reports the two specification tests. The first test examines whether the price of risk is significant and the second assesses if the price of risk remains constant over time. The table also shows the average price of covariance risk and the average price of beta risk, which is the standardized average price of covariance risk computed as the inverse covariance matrix multiplied by the price of covariance risk. The findings reveal that the price of world market risk is significantly different from zero and varies over time in both specifications. The average price of world market risk across the two specifications is approximately 3.14, with a standardized annualized coefficient of around 6.99%. The price of the dollar factor, representing the risk of dollar depreciation, consistently shows a negative value. However, it is not statistically different from zero in specification (2). This finding aligns with previous studies. For example, Karolyi and Wu (2021) finds a negative dollar risk premium in global returns, with a weak statistical significance. According to Verdelhan (2018), investors who bear greater macroeconomic risk related to the dollar factor are likely to earn higher average returns. Given the negative correlation of our dollar factor and the one defined in Verdelhan (2018) it is not surprising to observe a negative expected return. Indeed, each country displays positive exposure to the dollar factor. Figure 5 shows the evolution of the price of risk of world market and dollar factor. The price of world market risk tends to increase during periods of economic contraction, as highlighted by the shaded areas in the figure, and typically peaks around business cycle troughs. The dollar risk price generally has a negative sign but tends to turn positive during economic recessions. In Table 4 the price of global headline inflation is significant and significantly time-varying. It is estimated at -3.39 on average, corresponding to an annualized value of 0.06% when adjusted by the time-varying covariance matrix. Given that the proxy for global headline inflation shocks is highly correlated with US inflation, one could interpret this result as US inflation being priced in international equities. This also aligns with the findings of Vassalou (2000) that US headline unexpected inflation is priced not only in US equities but also in major developed markets. We further discuss pricing of US headline inflation in the robustenss section.

Specification (2), which allows for different pricing of the three inflation sub-components, shows that global core inflation is the only sub-component with a price that is statistically different from zero and time-varying. It has an average price of risk of -186.30, corresponding to a standardized annualized coefficient of -0.46%. In other words, investors require a compensation of 0.46% of expected excess return per annum for each unit of negative exposure of an asset to global core inflation shocks. Running Fama-MacBeth cross-sectional regressions of average returns onto asset betas in an unconditional setup, Fang et al. (2021) similarly find a negative and significant pricing of core inflation risk across different asset classes in the US. They also find the price of energy inflation risk is positive but insignificant. Our results show the role of core inflation risk in a global context. We uncover significant commonality in core inflation across DMs and find exposure to global core inflation is significantly negatively priced. Figure 4 shows the evolution of inflation risk price over time. The price of global headline inflation risk displays an increasing trend and changes sign in the early 2000s from negative to positive. Similar change in the sign of the price of headline inflation was documented in the US (see, for example, Boons et al. (2020)). Overall, the price of global headline inflation risk shows positive values in 49% of the time series, ranging from an annualized standardized price of risk of -2.96% to 2.56%. This change of sign explains also the small average magnitude presented in Table 4. The price of global core inflation risk also shows an upward trend, shifting from negative to positive after the Global Financial Crisis. However, it is positive only 28% of the time, with values ranging from -3.22% to 0.74%. The price of global energy inflation risk fluctuates around zero, with extreme values between -5.92% and 20.93% during the Global Financial Crisis, and is positive for 62% of the time. The price of global food inflation risk ranges from -6.01% to 3.06%, being positive for 80% of the time. The trends depicted in this figure help contextualize the results in Table 4. While the prices of global headline and core inflation risks are time-varying and significantly different from zero, the prices for food and energy inflation risks hovers around zero, except during crisis periods. This finding suggests that global headline inflation pricing primarily reflects the pricing of global core inflation. To better understand the dynamics underlying our results, we examined the loadings on the instruments (see online Appendix). We find that the price of global headline inflation risk and global core inflation risk increase with the world dividend yield, WDYe. Global headline and core inflation risk prices load negatively on the 10-year minus 3-month term spread, T10Y3M, but these coefficients are not statistically significant. Fang et al. (2021) find the price of US core inflation risk decreases with the term spread.

4.2 Price of local inflation risk in partially segmented markets

We impose the estimated prices of global risk factors from the first stage in the country-level estimations and test whether exposure to unspanned local market and domestic inflation risk is priced for the equity markets of our sample of countries. Table 5 displays the percentage of countries where the prices of risk associated with local market, currency, and inflation risks are statistically significant at the 90% confidence level, based on two specification tests: one for the null hypothesis of a zero price of risk at each point in time and the other for constant price of risk. Column (1) reports results using local headline inflation, while Column (2) breaks down local inflation into sub-components: core, energy, and food inflation.

We report the average standardized price of risks for DMs and EMs, along with their ranges. We do observe significant variations in risk prices over time and across countries, which complicates the interpretation of average estimates. The table shows that the price of local market risk is statistically different from zero in 75% of DMs and approximately 80% of EMs. It is not surprising that our sample of DMs exhibits some degree of market segmentation, as we have excluded the open markets used in the first-stage estimation to compute global prices. Local currency risk is priced less frequently in DMs, with only around 25-33% of countries showing a statistically significant price of risk. In contrast, 40-50% of EMs exhibit significant local currency risk price. Local headline inflation risk price is significant in about 58% of DMs and 50% of EMs, with average annual price of risk of -0.97% and -3.59%, respectively. The higher percentage of significance in DMs is primarily due to their smaller sample size, whereas EMs consist of a larger number of countries. Core inflation risk is significantly priced in 42% of DMs and 67% of EMs, with average annual prices of 0.21% and -0.65%, respectively. Hence, core inflation is priced both globally and locally. Additionally, local energy inflation is priced in 50% of DMs and 56% of EMs, with average prices of 0.13% and -15.71%. Local food inflation is priced in 42% of DMs and 50% of EMs, with average prices of -3.27% and 6.72%. We report a series of tests on the residuals, including the Lagrange Multiplier test for autocorrelation of order 12, along with the root mean square error (RMSE).

Our results show that despite the increasing financial market integration of economies over time, equity returns continue to be significantly influenced by local factors, particularly in emerging markets.

4.3 Exposure to Global and Local Inflation Risk

In this section, we analyze exposure to both global and local inflation risk. Previous literature has highlighted significant time variation in the inflation betas of equity indexes, challenging the construction of effective out-of-sample inflation-hedging portfolios. This paper aims to understand the characteristics of such exposure, particularly how it differs across countries and over time. We measure global inflation risk as the covariance between the returns of (r_{DP}) and global unexpected inflation and unspanned local inflation risk is measured as the covariance between the returns of the hedge portfolios (r_{HP}) and local unexpected inflation. Hence, we examine inflation betas of the returns from DP and HP. Table 6 reports the percentage of time the beta coefficients are positive for DMs and EMs, specifying these percentages separately for betas between 0 and 1, and greater than 1. Exposure to global core inflation risk is positive 41% of the time for DMs and 45% for EMs. Exposure to local core inflation risk is positive 53% of the time for DMs and 48% for EMs. Exposure to local energy risk is positive 44% of the time for DMs and 56% for EMs. Exposure to local food risk is positive 53% of the time for DMs and 43% for EMs. Figure 6 displays the time-varying global core inflation betas of the DPs for each country[13]. This figure illustrates and confirms the considerable time variations in these betas. Notably, there is significant heterogeneity at the beginning of our sample, whereas, after early 2000s, more synchronized patterns emerge. The average correlation among exposures of DMs is 0.75 and 0.70 for EMs. In DMs, the average correlation increased from 0.57 to 0.76 after 2001. In EMs, the average correlation went from 0.41 to 0.70. The Figure shows that the DPs of some countries were effective hedges against shocks to global core inflation, hence the negative expected returns. This is especially the case for Brazil and South Africa. Figure 7 illustrates the local core inflation betas of the hedge portfolio returns. As expected, we observe large heterogeneity in the betas of both DMs and EM, with some countries, such as Ireland, Portugal, Czech republic, Peru and Philippines, having a hedge portfolios that effectively hedged against local core inflation. Figure 8 and Figure 9 illustrates the local energy

[13]Note that we have scaled the time-varying covariances with the variances to obtain the beta form.

and food inflation betas, respectively. Similarly, both figures document a large heterogeneity in the exposure of EMs.

4.4 Equity Risk Premia

In this section, we explore how global and local inflation risks contribute to country equity risk premia. The contribution of (global and local) inflation risk premium to the total premium varies widely over time and across countries switching sign between positive and negative values.

Table 7 reports average absolute contributions to the risk premia of global factors — such as the global market, dollar factor, global core inflation — as well as local factors, including market risk, FX risk, core inflation, energy prices, and food prices. As expected, global market risk makes the largest contribution to the equity premium for both DMs and EMs. Global market risk accounts for 36.97% and 24.63% of the equity premia in DMs and EMs, respectively. Local market risk contributes to a larger extent to the EMs equity premia. It accounts for 18.41% and 24.76% in DMs and EMs, respectively. Similarly, currency risk contributes more substantially to the equity risk premium in EMs. Currency risk contributes to 4.88% of equity premia in DMs and almost twice as much in EMs, 8.49%. The equity premia contributions of global core inflation risk are smaller but statistically significant, accounting for about 3% of total premia in DMs and EMs. All local inflation risks contribute to some extent to the equity risk premia. Specifically, local core inflation risk accounts for 6.60% of the equity premium in DMs and 7.79% in EMs. Energy inflation risk contribution is 4.85% in DMs and 7.69% in EMs, on average. Lastly, food inflation accounts for 4.02% of the equity premium in DMs and 6.51% in EMs.

Figure 10 presents the breakdown of various risk factors contributing to equity risk premia. For each country, the risk premium components are ranked in descending order based on their average absolute contribution. The rank of each component is calculated by dividing its rank position by the total number of significant factors. Darker shades in the figure indicate higher-ranked components, highlighting their greater contribution to the equity premium. The figure illustrates the results previously discussed and highlights differences across countries. Overall, local risk factors are more significant for EMs than for DMs. Specifically, Indonesia, Peru, and the Philippines exhibit a strong contribution of local market risk, suggesting that these markets are more segmented. Local market risk also contributes to equity premia in a few DMs, including Finland and Switzerland. Currency risk plays a substantial role in the equity premia of EMs, especially in the case of Chile. Local core inflation risk significantly contributes to the equity premium in Canada and Ireland. Across EMs, it is particularly important for Mexico. Local energy risk is particularly significant for equity premia in Thailand and Turkey. Figure 12 shows the time-varying monthly percentage contributions of local inflation components to the total equity risk premium. Contributions decrease over time with greater market integration both for DMs and EMs.

4.5 Time-variation and Unconditional Models

The main advantage of our study is the use of a conditional model, which allows us to analyze time-varying prices of risk. Our methodology captures risk premia through both time-varying prices of risk and exposures. Previous studies, such as Boons et al. (2020), have shown that inflation risk premia fluctuate over time, even changing sign. As a result, an unconditional model might overlook the significance of inflation risk premia due to this variability. It is important to emphasize that the expectation of the conditional model is not equivalent to simply calculating unconditional expectations. The covariance between conditional exposures and prices of risk plays a crucial role in understanding these dynamics. Table 8 shows that the covariances between the price of risk of local unexpected inflation components and their corresponding exposures are different from zero. This fact highlights the importance of using time-varying models when analyzing how inflation risk is priced in international equity markets compared unconditional models.

5 Robustness

We conduct a series of robustness checks to validate our empirical findings. Specifically, we find that the evidence on the pricing of global inflation risk remains consistent with the results presented in sub-section 4.1. Table 9 shows that our results hold under alternative specifications, including: (i) filtering inflation shocks with a VAR model instead of an ARMA (1,1), (ii) adjusting inflation for seasonality, (iii) using the median unexpected inflation rate across developed and emerging markets as an alternative measure for global inflation, (iv) using equal weights (as opposed to GDP weights) for the construction of the global inflation risk or the US inflation rate, and (v) accounting for the carry factor. Table 10 shows robustness checks for the price of local inflation risk. We document that the all components of inflation are priced to some extent as reported in sub-section 4.2. In column (1), we show the results when filtering inflation using a VAR model, while in column (2), we report the results after adjusting the inflation data for seasonality. Additionally, we test the robustness of our results by changing the set of global and local instruments. In the first-stage estimation, excluding the term spread (T103M) or the default spread (Baa-Aaa) does not affect the significance of the global core inflation risk price. However, the world dividend yield in excess of the risk-free rate (WDYe) remains critical for the significance of the market factor. In the second-stage estimation, sequentially removing one instrument at a time does not alter the overall conclusion that all sub-components of inflation are priced in some countries. These results are available upon request from the authors.

We estimated the model using U.S. inflation shocks instead of a global inflation measure. We used U.S. equity index as proxy for global returns and five open markets. Since U.S. inflation is already expressed in dollars, the dollar factor does not emerge in the model. We include the following instruments: U.S. excess dividend yield, T10Y3M,and BaaAaa. The results show a negative and significant price of core inflation risk, standardized at -0.42, while food and energy are not priced.

6 Conclusion

We analyze how inflation risk is priced in partially segmented markets allowing for time-varying risk prices and exposures. Our findings indicate that headline inflation risk is priced globally and locally. By decomposing inflation into core, energy, and food components, we find that global core inflation is priced, while non-core inflation risks are not. Locally, however, all of core, energy, and food inflation are priced for about half of our sample countries. Hence, we show that while the global inflation risk premium is mainly driven by core inflation, all inflation components contribute to the local risk premium. This study underscores the importance of differentiating between local and global inflation effects when studying inflation risk pricing.

7 Figures and Tables

7.1 Tables

Table 1 Summary statistics inflation - DMs

	A. Summary			
	Mean	SD	Autocorr	
Headline	2.21	4.83	0.55	
Core	2.05	4.84	0.73	
Food	2.04	8.24	0.37	
Energy	4.16	25.65	0.10	
	B. Regression			
	β	se	R-square	
Core	0.76	0.01	0.97	
Food	0.15	0.01		
Energy	0.08	0.00		
	C. Correlation			
	Headline	Core	Food	Energy
Headline	1			
Core	0.8	1		
Food	0.37	0.11	1	
Energy	0.53	0.13	0.1	1

Average percentage inflation in DMs with row data. The statistics are computed using log change in the Consumer Price Index of 18 DM countries: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, UK, US. Data is annualized with monthly frequency from 1989-2022 according to country-specific availabilities. Autocorrelation is computed with a 12-month lag.

Table 2 Summary statistics inflation - EMs

	A. Summary			
	Mean	SD	Autocorr	
Headline	5.86	8.40	0.43	
Core	5.36	7.10	0.53	
Food	6.62	15.54	0.37	
Energy	6.98	24.73	0.26	
	B. Regression			
	β	se	R-square	
Core	0.64	0.03	0.91	
Food	0.25	0.01		
Energy	0.09	0.01		
	C. Correlation			
	Headline	Core	Food	Energy
Headline	1			
Core	0.74	1		
Food	0.71	0.36	1	
Energy	0.48	0.31	0.2	1

Average percentage inflation in EMs with row data. The statistics are computed using log change in the Consumer Price Index of 18 EM countries: Brazil, Chile, China, Colombia, Czech Republic, Greece, Hungary, Indonesia, Mexico, Peru, Philippines, Poland, Russia, South Africa, South Korea, Taiwan, Thailand, Turkey. Data is annualized with monthly frequency from 1989-2022 according to country-specific availabilities. Autocorrelation is computed with a 12-month lag.

Table 3 Summary statistics global factors

A. Summary

	Mean	SD	Min	Max	Autocorr
MSCIW	4.462	53.135	-252.849	144.711	0.024
Dollar	-0.335	16.249	-64.556	44.585	-0.016
Headline	0.01	2.464	-11.825	11.673	0.345
Core	0.016	1.781	-5.191	5.59	0.786
Food	0.02	4.022	-12.953	21.984	0.422
Energy	0.005	20.91	-109.981	99.399	0.065

B. Correlation

	MSCIW	Dollar	Headline	Core	Energy	Food
MSCIW	1					
Dollar	0.359	1				
Headline	0.038	0.073	1			
Core	-0.039	-0.004	0.617	1		
Food	-0.055	-0.063	0.314	0.082	1	
Energy	0.071	0.112	0.807	0.126	0.091	1

All values are annualized. Headline, Core, Energy, Food are global factors computed as GDP-weighted average inflation shocks across DMs. Autocorrelation is computed with a 12-month lag.

Table 4 Price of Global Inflation Risk

		(1)	(2)
Market	H_0: zero price	(0.001)	(0.000)
	H_0: constant price	(0.128)	(0.033)
	Average price	2.672	3.599
	Average price std (%)	6.343	7.634
Dollar	H_0: zero price	(0.071)	(0.190)
	H_0: constant price	(0.036)	(0.159)
	Average price	-21.855	-9.308
	Average price std (%)	-1.912	-0.731
Headline	H_0: zero price	(0.059)	-
	H_0: constant price	(0.029)	
	Average price	-3.391	
	Average price std (%)	0.062	
Core	H_0: zero price	-	(0.000)
	H_0: constant price		(0.055)
	Average price		-186.301
	Average price std (%)		-0.464
Energy	H_0: zero price	-	(0.793)
	H_0: constant price		(0.786)
	Average price		3.367
	Average price std (%)		1.095
Food	H_0: zero price	-	(0.531)
	H_0: constant price		(0.426)
	Average price		55.941
	Average price std (%)		0.462
N obs		406	406
LM test		16.046	16.153
		(0.189)	(0.184)
RMSE		0.051	0.048
Pseudo R^2		0.503	0.508

The table reports the estimated price of risk for global market, dollar factor and global inflation. Specification (1) shows results with global headline inflation and Specification (2) with global inflation sub-components: core, energy, and food. For each factor we report two specification tests, the monthly average price of risk, and the annual average price of risk standardized by the time-varying covariance matrix. The first tests if the price is zero at each point in time, and the second tests that the price of risk is non-time varying. We also report the LM test for autocorrelation of order 12 for the residuals, the root mean square error, the pseudo R-square computed as the ratio between the explained sum of squares and the total sum of squares.

Table 5 Price of Local Risk

		(1)		(2)	
		DM	EM	DM	EM
Market	H_0: zero price	75%	80%	75%	83%
	H_0: constant price	75%	70%	67%	67%
	Average price	3.35	3.89	3.84	2.87
	Price range	[0.99, 14.27]	[0.49, 16.6]	[0.85, 13.13]	[0.41, 8.71]
	Average price std (%)	3.97	14.57	6.37	12.38
	Price range std (%)	[1.08, 10.33]	[1.68, 0.53.12]	[0.88, 27.11]	[1.23, 31.86]
Exchange	H_0: zero price	25%	40%	33%	50%
	H_0: constant price	25%	35%	33%	50%
	Average price	-3.60	-13.53	7.14	0.22
	Price range	[-34.08, 30.53]	[-70.16, 41.1]	[-13.77, 86.21]	[-16.22, 95.36]
	Average price std (%)	-0.18	-4.85	-1.37	-2.21
	Price range std (%)	[-15.53, 13.17]	[-40.41, 12.86]	[-7.41, 13.84]	[-14.47, 5.64]
Headline	H_0: zero price	58%	50%	-	-
	H_0: constant price	67%	35%		
	Average price	-19.65	-55.04		
	Price range	[-295.15, 284.76]	[-526.27, 226.5]		
	Average price std (%)	-0.97	-3.59		
	Price range std (%)	[-6.05, 5.78]	[-20.43, 12.69]		
Core	H_0: zero price	-	-	42%	67%
	H_0: constant price			42%	56%
	Average price			-2.61	-77.25
	Price range			[-708.24, 749.18]	[-997.54, 529.35]
	Average price std (%)			0.21	-0.65
	Price range std (%)			[-10.66, 10.42]	[-31.96, 43.48]
Energy	H_0: zero price	-	-	50%	56%
	H_0: constant price			33%	56%
	Average price			12.41	15.02
	Price range			[-100.33, 91.88]	[-149.76, 640.99]
	Average price std (%)			0.13	-15.71
	Price range std (%)			[-50.09, 34.74]	[-185,52, 99.81]
Food	H_0: zero price	-	-	42%	50%
	H_0: constant price			33%	50%
	Average price			-74.44	17.2
	Price range			[-349.01, 236.22]	[-193.37, 268.04]
	Average price std (%)			-3.27	6.72
	Price range std (%)			[-16.39,12.52]	[-21.71, 52.52]
N country		12	20	12	18

The table shows the percentage of countries where the risk prices for local market, currency, and local inflation are significant at the 90% confidence level across two specification tests. Specification (1) includes local headline inflation, while Specification (2) focuses on local inflation sub-components: core, energy, and food. Results are presented separately for developed markets (DM) and emerging markets (EM). The two specification tests evaluate: (1) the null hypothesis that price of risk is non-time varying, and (2) whether the price of risk is zero at each point in time. We report the monthly average price of risks and the standardized average price of risk along with their ranges.

Table 6 Positive Exposure to Inflation Risks

	% $0 < \beta < 1$			% $\beta > 1$		
	Global Core			Global Core		
DM	14%			27%		
EM	9%			36%		
	Core	Energy	Food	Core	Energy	Food
DM	42%	44%	50%	11%	0%	3%
EM	26%	52%	40%	22%	4%	3%

This table displays the percentage of time the beta coefficients are positive for developed markets (DMs) and emerging markets (EMs). We categorize beta into two ranges: (1) between 0 and 1, and (2) greater than 1. The upper panel illustrates the average exposure of diversification portfolio returns to global core inflation risk, while the lower panel presents the exposure of hedge portfolio returns to local core energy and food inflation risk.

Table 7 Average Contribution to Total Risk Premia

	α	Global Mkt	Dollar	Global Core	Mkt	Fx	Inflation		
Panel A									
DM	7.57%	38.24%	14.41%	3.13%	19.08%	5.06%	12.51%		
EM	10.00%	27.25%	8.93%	3.45%	26.80%	9.28%	14.29%		
	α	Global Mkt	Dollar	Global Core	Mkt	Fx	Core	Energy	Food
Panel B									
DM	7.32%	36.97%	13.94%	3.02%	18.41%	4.88%	6.60%	4.85%	4.02%
EM	8.89%	24.62%	8.13%	3.13%	24.76%	8.49%	7.79%	7.69%	6.51%

The table displays the average absolute contribution of each risk component to the total risk premia for developed markets (DM) and emerging markets (EM). Panel A outlines the contributions to risk premia aggregating local inflation components, while Panel B separates each inflation sub-cmponents. Note that in panel A, we first sum the inflation subcomponents and then take the absolute value of the total local inflation. This approach addresses the sign changes in inflation, where different components may offset each other.

Table 8 Covariance between lambdas and betas

	$\text{cov}(\lambda_{\text{core}}, \beta_{\text{core}})$	$\text{cov}(\lambda_{\text{energy}}, \beta_{\text{energy}})$	$\text{cov}(\lambda_{\text{food}}, \beta_{\text{food}})$
Panel A: DM			
Min	-4.21	-17.20	-7.19
Max	3.76	0.91	3.08
Panel B: EM			
Min	-20.96	-0.25	-4.67
Max	6.21	9.40	18.97

The table presents the covariance between time-varying exposures and price of risk. We standardized prices and exposure using the time-varying covariance matrix. Panel A displays the minimum and maximum covariance values for developed markets (DMs), while Panel B provides the corresponding values for emerging markets (EMs).

Table 9 Robustness - Price of Global Inflation Risk

		(1)	(2)	(3)	(4)	(5)
Market	H_0: zero price	(0.000)	(0.000)	(0.001)	(0.002)	(0.000)
	H_0: constant price	(0.083)	(0.057)	(0.206)	(0.122)	(0.028)
	Average price	3.611	3.431	3.083	3.012	4.340
	Average price std (%)	7.907	7.318	6.716	6.097	8.499
Dollar	H_0: zero price	(0.167)	(0.086)	(0.427)	(0.427)	(0.016)
	H_0: constant price	(0.152)	(0.073)	(0.343)	(0.329)	(0.035)
	Average price	-9.534	-8.880	-2.881	-3.222	-12.498
	Average price std (%)	-0.896	-0.851	-0.942	-0.491	-1.575
Carry	H_0: zero price	-	-	-	-	(0.691)
	H_0: constant price					(0.663)
	Average price					1.578
	Average price std (%)					2.946
Core	H_0: zero price	(0.000)	(0.005)	(0.010)	(0.050)	(0.000)
	H_0: constant price	(0.074)	(0.267)	(0.062)	(0.113)	(0.008)
	Average price	-249.155	-559.228	-177.878	-113.714	-161.949
	Average price std (%)	-0.638	-0.303	-0.750	-0.586	-0.444
Energy	H_0: zero price	(0.898)	(0.939)	(0.818)	(0.894)	(0.978)
	H_0: constant price	(0.945)	(0.873)	(0.748)	(0.796)	(0.953)
	Average price	7.815	-1.234	3.061	-1.227	-0.609
	Average price std (%)	1.910	-1.264	0.353	-0.246%	0.144
Food	H_0: zero price	(0.390)	(0.405)	(0.605)	(0.839)	(0.528)
	H_0: constant price	(0.250)	(0.450)	(0.457)	(0.716)	(0.682)
	Average price	31.799	33.772	-0.810	-4.856	109.575
	Average price std (%)	0.148	0.158	-0.167	-0.251	0.926

The table presents robustness checks for the price of global inflation risk. Column (1) shows results using a VAR filtering process instead of ARMA(1,1). Column (2) presents results with seasonally adjusted inflation data. Columns (3) and (4) provide results based on alternative measures of global inflation: the median rate and an equally weighted average, respectively. Column (5) accounts for the carry factor as a test factor, using Verdelhan's dataset that is available till May 31, 2021. We report the monthly average price of risk, and the annualized standardized price of risk.

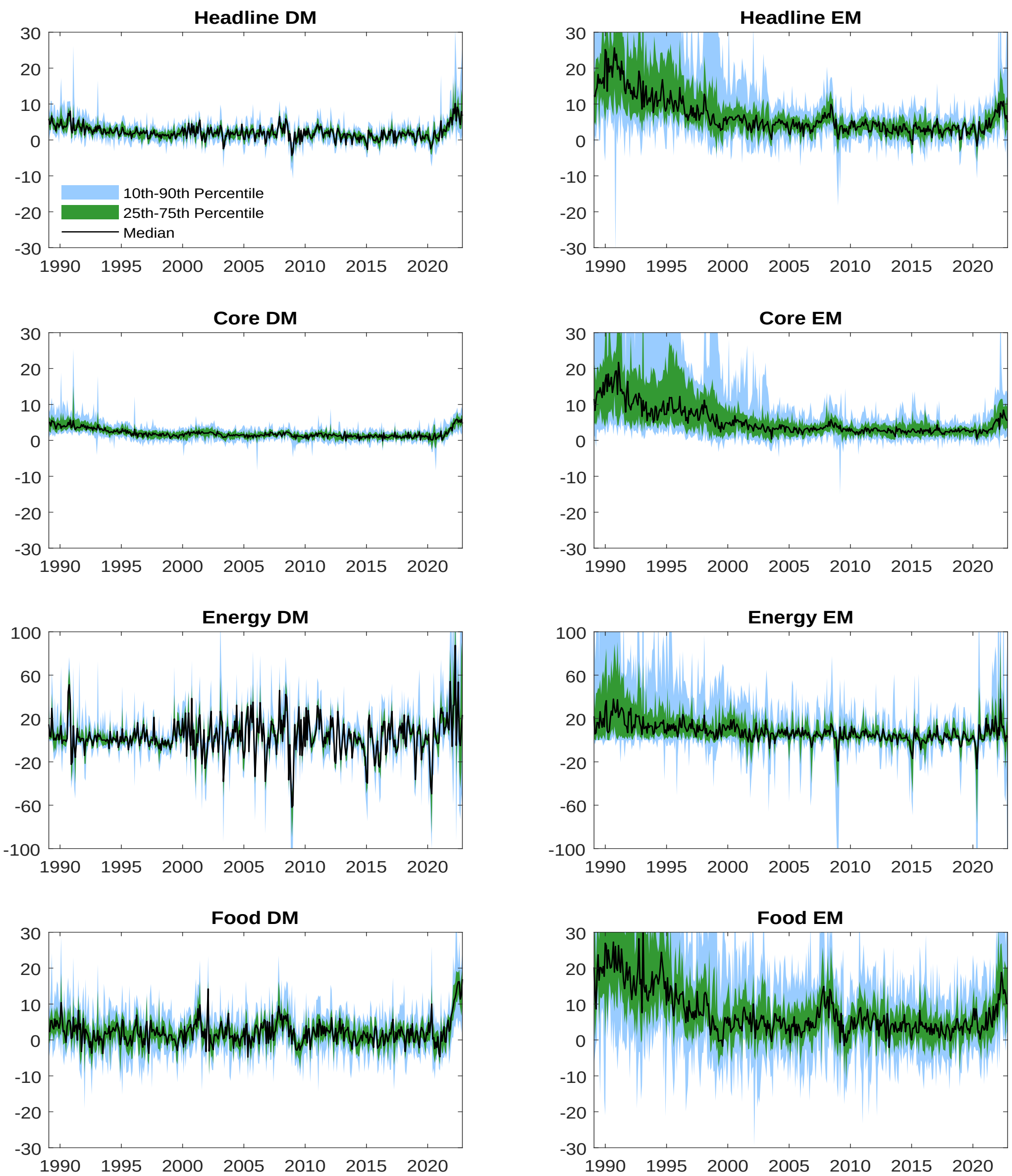
Table 10 Robustness - Price of Local Inflation Risk

		(1)		(2)	
		DM	EM	DM	EM
Market	H_0: zero price	83%	78%	75%	89%
	H_0: constant price	75%	67%	75%	67%
Exchange	H_0: zero price	25%	50%	67%	56%
	H_0: constant price	25%	50%	58%	39%
Core	H_0: zero price	42%	67%	83%	67%
	H_0: constant price	42%	56%	83%	61%
Energy	H_0: zero price	50%	50%	67%	56%
	H_0: constant price	50%	44%	42%	56%
Food	H_0: zero price	50%	50%	33%	44%
	H_0: constant price	25%	44%	33%	44%

The table presents robustness checks for the pricing of local inflation risk. Column (1) reports results obtained by applying a VAR filtering process to inflation data, while Column (2) presents results with seasonally adjusted inflation data. In both cases, the first-stage estimations are conducted consistently with the second-stage analysis.

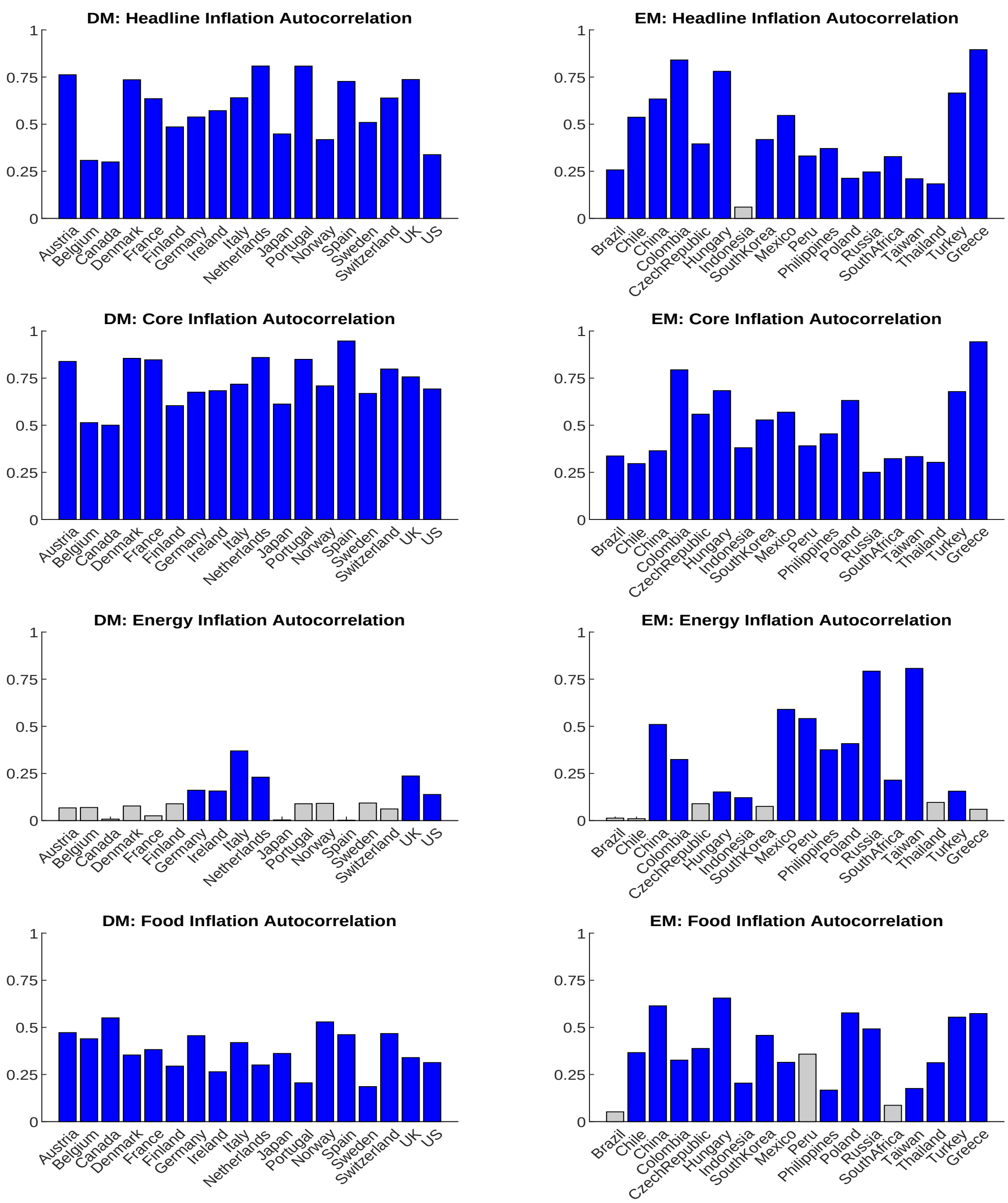
7.2 Figures

Figure 1 Distribution of inflation in DMs and EMs



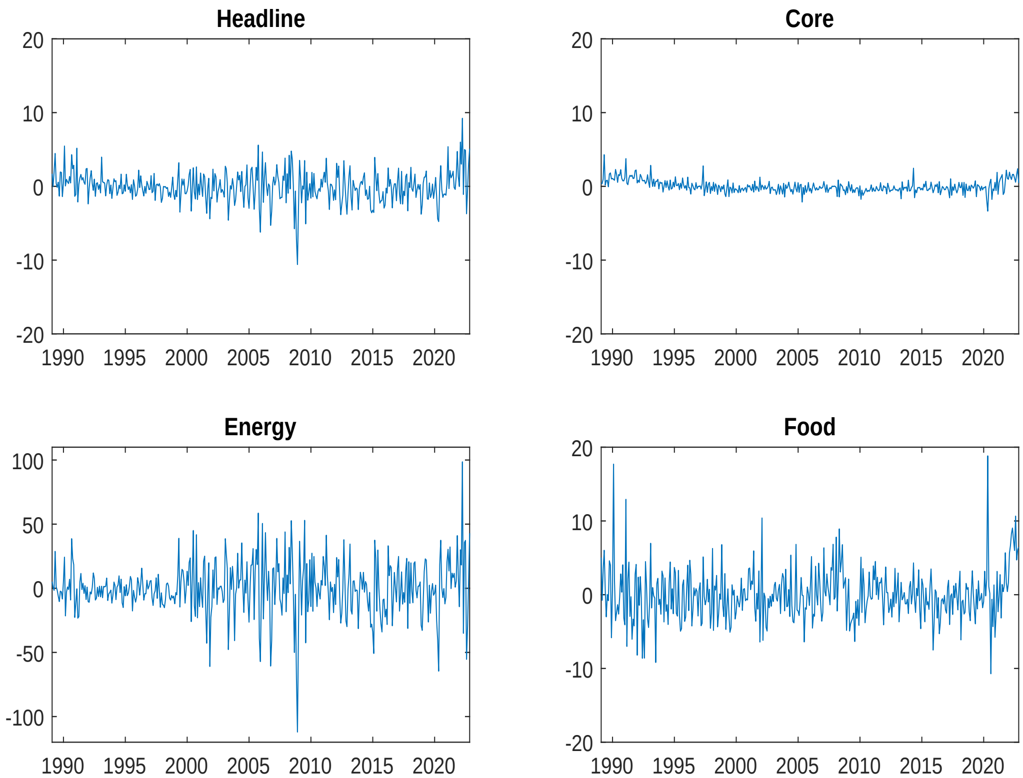
The figure illustrates the annualized inflation rate distribution for developed and emerging markets. Inflation is seasonally adjusted. The top plots show headline inflation, while the lower plots break down inflation into core, energy, and food components. The black line represents the median rate, with the green shaded area covering the 25th to 75th percentiles and the blue shaded area showing the broader range from the 10th to 90th percentiles.

Figure 2 Inflation Persistence



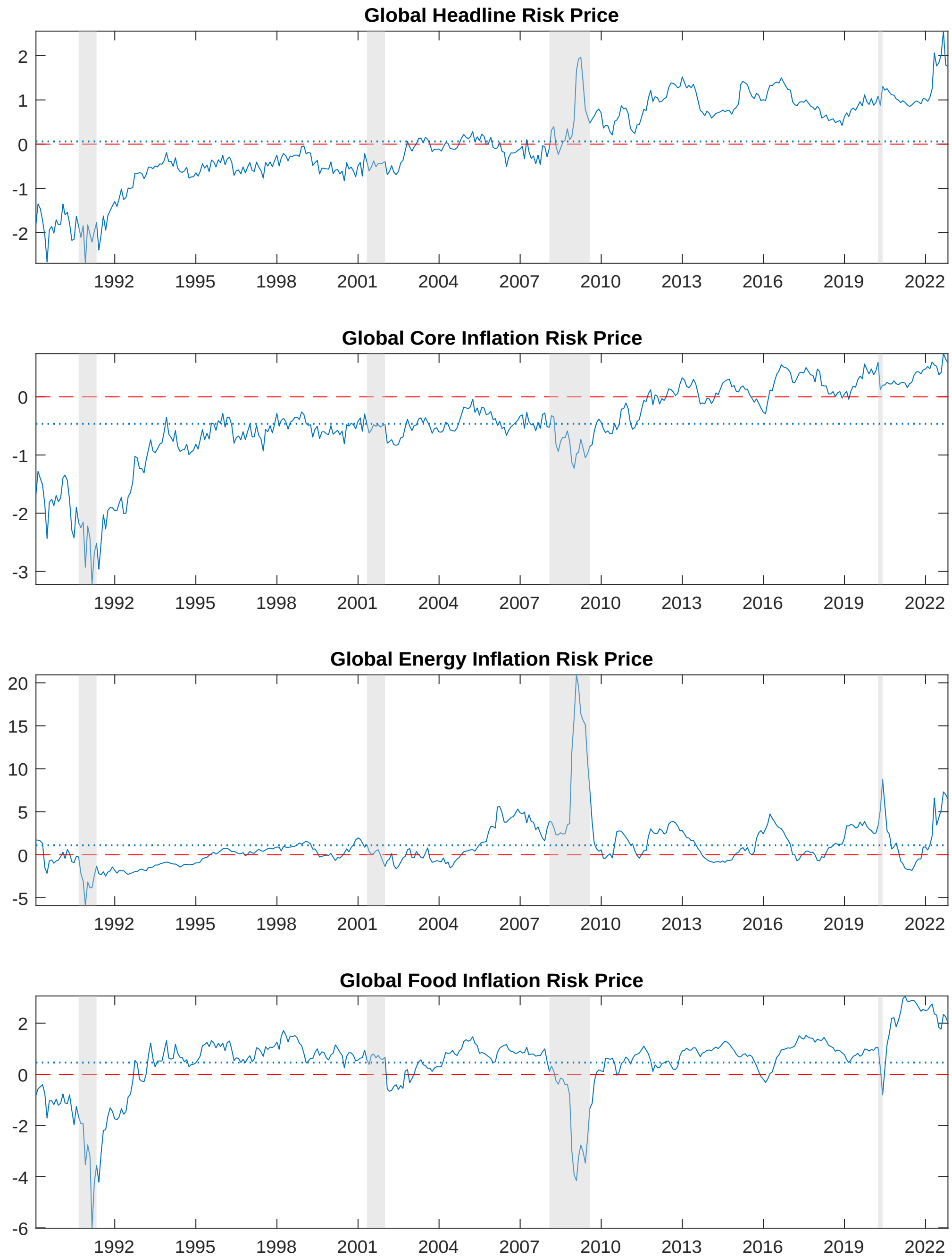
The figure illustrates the persistence of realized inflation on a country-by-country basis. The blue color highlights countries where the autocorrelation with 12-month lag is statistically significant at the 95% confidence interval. The autocorrelation declines slowly at a higher-order lags.

Figure 3 Shocks to Global Inflation



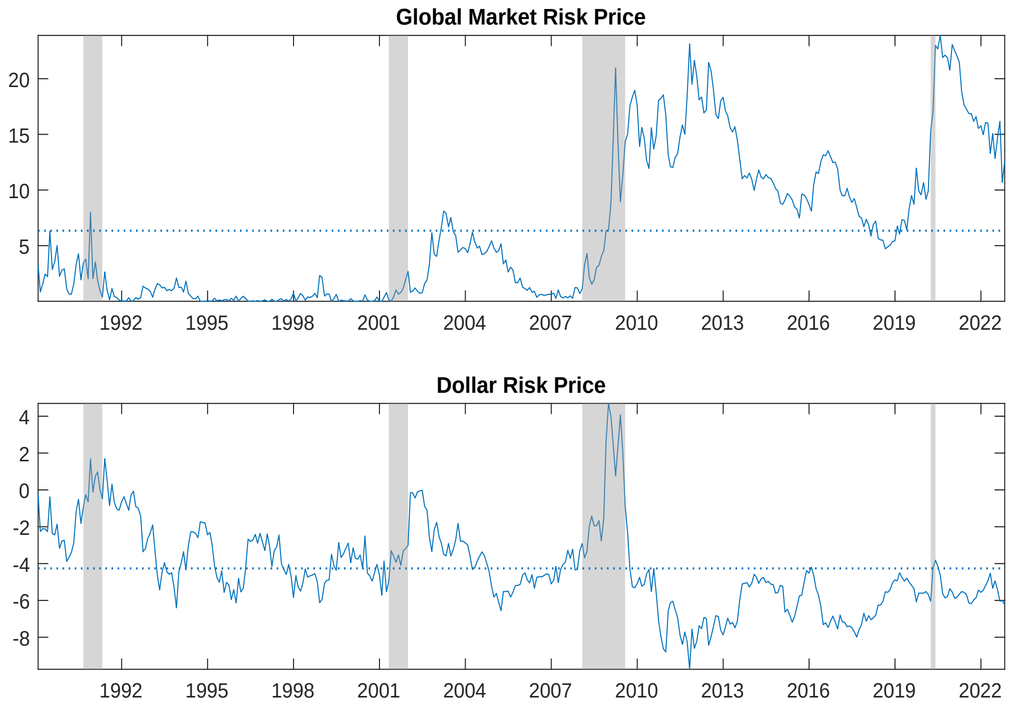
The plots display annualized global inflation indicators for headline inflation as well as its sub-components: core, energy, and food. These global indicators are calculated as GDP-weighted averages of inflation shocks from developed countries.

Figure 4 Global Inflation Risk Price Time Series



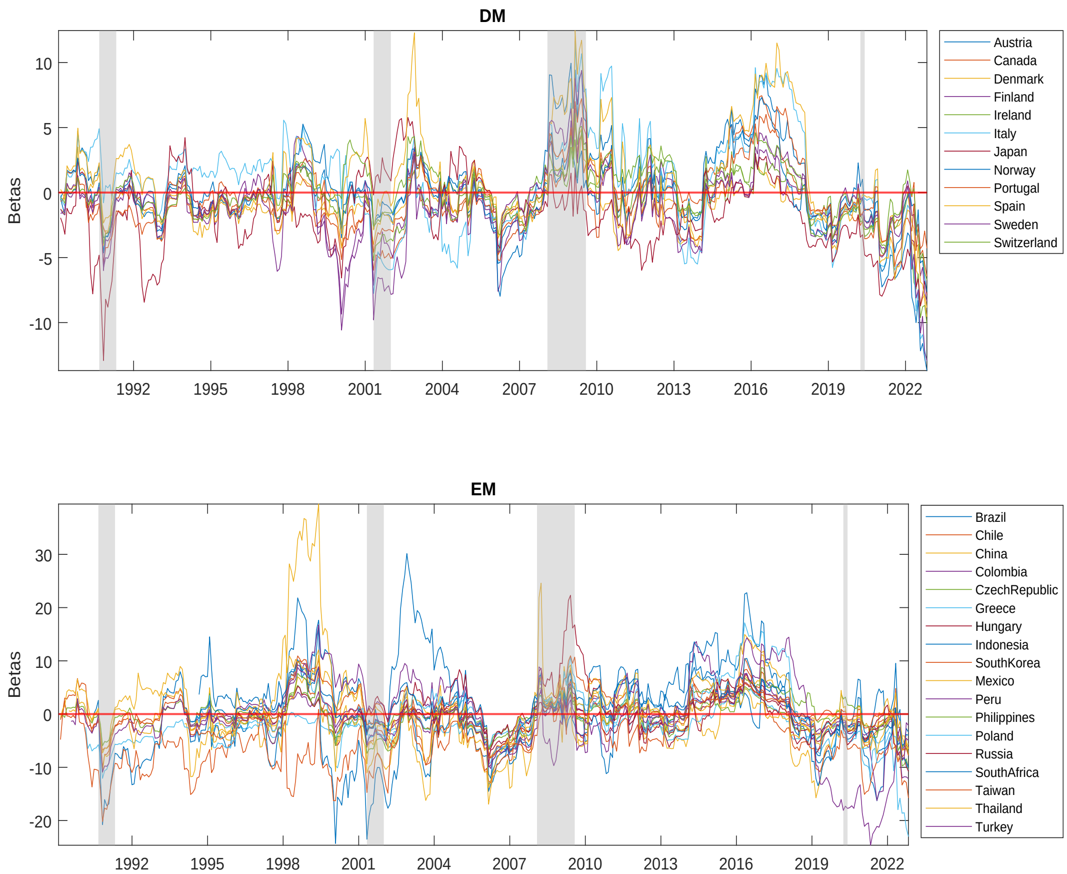
The figure illustrates the evolution of global inflation risk price from 1989 to 2022. The first subplot presents the price of global headline inflation, while the subsequent subplots display the prices of global core inflation, global energy inflation, and global food inflation, respectively. Shaded areas indicate periods of U.S. recessions as defined by the NBER. The dotted lines represent the time series averages, and the dashed red line marks the zero level. The reported risk prices are annualized percentages and are standardized using the time-varying covariance matrix.

Figure 5 Global Market and Dollar Factor Risk Price Time Series



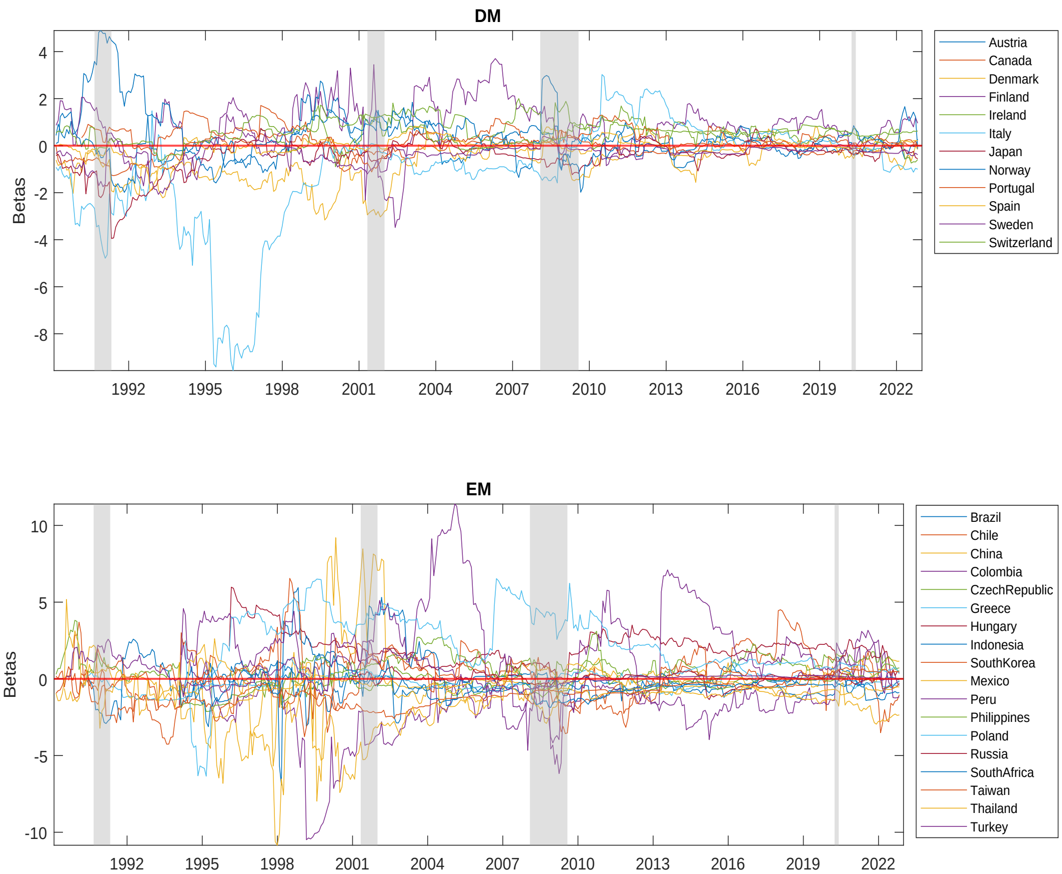
The figure illustrates the evolution of the risk price of global market and the dollar factor from 1989 to 2022. Shaded areas indicate periods of U.S. recessions as defined by the NBER. The dotted lines represent the time series averages. The reported risk prices are annualized percentages and are standardized using the time-varying covariance matrix.

Figure 6 Exposure to Global Core Inflation Shocks



The figure illustrates the country-by-country exposure of diversification portfolio returns to global core inflation risk. The upper plot presents the results for Developed Markets, while the lower plot displays the results for Emerging Markets. Shaded areas indicate periods of U.S. recessions as defined by the NBER. The red horizontal line indicates zero level.

Figure 7 Exposure to Local Core Inflation Shocks

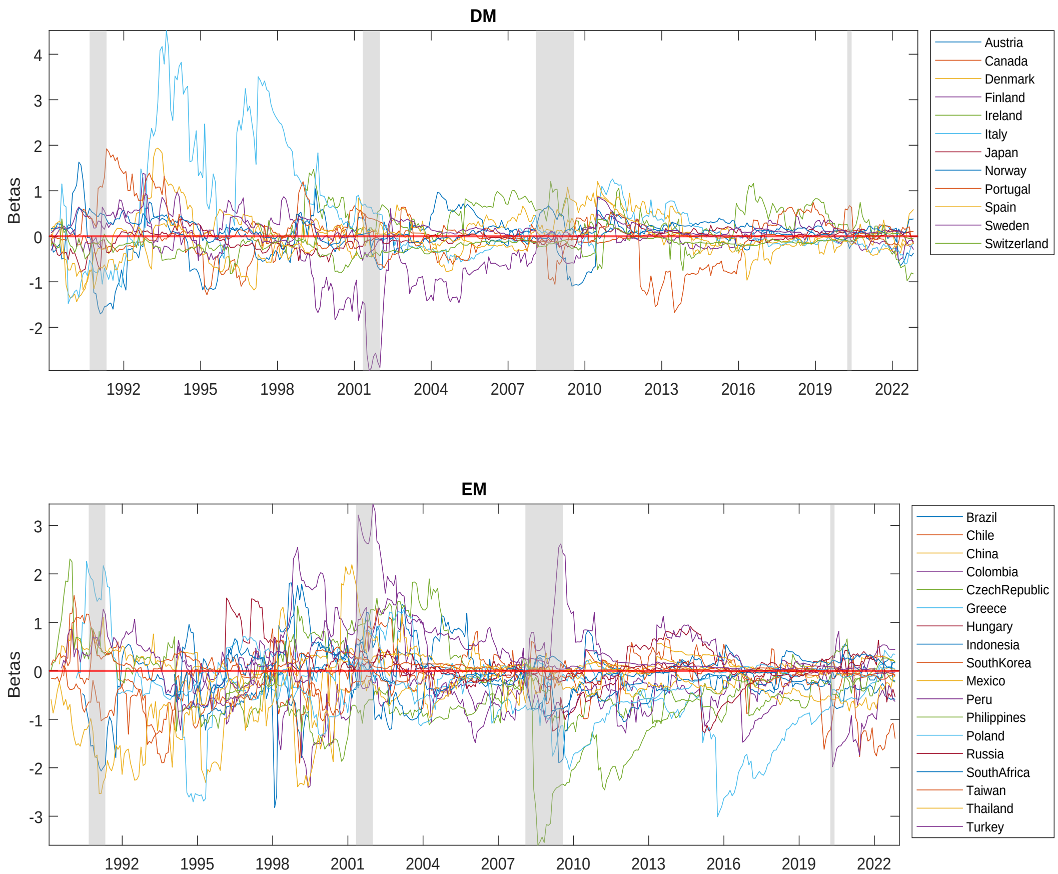


The figure illustrates the country-by-country exposure of hedge portfolio returns to local core inflation risk. The upper plot presents the results for Developed Markets, while the lower plot displays the results for Emerging Markets. Shaded areas indicate periods of U.S. recessions as defined by the NBER. The red horizontal line indicates zero level.

Figure 8 Exposure to Local Energy Inflation Shocks

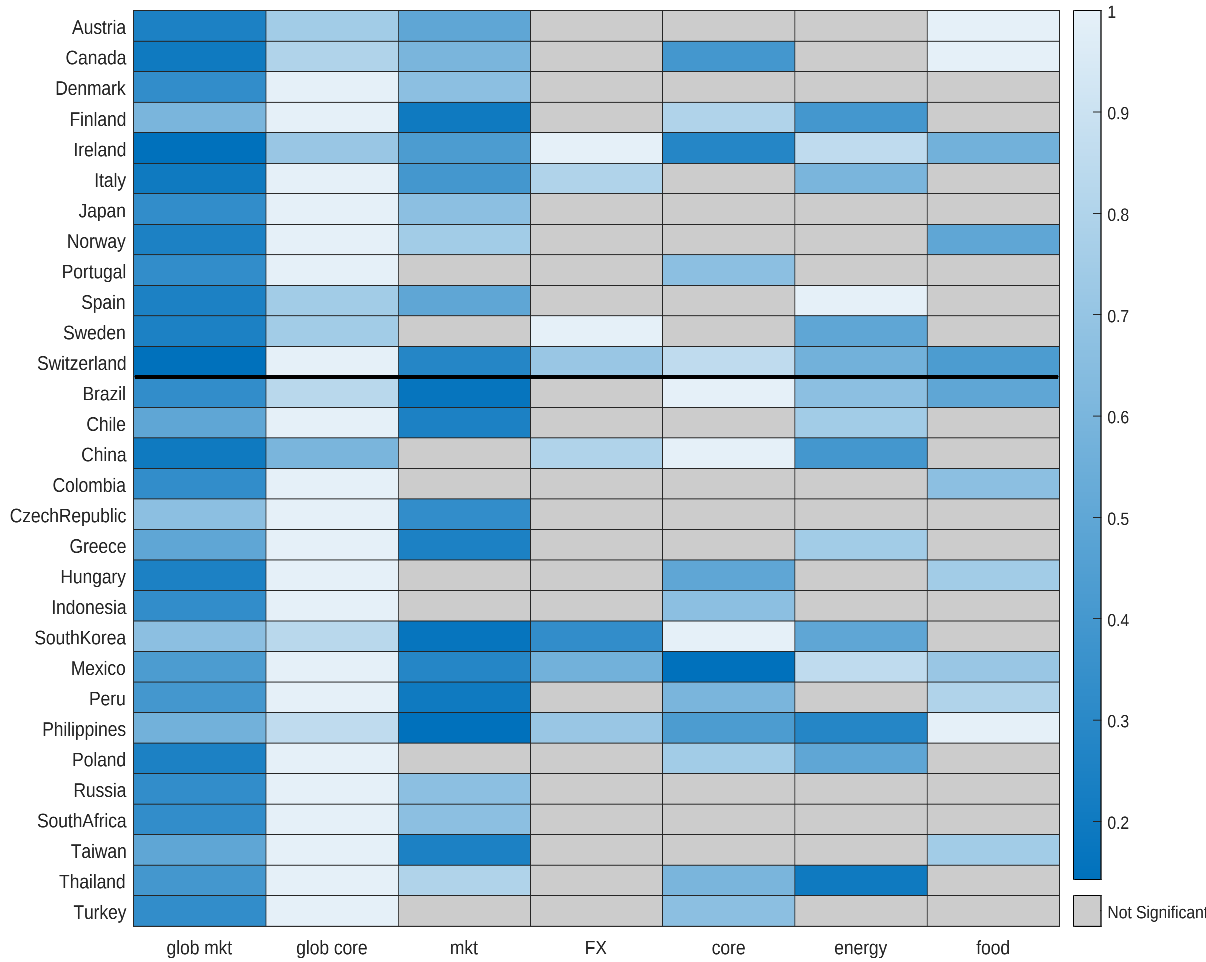
The figure illustrates the country-by-country exposure of hedge portfolio returns to local energy inflation risk. The upper plot presents the results for Developed Markets, while the lower plot displays the results for Emerging Markets. Shaded areas indicate periods of U.S. recessions as defined by the NBER. The red horizontal line indicates zero level.

Figure 9 Exposure to Local Food Inflation Shocks



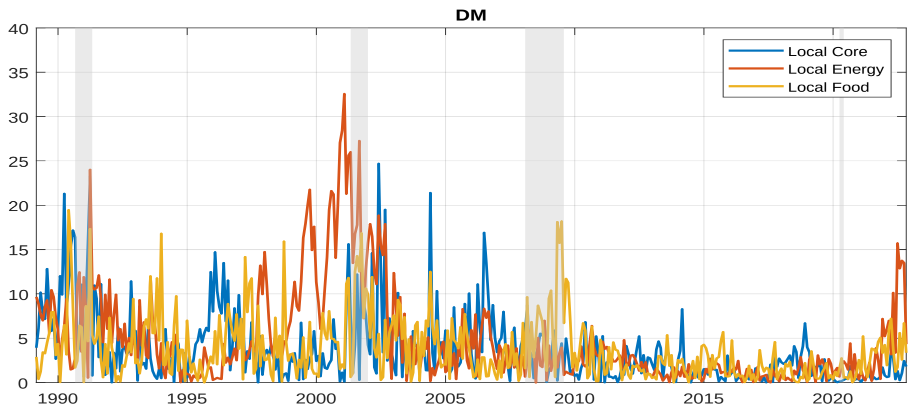
The figure illustrates the country-by-country exposure of hedge portfolio returns to local food inflation risk. The upper plot presents the results for Developed Markets, while the lower plot displays the results for Emerging Markets. Shaded areas indicate periods of U.S. recessions as defined by the NBER. The red horizontal line indicates zero level.

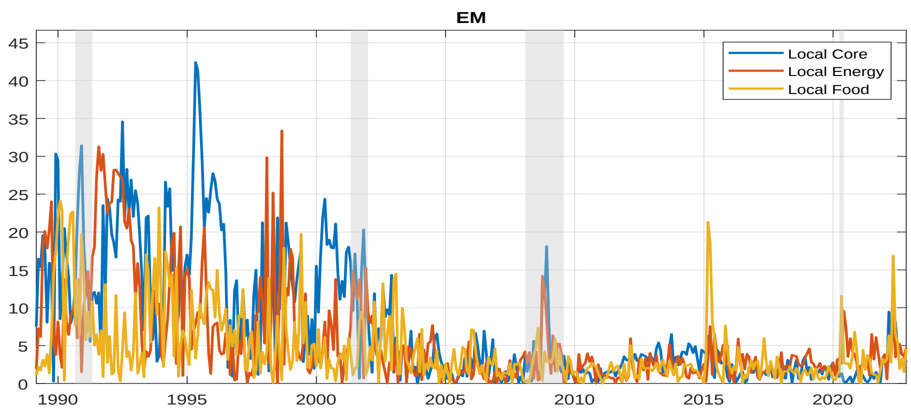
Figure 10 Equity Risk Premia Decomposition



The figure illustrates the contribution of different risk factors to equity risk premia for each country. The upper section of the figure presents results for DMs, while the lower section covers emerging markets EMs. The decomposition includes both global factors (global market and global core) and local factors (market, FX, core, energy, and food). The dollar factor is omitted due to its statistically insignificant price of risk. For each country, the equity risk premium components are ranked from highest to lowest based on their average contribution in absolute terms. The rank positions are calculated by dividing each component's rank by the total number of significant factors. Darker colors represent higher-ranked components. Only components with statistically significant risk premiums are included in the ranking. Components with non-significant p-values are shown in grey.

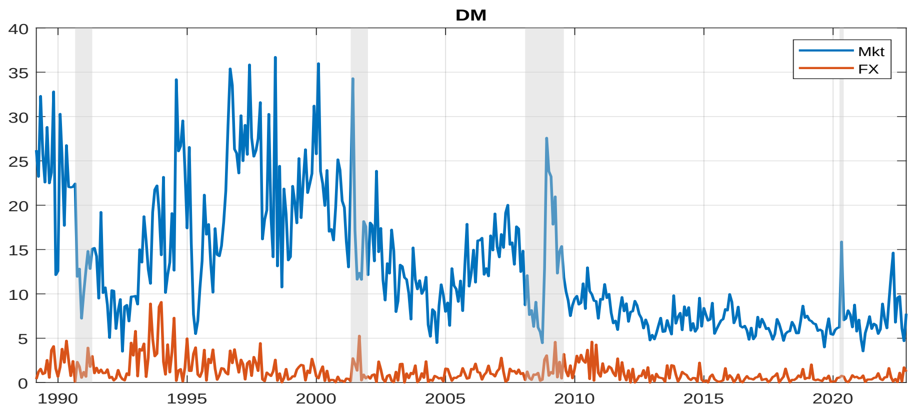
Figure 11 Equity Risk Premia - Local Inflation

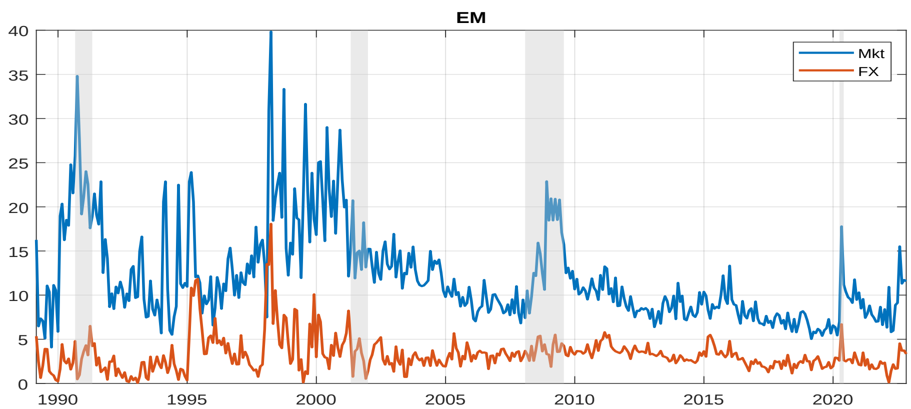




The figure shows the absolute monthly percentage contributions of each local inflation component to the total equity risk premium.

Figure 12 Equity Risk Premia - Local Market and Exchange Rate





The figure shows the absolute monthly percentage contributions of the local market and local exchange rate to the total equity risk premium.

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