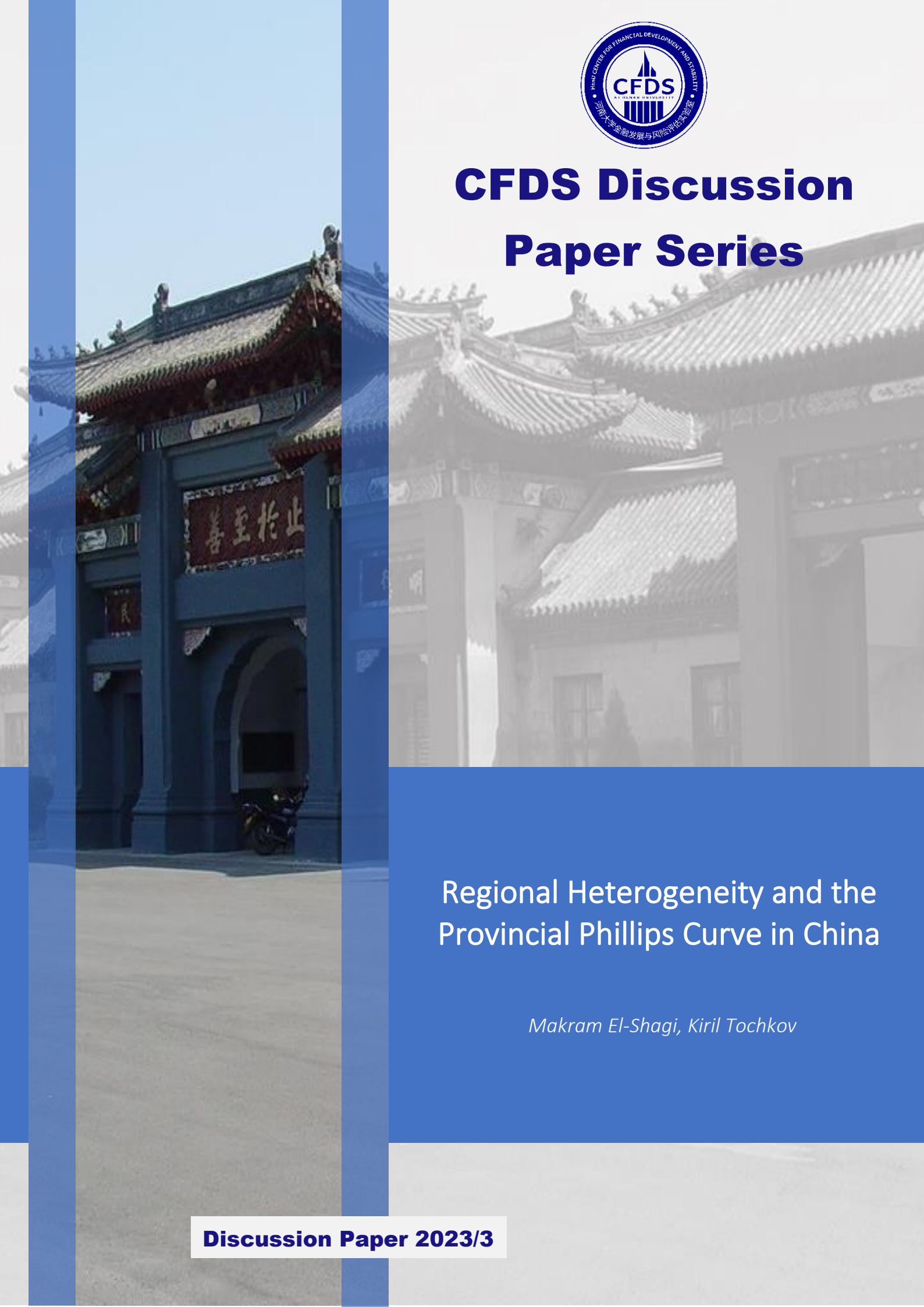

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Regional heterogeneity and the provincial Phillips curve in China

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Abstract

This paper explores the presence of regional heterogeneity in the response of inflation to changes in the output gap in China. We estimate the slope of the provincial Phillips curve for five different price indices using quarterly data over the period 2000-2022. The presence of regional heterogeneity is tested by comparing a fixed effects and a mean group specification. Our results indicate that the slope of the provincial Phillips curve in China is positive and significant for property prices and the producer price index (PPI), which is explained by their focus on non-tradables and goods specific to the local economy, respectively. Other price indices centered on tradables do not show significant sensitivity to provincial output shocks. Regional heterogeneity in the provincial slope is confimed only in the case of the PPI with around 60% of provinces, including most coastal provinces, exhibiting a positive coefficient. Our findings point to the share of industry and the market power of industrial enterprises as significant contributors to the sensitivity of inflation to provincial demand shocks. Moreover, we show that a stronger market-orientation and a smaller role of the state in a given province are also positively associated with the slope of the Phillips curve.

Keywords: Phillips curve, inflation, China, regional heterogeneity
JEL: E31

1 Introduction

The Phillips curve, which in its New Keynesian version examines the relationship between price inflation and the output gap, is a key component of the forecasting models used by monetary authorities to guide their policy decisions. Its slope is traditionally estimated at the national level, but over the past two decades a growing number of studies motivated by various reasons have chosen to utilize regional data. Coen et al. (1999) point out that, unlike the rich data at the regional level, national data on inflation and unemployment have a limited range of observations, producing estimates that rely on extrapolations of fitted relationships, while Kapetanios et al. (2021) argue that aggregation in the presence of heterogeneity at the disaggregate level leads to biased estimates.

Furthermore, the regional approach can solve some fundamental issues that plague the identification and estimation of the Phillips curve. For instance, a successful monetary policy aimed at offsetting demand shocks at the national level will eliminate the variation in the output gap, leaving inflation to be determined by supply shocks that are unforecastable by the monetary authorities. Fitzgerald and Nicolini (2014) and McLeay and Tenreyro (2019) show that regional data can help distinguish demand from supply shocks because a unitary monetary policy cannot offset regional demand shocks. Another issue relates to the difficulty of accounting for inflation expectations as estimates are extremely sensitive to specification choices (Mavroeidis et al., 2014). Hazell et al. (2022) demonstrate that time fixed effects in a panel regression with regional data absorb the variation in the long-run inflation expectations as they are determined by beliefs about the monetary regime common to all regions.

The literature on the regional Phillips curve focuses predominantly on US cities and states as well as Euro Area countries (Beraja et al., 2019; Berk and Swank, 2011; Fitzgerald et al., 2020; Hooper et al., 2019; Hazell et al., 2022; Schuffels et al., 2022), while only a few studies have conducted a similar investigation on emerging economies due to the lack of appropriate regional data of sufficient length. Behera et al. (2018) estimate a Phillips curve for India using annual CPI data for 21 Indian states over the period 2011-2016. Averina et al. (2018) analyze regional heterogeneity in Russia by estimating Phillips curves for four regional clusters over the period 2000-2015, while Orlov and Postnikov (2022) utilize quarterly data to generate separate Phillips curves for 80 Russian regions.

This paper contributes to existing research by exploring the relationship between inflation and the output gap at the regional level in China. In particular, we calculate inflation for five different price indices using quarterly data for 29 Chinese provinces over the period 2000-2022. The price indices contain different combinations of tradables and non-tradables, allowing us to distinguish between prices set at the national and regional levels. For instance, property prices are much more sensitive to local demand or supply shocks, whereas prices of intermediate goods that are imported or regulated at the national level are less likely to react to province-specific changes in the output gap.

Furthermore, we test for the regional homogeneity of the slope of the provin-

cial Phillips curve in China. For this purpose, we estimate two model specifications. The fixed effects model produces a single estimate of the provincial slope, while the mean group estimator obtains the slopes for each province and reports the average. Using a Hausman test, we determine which model is preferred across the five price indices. In the presence of regional homogeneity, the fixed effects model is consistent and efficient, whereas the mean group model is superior, if the inflationary response varies by province. In those cases where regional heterogeneity is detected, we use the mean group estimator to obtain the individual slopes for each province and employ regression analysis to identify the factors responsible for the cross-regional variation. Lastly, we generate an estimate for the slope of the national Phillips curve and compare it to the regional one from our analysis. The robustness of our results is checked for a reduced sample of provinces (excluding autonomous regions and metropolitan areas) and time (pre-COVID period).

A number of studies estimate a Phillips curve for China at the national level (Ji et al., 2015; Zhang and Murasawa, 2011, 2012; Zhang, 2013, 2017); however, to the best of our knowledge, only three papers use provincial data in this context. Holz and Mehrotra (2016) investigate the impact of unit labor costs on inflation in a Phillips curve framework using panel data of annual frequency for 30 provinces over the period 1998-2010. Chen et al. (2017) examine the role of the national output gap on provincial wage and price inflation, estimating separate Phillips curves for 29 provinces over the years 1978-2014. Similarly, Mehrotra et al. (2010) conduct the empirical investigation for each province individually, revealing that a positive and significant slope of the Phillips curve is correlated with coastal provinces, financial deepening, trade openness, and a larger industry share.

Our paper is unique in applying a panel model with time and province fixed effects that was originally proposed by Hazell et al. (2022) to identify the true slope of the national Phillips curve using regional data. Hazell et al. (2022) focus on goods that even between regions of the same country can be considered non-tradable, so that regional demand differences cause the prices of such goods to deviate from their national mean. If the underlying structural parameters of the Phillips curve for those non-tradables and a broader basket of goods are identical, the slope of the regional Phillips curve reflects the true national Phillips curve that might be obfuscated by monetary policy when using national aggregates.

Contrarily, our paper is interested in the Phillips curve's regional component for its own sake. When regional demand causes regional price deviations, traditional monetary policy faces obstacles in stabilizing prices, especially in large heterogeneous countries like China where economic development varies widely across regions. Unlike Hazell et al. (2022), we, therefore, look at various broader price indices that contain different shares of tradables. The existence of Phillips-curve behavior after controlling for time fixed effects implies frictions to domestic trade of the products in the respective market baskets. Furthermore, regional heterogeneity in the slope of the regional Phillips curve would indicate regional variation in those frictions.

Keeping in mind that our primary motivation is to test for and explore the variation in the sensitivity of price inflation to demand shocks across Chinese provinces, this study makes several important contributions to the existing literature. First, we conduct the estimation using quarterly data over the past two decades. While quarterly data is widely used at the national level, all regional Phillips curves for China so far have been estimated with annual data, resulting in a relatively small number of observations (as only Holz and Mehrotra (2016) take advantage of a panel specification). Second, we obtain estimates for five different price indices that help us identify the province-specific sensitivity of inflation, whereas most previous studies have focused on one or two price measures. Third, we test for regional heterogeneity and report the individual slopes for each province but, unlike the existing literature on China, we use a panel setting which enables us to control for the national effects common to all provinces. Fourth, we investigate the determinants of the variation in the provincial slope, which has not been undertaken before.[1] Last but not least, our study on a major emerging economy expands the scope of the literature on the regional Phillips curve beyond its focus on the US and the Euro Area.

The rest of the paper is structured as follows. The next section presents the methodology used to estimate the provincial Phillips curve, while Section 3 describes the data. Section 4 discusses the results and Section 5 provides some conclusions.

2 Methodology

Our empirical model follows the standard New Keynesian specification of the Phillips curve given by:

$$\pi_{it} = \alpha + \beta \tilde{y}_{it} + \eta_t + u_i + \varepsilon_{it} \tag{1}$$

where π_{it} is year-over-year inflation of province i in quarter t. We estimate the model for five different price indices described in the next section. $\tilde{y}$ is the output gap measured as the HP-filtered log GDP of province i in quarter t. The main coefficient of interest is β, the slope of the Phillips curve, which represents the sensitivity of inflation to the output gap.

Besides province fixed effects (u_i), the model in Eq. (1) also includes time fixed effects (η_t) which are important in the context of the regional Phillips curve because they control for monetary policy, long-run inflation expectations, and other national measures that vary over time but are constant across regions within a monetary union. In particular, Hazell et al. (2022) show for US states that the slope of the regional Phillips curve is considerably smaller than the national one, arguing that this is the result of time fixed effects absorbing the

[1] Mehrotra et al. (2010) try to address this question by estimating probit regressions with the dependent variable taking the value of one, if the coefficients of the output gap and forward-looking inflation in the provincial Phillips curve models are statistically significant, and zero otherwise. However, this empirical framework does not explain the variation in the slope across provinces.

long-run inflation expectation. We also explore this aspect by comparing the slopes of the provincial and national Phillips curves in China.

We use two different techniques to estimate the Phillips curve in Eq. (1). The first one is a standard fixed effects (FE) model, which allows the intercepts to differ across groups but constrains the other coefficients to be the same. Accordingly, we obtain a single β estimate for the slope of the provincial Phillips curve in China. The second approach adopts a mean group (MG) estimator suggested by Pesaran and Smith (1995), which allows the slope coefficient to differ across groups. The resulting β in Eq. (1) is then the mean of the individually estimated β_i coefficients for each province.

We determine whether the slope of the Phillips curve is homogeneous across Chinese provinces by comparing the two aforementioned estimators via a Hausman test. If the slope is indeed homogeneous, then both estimators are consistent but only the FE is efficient (null hypothesis). If the β coefficient actually varies across provinces, MG is consistent while FE is not (alternative hypothesis). In other words, if the Hausman test fails to reject the null hypothesis, then the FE estimator is preferable to MG. If we reject the null hypothesis, then the MG estimator is superior to FE. In that case, the single slope coefficient representing the provincial average is still meaningful but compels us to explore regional heterogeneity in more detail.

3 Data

We employ quarterly data for 29 (out of a total of 31) Chinese provinces over the period 2000q1-2022q4, excluding Tibet due to the lack of data and Chongqing because data issues cause seasonal adjustment to fail. The year-over-year inflation is calculated for five price indices, reflecting different sets of tradables and non-tradables. The Consumer Price Index (CPI) measures the price of a representative basket of goods and services consumed by urban and rural households. The Producer Price Index (PPI) focuses on ex-factory prices for manufactured products from the first commercial transaction, excluding agriculture and services. The Purchasing Price Index (PuPI) reflects the prices of products purchased by industrial enterprises as intermediate inputs, such as raw materials, fuel, and energy.[2] The Retail Price Index (RPI) measures retail prices of goods but excludes services. The Property Price (PP) represents the average square-meter price of residential real estate.

The price series are reported on a monthly basis by China's National Bureau of Statistics (NBS), while nominal GDP is available quarterly. We transform the monthly price data into quarterly by taking the corresponding three-month average. All variables are seasonally adjusted using the X-13 ARIMA-SEATS procedure.[3] Nominal GDP is converted to real by deflating it with the CPI.

[2] Two missing observations for PuPI (Inner Mongolia in June 2002 and Zhejiang in October 2002) are interpolated.

[3] Quarterly data has the added advantage of avoiding specific problems with the seasonal adjustment of monthly series due to moving holidays, such as the Chinese New Year.

The output gap is estimated with the help of the Hodrick-Prescott (HP) filter.

The descriptive statistics of the two main variables (inflation and output gap) are reported in Table 1, revealing heterogeneity across Chinese provinces.

4 Results

4.1 Slope estimates

We estimate the provincial Phillips curve in Eq. (1) for five price indices and present the results for the full sample in the left panel of Table 2. The slope coefficient is expected to carry a positive sign because the New Keynesian theory postulates that an increase in the output gap produces inflationary pressures. Our findings reveal that we obtain a positive sign only when we measure inflation using PPI and property prices. For the remaining three price indices (CPI, RPI, and PuPI), coefficients are negative, and with the exception of CPI, not statistically significant. To make sense of the results, we need to explore the likely role of tradables and non-tradables across the various price indices.

Tradable goods are shared across Chinese provinces and their prices are likely to be determined at the national level. Consequently, the larger the share of tradables in a provincial price index, the weaker the inflation response to changes in the provincial output gap. By contrast, prices of non-tradables are much more sensitive to regional demand or supply shocks, making them more appropriate for investigating cross-regional variation in inflation. In our study, RPI covers the retail sector excluding services, thus measuring per definition the prices of tradable goods. On the opposite side of the spectrum are the property prices, which focus solely on a non-tradable. Our results concur with this interpretation by indicating that property prices exhibit a positive and significant coefficient, while RPI inflation is not affected by the provincial output gap (in the preferred FE model).

The CPI basket contains both tradables and non-tradables, although their composition changes every five years and their respective weights are not revealed by the NBS. Estimates indicate that between 2016-2019 goods made up 63% of the market basket, while services accounted for the rest (Qu, 2019). The negative and significant coefficients for CPI in Table 2 could be a reflection of the larger share of tradables goods in the market basket or of the fact that provincial governments are keen on keeping the prices of basic goods and services in check through administrative measures.

Raw materials, fuels, and energy that are included in PuPI are mostly priced at the national level, as they are often imported, produced, or delivered by large national state-owned conglomerates (e.g., Sinopec, CNPC). Accordingly, our estimation shows that PuPI inflation is not significantly linked to changes in the provincial output gap. PPI, on the other hand, has a positive and significant coefficient (in the preferred MG model), which might be explained by the specifics of its measurement in China. One of the 5 key criteria for including a specific good in the index is that the good is representative of or typical for the locality

Table 1: Descriptive statistics of inflation and the output gap by province, 2000-2022

	CPI	PPI	RPI	PuPI	PP	Output gap
Anhui	2.10 (2.11)	1.96 (5.12)	1.56 (2.22)	3.33 (6.45)	8.82 (10.59)	0.103
Beijing	1.93 (1.99)	-0.22 (2.62)	0.04 (1.79)	2.61 (6.92)	10.38 (16.98)	0.058
Fujian	1.91 (1.99)	0.40 (2.88)	1.18 (2.27)	2.44 (5.91)	7.94 (12.00)	0.031
Gansu	2.39 (2.13)	3.34 (9.39)	1.89 (2.22)	3.86 (9.37)	8.00 (16.54)	0.036
Guangdong	1.98 (2.07)	0.42 (2.66)	1.39 (2.24)	1.89 (4.93)	7.68 (8.657)	0.026
Guangxi	2.26 (2.51)	2.89 (5.88)	1.50 (2.64)	3.61 (6.44)	6.86 (9.235)	0.063
Guizhou	2.09 (2.39)	2.46 (4.83)	1.41 (2.48)	4.10 (6.60)	7.31 (11.62)	0.033
Hainan	2.29 (2.42)	1.42 (7.20)	1.68 (2.37)	3.21 (10.2)	12.06 (23.50)	0.090
Hebei	2.12 (2.03)	2.60 (8.41)	1.71 (2.10)	4.10 (8.63)	8.26 (11.34)	0.131
Heilongjiang	2.03 (2.18)	3.46 (10.9)	1.41 (2.36)	3.77 (8.13)	6.08 (10.93)	0.096
Henan	2.29 (2.23)	2.81 (5.05)	1.91 (2.44)	3.89 (5.68)	8.02 (14.31)	0.159
Hubei	2.25 (2.11)	1.79 (3.50)	1.59 (2.45)	3.16 (6.33)	8.60 (11.14)	0.066
Hunan	2.20 (2.01)	2.24 (4.47)	1.69 (2.10)	3.41 (6.01)	8.42 (10.52)	0.024
In. Mongolia	2.16 (1.78)	3.60 (7.82)	1.63 (2.01)	4.13 (7.32)	9.78 (19.68)	0.095
Jiangsu	2.20 (1.80)	1.11 (4.06)	1.45 (1.97)	3.13 (7.67)	9.81 (8.367)	0.025
Jiangxi	2.10 (1.92)	2.89 (6.85)	1.46 (2.03)	3.68 (7.34)	10.12 (12.04)	0.048
Jilin	2.08 (1.94)	1.21 (3.39)	1.69 (2.16)	2.58 (4.60)	6.60 (18.65)	0.104
Liaoning	1.96 (1.92)	2.66 (5.68)	1.32 (2.23)	3.30 (6.28)	6.84 (7.349)	0.155
Ningxia	2.37 (2.25)	3.61 (7.57)	1.57 (2.45)	5.17 (9.37)	8.36 (10.43)	0.078
Qinghai	2.97 (2.39)	2.97 (8.27)	2.21 (2.60)	3.08 (5.77)	9.50 (21.62)	0.027
Shaanxi	2.17 (2.04)	3.26 (7.02)	1.62 (2.28)	3.58 (6.04)	8.58 (13.20)	0.143
Shandong	2.09 (1.75)	1.90 (4.69)	1.44 (1.88)	3.03 (5.72)	8.23 (9.621)	0.070
Shanghai	2.11 (1.76)	-0.03 (2.98)	0.72 (1.99)	2.04 (7.31)	11.85 (18.46)	0.040
Shanxi	2.24 (2.25)	4.15 (11.8)	1.41 (2.45)	4.15 (7.77)	8.17 (20.50)	0.063
Sichuan	2.34 (1.97)	1.74 (3.91)	1.66 (2.17)	3.29 (5.27)	8.77 (10.63)	0.059
Tianjin	2.02 (1.84)	0.36 (5.74)	0.99 (2.26)	3.00 (7.84)	8.81 (13.18)	0.205
Xinjiang	2.34 (2.33)	4.37 (13.9)	1.71 (2.70)	4.73 (11.6)	5.97 (9.870)	0.147
Yunnan	2.12 (2.31)	1.72 (5.43)	1.63 (2.41)	2.94 (5.53)	7.41 (15.36)	0.034
Zhejiang	2.05 (1.95)	0.97 (3.89)	1.50 (2.29)	2.88 (6.90)	11.07 (10.81)	0.034

Note: Average annual inflation with standard deviation in parenthesis using raw data. Last column reports the standard deviation of the output gap. CPI = Consumer Price Index. PPI = Producer Price Index. RPI = Retail Price Index. PuPI = Purchasing Price Index. PP = Property Price.

Table 2: Phillips curve elasticity estimates for Chinese provinces, 2000q1-2022q4

	Full sample			Reduced provincial sample			pre-COVID		
	FE	MG	Hausman	FE	MG	Hausman	FE	MG	Hausman
CPI	-0.010	-0.024	2.883	-0.006	-0.025	2.825	-0.010	-0.029	3.057
	(0.002)	(0.008)	(0.090)	(0.093)	(0.035)	(0.093)	(0.030)	(0.015)	(0.080)
PPI	0.010	0.048	6.819	0.015	0.058	4.677	0.010	0.037	5.869
	(0.369)	(0.009)	(0.009)	(0.255)	(0.015)	(0.031)	(0.464)	(0.033)	(0.015)
PuPI	-0.002	-0.010	0.193	0.000	-0.006	0.058	-0.003	-0.025	1.415
	(0.828)	(0.624)	(0.660)	(0.992)	(0.821)	(0.809)	(0.743)	(0.228)	(0.234)
RPI	-0.004	-0.014	2.555	-0.010	-0.023	1.819	-0.003	-0.011	1.157
	(0.123)	(0.038)	(0.110)	(0.002)	(0.023)	(0.177)	(0.401)	(0.182)	(0.282)
PP	0.0670	0.0667	0.0001	0.043	0.090	1.233	0.064	0.046	0.204
	(0.0161)	(0.0660)	(0.9910)	(0.210)	(0.058)	(0.267)	(0.117)	(0.416)	(0.652)

Note: Reported coefficients represent estimates of β from Eq. (1). p-values in parentheses. CPI = Consumer Price Index. PPI = Producer Price Index. PuPI = Purchasing Price Index. RPI = Retail Price Index. PP = Property Price. FE = fixed effects model. MG = mean group estimation. Reduced provincial sample excludes 4 autonomous regions and 3 metropolitan areas. Pre-COVID sample covers the period 2000q1-2019q4.

where it is produced (*juyou difang tese de chanpin*). The emphasis on such goods is likely to make PPI considerably more sensitive to changes in the local output gap.

4.2 Regional heterogeneity

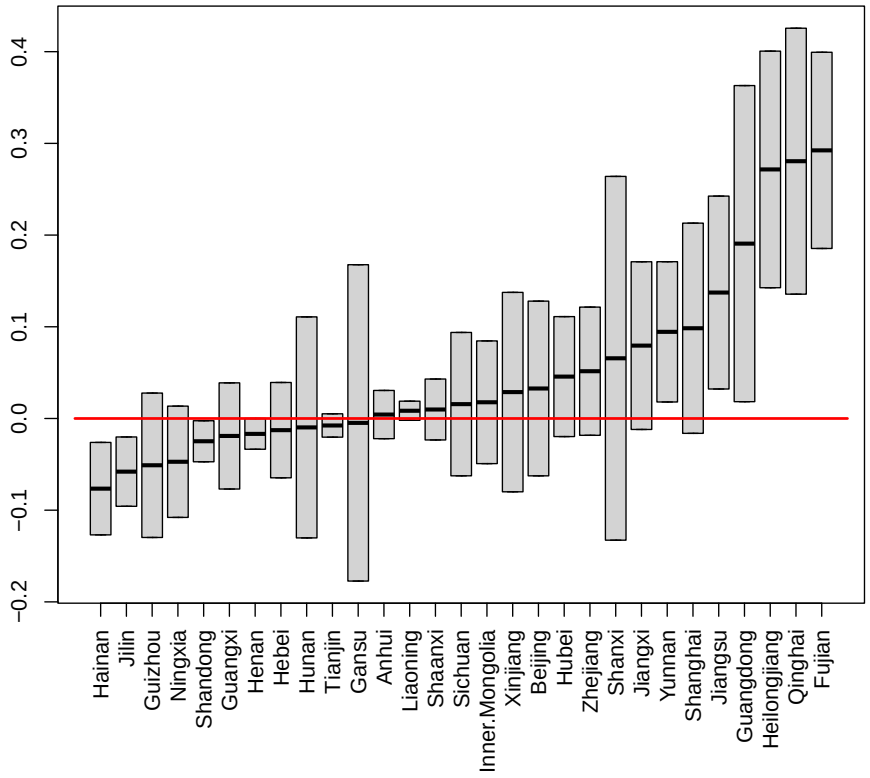
One of the main objectives of our study is to test for regional heterogeneity of the slope of the Phillips curve. For this purpose, we estimate a FE model that generates a single slope estimate for all provinces and a MG model that averages the individually estimated provincial slopes. We determine which of the two models is the preferred option via a Hausman test. The left panel of Table 2 reveals that the Hausman test fails to reject the null hypothesis of regional homogeneity for CPI, RPI, PuPI, and property prices, compelling us to conclude that the FE model is superior to MG for those four price indices. At the same time, two of the four corresponding FE estimates are statistically insignificant (RPI and PuPI), which, as explained above, is expected given the prominent share of tradables. The FE estimates for CPI and property prices are significant but only the latter has the expected positive reaction to output shocks.

With regards to the PPI, the Hausman test rejects the null hypothesis, pointing to MG as the preferred model and suggesting that the slope of the Phillips curve varies across Chinese provinces. The corresponding MG estimate is not only positive and significant but has also the largest magnitude across all price indices. We explore the regional heterogeneity further by plotting the slopes of the Phillips curve for each province in Fig. 1. Around 60% of provinces have a slope that is above zero. This group includes roughly the same share of coastal and interior provinces, while the one with negative slopes consists mostly of provinces from Central and Western China.

To test the robustness of our results, we run the regressions for two reduced samples. The first one excludes the four autonomous regions (Guangxi, Inner Mongolia, Ningxia, and Xinjiang) and three metropolitan areas (Beijing, Shanghai, and Tianjin), while the second involves all 29 provinces but limits the time dimension to the pre-COVID period (2000q1-2019q4). The results are shown in the middle and right panel of Table 2, respectively, and indicate that our results remain broadly robust. The Hausman test identifies the MG model as the preferred option for property prices in the reduced sample of provinces but the estimate is still positive and significant. In the pre-COVID period, the magnitude and significance of all estimates is almost identical.

Lastly, we compare the slope of the regional Phillips curve with the national one for China, which is presented in Table 4. The slope of the national Phillips curve is positive across price indices as expected but attains statistical significance only for PPI and RPI. Moreover, the magnitude of the slopes is considerably larger than is the case for the regional Phillips curve in Table 3. This matches the findings of Hazell et al. (2022) who construct and use regional price indices for non-tradables, arguing that national data are uninformative regarding the true relationship between inflation and the output gap due to

Figure 1: Slope estimates of the regional Phillips curve with one standard error confidence bounds



Note: Reported coefficients are estimates of β from Eq. (1) with one standard error confidence bounds obtained from the mean group (MG) estimator.

Table 3: Phillips curve elasticity estimates for China, 2000q1-2022q4

	CPI	PPI	PuPI	RPI	PP
Constant	0.021***	0.003	0.004	0.003	0.081***
	(0.002)	(0.006)	(0.009)	(0.003)	(0.014)
Output gap	0.139	0.510*	0.654	0.290***	0.186
	(0.096)	(0.304)	(0.430)	(0.128)	(0.678)
N	92	92	92	92	92
R^2	0.023	0.030	0.025	0.054	0.001
$adjR^2$	0.012	0.020	0.014	0.044	-0.010
AIC	-463.14	-251.93	-188.07	-411.36	-104.34

Note: Reported coefficients represent estimates of β from Eq. (1) using quarterly data for China. Standard errors in parentheses. CPI = Consumer Price Index. PPI = Producer Price Index. PuPI = Purchasing Price Index. RPI = Retail Price Index. PP = Property Price.

endogeneity issues. Since we, by contrast, explore broad price indices that include tradables, the revelation of a flatter regional Phillips curve for China is not necessarily exclusively driven by an upward bias in the slope of the national Phillips curve, as speculated by Hazell et al. (2022). Given that China is a common market (even if accounting for a certain degree of fragmentation), prices are expected to respond less to local demand shocks due to interprovincial competition.

4.3 Determinants of regional heterogeneity

The regional heterogeneity detected in the previous section calls for a further investigation of the factors that potentially influence the slope of the Phillips curve. We identify two groups of variables and employ a simple cross-sectional regression to estimate their effect on the slope. Since regional differences were found for the PPI inflation, the first group of variables focuses on the industrial sector across provinces and includes: (1) the share of industry in provincial GDP, (2) the share of state-owned enterprises (SOE) in the industrial sector, and (3) the average profit-to-sales ratio of industrial enterprises, which is a proxy for market power. The relevant statistics for each province were collected from the CEIC database and the annual values were averaged over the period 2000-2020.

The second group of variables explores the broader institutional aspects of provincial economies in China. In particular, we employ the NERI (National Economic Research Institute) Marketization Index, which measures the advancement of the market economy in each province on an annual basis. The data were obtained from the annual NERI reports over the period 2000-2020 Fan and Wang, 2001; Wang et al., 2021. We include the overall marketization index as well as four sub-indices, each ranging from 0 to 10. The sub-indices are averages of relevant variables, while the overall index is the average across all sub-indices.

Table 4: Determinants of the slope of the regional Phillips curve

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Market power	1.121*	1.213**	1.779**	1.512**	1.510**	1.446**	1.542**	1.323***
	(0.592)	(0.575)	(0.664)	(0.610)	(0.626)	(0.588)	(0.649)	(0.635)
Industry share		0.41*						
		(0.241)						
SOE			-0.414*					
			(0.219)					
Marketization				0.020*				
				(0.011)				
Market expansion					0.021			
					(0.013)			
Factor markets						0.016*		
						(0.008)		
Private sector							0.014	
							(0.009)	
Product markets								0.013
								(0.014)
N	29	29	29	29	29	29	29	29
$adjR^2$	0.09	0.15	0.17	0.15	0.13	0.17	0.12	0.08

Note: Standard errors in parentheses. *** $p < .01$; ** $p < .05$; * $p < .10$.

The four sub-indices measure, respectively, (1) the extent of market expansion relative to state intervention, and the development of the (2) private sector, (3) factor markets, and (4) product markets. The market expansion covers aspects related to lowering the tax burden on enterprises, reducing bureaucratic procedures and red tape, and scaling down the government apparatus. The development of the private sector is assessed via the share of privately-owned industrial enterprises, and non-government fixed investment and employment. The advancement of the factor markets looks at the mobility of labor, access to foreign capital, and competitiveness in the banking sector. Lastly, the development of product markets explores the extent to which prices are set by the market and the magnitude of regional trade barriers.

The results of the estimation in Table 4 indicate that market power in the industrial sector has a consistently positive and significant effect on the slope of the PPI Phillips curve. Enterprises with market power are likely to respond to a demand shock by increasing margins, and thereby amplifying the inflationary impact of higher demand (Menezes and Quiggin, 2022). A larger share of industry in the provincial economy also increases the sensitivity of inflation to changes in the output gap, which can be explained by the PPI's focus on manufactured products. SOEs are less likely to react to demand shocks by raising prices, be it because they are less exposed to market forces or because of political concerns about inflationary pressures. It is, therefore, not surprising that

the SOE coefficient is negative and significant.

The overall index of marketization is positively and significantly correlated with the slope of the Phillips curve, suggesting that the more advanced the market economy of a given province, the greater the responsiveness to market signals and the smoother the transmission mechanisms. The coefficients of the four sub-indices also exhibit positive signs but only the advancement of factor markets attains statistical significance. This is important because factor markets are directly related to the PPI as they affect production costs.

5 Conclusion

This paper explores the response of price inflation to the output gap at the regional level in China over the past two decades. In particular, we provide estimates of the slope of the regional Phillips curve across five different price indices and test for regional heterogeneity by comparing a model with fixed effects and a mean group estimator. In contrast to previous studies on China, we employ quarterly data in a panel setting and include time fixed effects in the model, which absorb national effects common to all provinces. Furthermore, we investigate the potential determinants of the variation in the slope of the Phillips curve across provinces.

Our results indicate that the provincial Phillips curve in China has the expected positive and significant slope only for inflation measured using the PPI and property prices, which is explained by the presence of non-tradables in the case of real estate and a focus on goods specific to the given province in the case of producer prices. When using prices for consumer goods, intermediate goods, and the retail sector, we find that the slope is not statistically significant (or has a negative sign in the case of CPI), which is likely caused by the fact that such prices are either determined at the national level or are regulated in some way, weakening their response to province-specific output shocks.

Regional heterogeneity in the slope of the provincial Phillips curve is confirmed only for the PPI and the mean group estimator produces estimates for the 29 provinces in our sample. Around 60% of them exhibit a positive slope, including most coastal provinces. Our findings point to the share of industry and the market power of industrial enterprises as significant contributors to the sensitivity of inflation to provincial demand shocks. Moreover, we show that a stronger market-orientation and a smaller role of the state in a given province are also positively associated with the slope of the Phillips curve.

From a policy perspective, our analysis suggests that the choice of price index for inflation targeting purposes matters for the effectiveness of monetary policy in a monetary union with heterogeneous regions like China. The higher sensitivity of regional PPI inflation and property prices to changes in the local output gap is likely to make it more difficult for monetary authorities that focus on CPI to achieve macroeconomic stability across provinces in the country. Accordingly, the regional heterogeneity in the inflationary response, driven by differences in industrial structure, market conditions, and institutional ar-

rangements, will continue to present a challenge to policymakers at the national level.

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