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The Global Slack Hypothesis: New Evidence from China*

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ABSTRACT

This paper evaluates the global slack hypothesis that economic globalization has increased the role of global factors in the inflation process in China. Towards that end, we augment and estimate conventional Phillips curve inflation equations by incorporating global economic slack that is obtained through China's eighteen major trading partners in the world. Empirical results with quarterly data spanning from 1995 to 2012 provide evidence in favor of altering the domestic Phillips curve to include global slack as an additional driving variable for inflation. The findings indicate that the Chinese central bank needs to react to developments in global economic slack.

1. Introduction

In recent years, a number of studies have addressed the question of whether greater global economic integration, or economic globalization, has had a significant impact on inflation. While there appears to be broad agreement on the importance of globalization as a real phenomenon, there is less agreement on whether global economic slack significantly drives inflation (i.e. the global slack hypothesis).[1] Borio and Filardo (2007) and Ihrig, Kamin, Lindner, and Marquez (2010) figure prominently among the most-often cited papers in the literature. These papers set the tone for the research agenda that followed, and articulated the empirical puzzle that surrounds the empirical testing of the global slack hypothesis. In short, the findings of Borio and Filardo (2007) and Ihrig et al. (2010) are somewhat surprising because they suggest that while by most standards the world has become more integrated over the past 2 to 3 decades—through trade and finance, via information and migration flows, etc.—there is little empirical evidence to conclusively validate the global slack hypothesis. Subsequent studies have reinforced this view presenting mixed results. This appears to be due in part to the relative recentness, in some sense, of globalization, and in part to serious data limitations (Martinez-Garcia & Wynne, 2010). However, a more important factor keeping the debate over the global slack hypothesis alive is the absence of a wide range of compelling and consistent empirical evidence (Ihrig et al., 2010).

To date, most of the existing studies have focused on industrial economies. The main motivation for concentrating on industrial economies, as explained in the literature, is that the increasing integration of China and other lower-cost producers into

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[1] Helbling, Jaumotte, and Sommer (2006); Pain, Koske, and Sollie (2006); Borio and Filardo (2007); Marzinotto (2009), Auer et al. (2010), Milani (2010), Pehnelt (2010), and Inerney (2013) appear to support the global slack hypothesis, while Ball (2006); Badinger (2009); Calza (2009); Mishkin (2009), and Ihrig et al. (2010) provide contrasting evidence showing that globalization has little impact on inflation process in industrial countries.

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world production networks may have induced downward pressure on wages and import prices in industrial countries. However, the existing different findings for the industrial economies indicate that the integration of emerging countries into the global economy can bring interconnecting and two-way impacts on the inflation process of advanced economies. On the one hand, higher demand may drive up prices for energy, raw materials, and general commodities, which eventually reflects in overall price inflation. On the other hand, an influx of lower cost labor, products and services into the world market can drive prices downward. This two-way impact may also explain, to some extent, why the global slack hypothesis remains a controversy when data for industrial countries are considered.

Unlike the industrial economies, China is less likely to experience the two-direction effects of globalization on its inflation process, being that it is the world's largest developing and emerging economy. For instance, economic globalization and the associated rise in trade integration have bolstered the dependence of Chinese economy on global demand and supply via the international goods market. When the prices of the global goods market increase, for example, China's domestic prices also tend to rise. In the meantime, there is no influx of lower cost labor, products, and services from industrial economies into China's market, so that there is no counter-effect to rising prices in China. From this aspect, the impact of globalization on inflation in China would be less ambiguous than industrial countries.

Indeed, China has now opened its economy markedly and improved their connectedness to world trade networks more than that in the industrial countries. In conjunction with rising globalization, China has also witnessed a marked change in the nature of the inflation process. For example, both the level of inflation and inflation persistence are found to be significantly lower in the recent ten years than before (Zhang & Clovis, 2010).

Therefore, this paper evaluates the global slack hypothesis for China. We attempt to examine the impact of global economic slack on inflation in China and link the results to broader debates in the academic literature as well as policy implications. To this end, we specify a dynamic model within a conventional backward-looking Phillips curve model, but modify the standard assumption of an elasticity of domestic demand via the inclusion of global economic slack, to provide a channel through which globalization may alter the dynamic response of inflation to domestic demand. To preview our results, we find that global economic slack exerts significant impact on China's inflation, but domestic output gap appears to be insignificant.

Our finding is in a broad consensus with existing studies of Phillips curve models using Chinese data. For example, Gerlach and Peng (2006) find that the standard Phillips curve model with domestic output gap does not fit the Chinese data well. They modify the Phillips curve model by including an unobserved variable that obeys a second-order autoregressive process to control for the omission of potentially important variables and obtain a better fit. In addition, Scheibe and Vines (2005); Funke (2006), and Zhang (2013) all find that the statistical significance of the output gap in the traditional Phillips curve models for China is fragile. In sum, while existing studies have examined various specifications for inflation dynamics in China, little evidence exists regarding their relevance for global economic slack in affecting Chinese inflation dynamics.

The rest of the paper is organized as follows: Section 2 describes the data used in the empirical analysis and stylized facts of inflation and globalization in China; Section 3 presents the baseline model and estimation results for inflation dynamics with globalization; Section 4 is a robustness analysis, followed by explorations of relevant implications in Section 5; Section 6 concludes the paper.

2. The data and stylized facts

The data series considered in this paper were chosen to provide relations that are of most interest for policy analysis and to facilitate comparisons with the relevant literature. In all, our empirical analysis involves series for overall inflation, a measure of the domestic real output gap, and a measure of the foreign real output gap. Most of the data series were obtained from the China Economic Information Center (CEIC) database, except for China's nominal and real gross domestic product (GDP) series, which were obtained from Datastream. The raw level data for all quarterly series were seasonally adjusted prior to any further application. The final series used in empirical estimations are stationary (confirmed by conventional unit root tests). The sample size in our empirical estimations spans the first quarter of 1995 to the last quarter of 2012 (i.e. 1995Q1–2012Q4).

China's overall inflation is measured by quarterly year-on-year growth rate of GDP deflator. The raw data for GDP deflator is derived by dividing real GDP by nominal GDP. The real domestic output gap was obtained from Hodrick–Prescott (HP) filter on the corresponding real GDP series (with the smoothing parameter 1600 for quarterly data). In robustness assessments, we also use growth rate of real GDP and quadratically detrended log real GDP to approximate the real output gap in the model. In addition, there are several approaches available for calculating the foreign output gap, namely, trade-weighted, exchange rate–weighted, and GDP-weighted foreign output gaps. As explained in Borio and Filardo (2007), the trade weights emphasize the role of trade competition, the exchange rate–weighted weights emphasize the role of the exchange rate regime in “exporting” inflation from one country to another, and the GDP weights reflect global slack conditions.

Since the exchange rates between Chinese yuan and foreign currencies generally remain fairly steady, exchange rate–weighted foreign output gap cannot really differentiate exchange rate regimes in the construction of foreign output gap. Therefore, in this article, we employ trade-weighted and GDP-weighted methods to construct foreign output gap.

In terms of constructing the trade-weighted foreign output gap, we calculate a weighted sum of the real GDP gap measure of China's top 18 major trading partners based on their trading weights with China.[2] Specifically, the weight for each trade partner in

[2] China's top 18 major trading partners include Australia, Canada, France, Germany, Hong Kong, Indonesia, Italy, Japan, Korea, Malaysia, Netherlands, Russia, Singapore, Thailand, Taiwan, The United Kingdom, The United States, and Latin America. Note that the trade data for Latin America aggregates the corresponding data of Argentina, Brazil, and Chile. The trade data and real GDP series for the 18 countries/regions were obtained from CEIC database.

each year is determined by the percentage of the partner's trade (both exports and imports) to China over the total trade between China and the 18 partners for that year. As the ranking of trading partners changes over time, the trade weights are updated annually. That is, the variations of the trade percentage are accommodated in the calculation of the foreign real GDP gap, i.e. $y_t^f = \sum_{j=1}^{18} w_{j,t} y_{j,t}$, where $w_{j,t}$ denotes the defined weight (i.e. trade percentage) for country/region j at time t (quarterly observations within one year use the same weight of the year) and $y_{j,t}$ is the real output gap measure for country/region j. More specifically, the trading weight for country/region j is defined as$w_{j,t} = (\text{import}_{j,t} + \text{export}_{j,t})/$(total imports and exports of China with its trading partners).where $\text{import}_{j,t}$ refers to imports of country/region j from China at time t and $\text{export}_{j,t}$ is defined analogously. The trade weights emphasize the role of trading relationship between China and its trading partners. This measure assigns a larger weight to those countries with which China has a closer trading relationship. To some extent, this measure captures how tied those economies are with the economy of China.

Table 1 presents the corresponding statistics for the trade weights of each country/region to China over 1995–2012. It shows that the trade weights of different countries/regions to China change over time. For example, the trade percentage of the U.S. to China witnessed a steady increase in the 1990s, rising from 16.5% in 1995 to virtually 20% in 1999. Interestingly, however, the trade percentage of Hong Kong to Mainland China has experienced a steady decline from the 1990s to the 2000s. A similar pattern of decline in trade percentage with China can also be observed for Japan, which was China's largest trading partner during the 1990s. The U.S. took over Japan as China's largest trading partner after 2004.

In addition to the trade weights, we also construct foreign output gap using the GDP weights. The GDP weight for country/region j is defined as

$$w^{GDP}{}_{j,t} = \text{GDP}_{j,t}/\text{World GDP}_t.$$

where $\text{GDP}_{j,t}$ refers to real GDP for country/region j at time t. The GDP-weighted output gap has the merit of not relying heavily on bilateral trade but has the limitation of not making adjustments for country-specific characteristics (Borio & Filardo, 2007). The GDP weights for the underlying regions are summarized in Table 2, which shows how the GDP weights compare with the trade weights shown in Table 1.

The resulting foreign output gap measures with the two different weighting methods and China's domestic output gap are illustrated in Fig. 1. It shows that the two foreign output gap measures are highly correlated and they nearly overlap with each other in most of the time during the sample period, implying that the different weighting methods do not make material differences in constructing foreign output gap. Fig. 1 also shows that the time series variable for domestic output gap does not overlap with the foreign output gap, although the general pattern of time series movement between them is similar.

To illustrate inflation developments and the evolution of the domestic and foreign output gap measures, Fig. 2 plots the time series of quarterly data for inflation in conjunction with the output gap measures. It shows that Chinese inflation witnessed the most striking peak in 1995 and has been generally low and stable since 1997, reflecting success in stabilizing inflation after the late 1990s.

The figure also shows that the cyclical movements of inflation in China seem to be more synchronized with those of the foreign output gap than the domestic output gap. This observation may reflect the fact that with the rising globalization over the recent decade, China's domestic markets are increasingly integrated with the global markets and domestic prices (and in turn inflation) may be increasingly influenced by supply-and-demand conditions in global markets rather than being set independently by domestic supply-and-demand conditions within the country. The following sections embark on empirical analyses of the impact of globalization on inflation in China.

3. Empirical analysis

3.1. Baseline results

There are several ways of thinking about the effect of globalization on domestic inflation. First, globalization may make domestic inflation less responsive to rising domestic resource utilization because households and businesses can go outside the country to buy goods and services, so there will be less pressure for domestic prices to change. Another way of thinking about this point is to recognize that globalization may reduce the likelihood of having supply bottlenecks as domestic resource utilization rises (Mishkin, 2009). Either way, the foreign economic slack exerts influences on domestic inflation. Second, in a globalized world, firms can sell their products both in the domestic and foreign markets, and the prices they charge in domestic markets are likely to be influenced by the foreign demand for their products. Third, the effect of globalization on inflation can operate through the impact of foreign economic performance on domestic inflation expectations, which eventually affect actual inflation.[3]

The essence of these alternative arguments, among other things, is that domestic inflation is increasingly influenced by global economic slack rather than being affected exclusively by domestic economic slack within a given country. We examine this issue for China by augmenting the conventional Phillips curve model. To facilitate notations, we will use variables with superscripts d

[3] There are several additional arguments for globalization and inflation nexus highlighting alternative channels through which globalization affects inflation, including global factor and product markets (Ihrig et al., 2010), global competition (Chen, Imbs, & Scott, 2004; Sbordone, 2009), and the terms of trade (Rogoff, 2006).

Table 1
Trade percentage of China's major trading partners (%)

Year	AUS	CAN	FRA	GEM	HK	IDO	ITA	JAP	KOR	MAL	NETH	RUS	SIN	THA	TW	UK	US	LAT
1995	1.7	1.7	1.8	5.5	18.0	1.4	2.1	23.3	6.9	1.4	1.6	2.2	2.8	1.4	7.2	1.9	16.5	2.5
1996	2.0	1.6	1.6	5.2	16.0	1.5	2.0	23.5	7.8	1.4	1.7	2.7	2.9	1.2	7.4	2.0	16.8	2.6
1997	1.9	1.4	2.0	4.5	17.9	1.6	1.7	21.4	8.5	1.6	1.9	2.2	3.1	1.2	7.0	2.0	17.3	3.0
1998	1.8	1.6	2.1	5.1	16.2	1.3	1.7	20.6	7.6	1.5	2.1	2.0	2.9	1.3	7.3	2.3	19.5	3.0
1999	2.0	1.5	2.2	5.2	14.1	1.6	1.8	21.3	8.1	1.7	2.1	1.8	2.8	1.4	7.6	2.5	19.8	2.7
2000	2.1	1.7	1.9	5.0	13.6	1.9	1.7	20.9	8.7	2.0	2.0	2.0	2.7	1.7	7.7	2.5	18.7	3.2
2001	2.1	1.7	1.8	5.5	13.1	1.6	1.8	20.6	8.4	2.2	2.0	2.5	2.6	1.7	7.6	2.4	18.9	3.5
2002	2.0	1.5	1.6	5.4	13.4	1.5	1.8	19.7	8.5	2.8	2.1	2.3	2.7	1.7	8.6	2.2	18.8	3.4
2003	2.0	1.4	1.9	6.0	12.6	1.5	1.7	19.2	9.1	2.9	2.2	2.3	2.8	1.8	8.4	2.1	18.2	3.9
2004	2.2	1.7	1.9	5.8	12.1	1.5	1.7	18.1	9.7	2.8	2.3	2.3	2.9	1.9	8.4	2.1	18.3	4.3
2005	2.4	1.7	1.8	5.6	12.2	1.5	1.7	16.5	10.0	2.7	2.6	2.6	3.0	1.9	8.1	2.2	18.9	4.5
2006	2.4	1.7	1.9	5.8	12.3	1.4	1.8	15.3	9.9	2.7	2.5	2.5	3.0	2.0	8.0	2.3	19.4	5.2
2007	2.7	1.8	2.0	5.7	12.0	1.5	1.9	14.4	9.7	2.8	2.8	2.9	2.9	2.1	7.6	2.4	18.4	6.2
2008	3.2	1.8	2.1	6.1	10.8	1.7	2.0	14.2	9.9	2.8	2.7	3.0	2.8	2.2	6.9	2.4	17.7	7.6
2009	3.7	1.8	2.1	6.5	10.7	1.7	1.9	14.0	9.6	3.2	2.6	2.4	2.9	2.3	6.5	2.4	18.3	7.5
2010	4.0	1.7	2.0	6.5	10.5	1.9	2.1	13.6	9.4	3.4	2.6	2.5	2.6	2.4	6.6	2.3	17.5	8.4
2011	4.4	1.8	2.0	6.4	10.7	2.3	1.9	13.0	9.3	3.4	2.6	3.0	2.4	2.5	6.1	2.2	16.9	9.1
2012	4.4	1.8	1.8	5.8	12.2	2.4	1.5	11.8	9.2	3.4	2.4	3.2	2.5	2.5	6.1	2.3	17.4	9.4

Notes: The statistic is calculated as the ratio of China's trade to each country (or region) as a percentage of total trade of China to all countries (regions) listed in the table; initial letters of each country/region's name are used as an acronym to represent the country/region.

and f refer to domestic and foreign variables, respectively. As such, the baseline inflation dynamic model can be written as an augmented form of the conventional Phillips curve, viz.

$$\pi_t = c + \beta\pi_{t-1} + \sum_{i=1}^{n-1} \alpha_i \Delta\pi_{t-i} + \delta_d y_t^d + \delta_f y_t^f + u_t \tag{1}$$

where π_t denotes domestic inflation for China; y^d and y^f refer to domestic and foreign output gaps; c denotes a constant term; n denotes the optimal lag order; and u_t is the model specification error term. By construction, β measures the degree of inflation persistence.

Note that the specification of Model (1) differs from the specifications in Borio and Filardo (2007) in a small but presumably important way. Specifically, we use contemporaneous output gap variables in Model (1), but Borio and Filardo (2007) use lagged output gaps in their models, viz.

$$\pi_t = c + \alpha(L)\pi_{t-1} + \delta_d y_{t-1}^d + \delta_f y_{t-1}^f + u_t \tag{2}$$

For models with quarterly data, it is highly plausible to observe the contemporaneous effect of real variables of inflation. Therefore, the use of lagged real variables may omit such contemporaneous effects. More importantly, recent developments in

Table 2
GDP weights for China's major trading partners (%)

Year	AUS	CAN	FRA	GEM	HK	IDO	ITA	JAP	KOR	MAL	NETH	RUS	SIN	THA	TW	UK	US	LAT
1995	1.6	2.6	6.9	11.1	0.6	1.1	5.0	22.9	2.4	0.4	1.9	1.3	0.4	1.2	0.7	5.3	32.9	1.7
1996	1.8	2.7	6.9	10.6	0.7	1.2	5.6	20.0	2.5	0.4	1.9	1.7	0.4	1.2	0.8	5.6	34.4	1.8
1997	1.8	2.8	6.3	9.5	0.8	1.1	5.3	18.6	2.4	0.4	1.8	1.7	0.4	1.3	0.7	6.2	37.0	1.9
1998	1.7	2.8	6.6	9.8	0.7	0.5	5.5	17.1	1.6	0.3	1.9	1.2	0.4	1.2	0.5	6.7	39.7	1.9
1999	1.7	2.8	6.2	9.1	0.7	0.7	5.2	18.4	2.0	0.3	1.8	0.8	0.4	1.3	0.5	6.5	40.1	1.4
2000	1.6	3.0	5.5	7.9	0.7	0.7	4.6	19.1	2.3	0.4	1.7	1.1	0.4	1.3	0.5	6.3	41.5	1.5
2001	1.5	3.0	5.7	8.0	0.7	0.7	4.8	17.0	2.2	0.4	1.7	1.3	0.4	1.2	0.5	6.3	43.5	1.3
2002	1.7	3.0	5.9	8.2	0.7	0.8	5.0	15.7	2.4	0.4	1.8	1.4	0.4	1.2	0.5	6.6	43.3	0.9
2003	1.9	3.2	6.6	8.9	0.6	0.9	5.6	15.3	2.4	0.4	2.0	1.5	0.3	1.1	0.5	6.9	40.9	0.9
2004	2.1	3.3	6.8	9.0	0.5	0.9	5.8	14.9	2.5	0.4	2.1	1.9	0.4	1.1	0.5	7.4	39.4	1.0
2005	2.2	3.5	6.7	8.7	0.6	0.9	5.6	13.9	2.7	0.4	2.0	2.3	0.4	1.1	0.5	7.3	39.7	1.3
2006	2.2	3.8	6.7	8.6	0.6	1.1	5.6	12.5	2.9	0.5	2.1	2.8	0.4	1.1	0.6	7.4	39.7	1.5
2007	2.5	3.8	7.0	9.0	0.6	1.2	5.8	11.4	3.0	0.5	2.2	3.4	0.5	1.1	0.7	7.8	38.0	1.7
2008	2.6	3.8	7.3	9.3	0.5	1.4	6.0	12.0	2.5	0.6	2.3	4.1	0.5	1.0	0.7	7.0	36.5	1.9
2009	2.6	3.6	7.1	9.0	0.6	1.5	5.8	13.2	2.4	0.5	2.3	3.2	0.5	1.0	0.7	6.1	37.9	1.9
2010	3.1	4.0	6.5	8.4	0.6	1.9	5.3	13.5	2.7	0.6	2.1	3.8	0.6	1.1	0.8	5.9	36.9	2.4
2011	3.4	4.1	6.5	8.6	0.6	2.0	5.2	13.5	2.7	0.7	2.0	4.3	0.6	1.1	0.8	5.9	35.4	2.6
2012	3.5	4.1	6.1	8.0	0.6	2.1	4.7	13.5	2.8	0.7	1.9	4.6	0.7	1.1	0.8	5.9	36.6	2.5

Notes: The table reports the GDP weights for China's major trading partners in constructing China's foreign output gap.

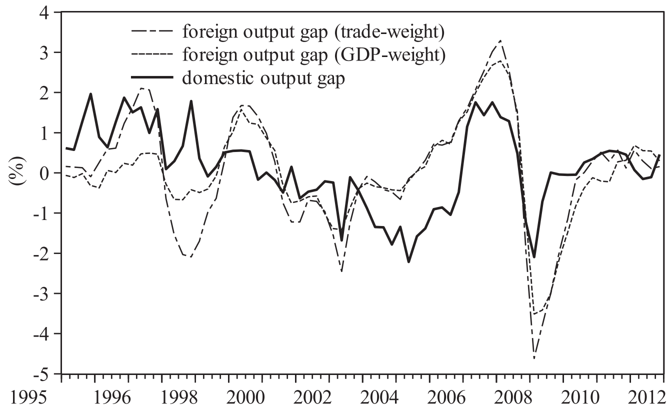


Fig. 1. China's domestic and foreign output gap measures: 1995Q1–2012Q4.

structural inflation dynamics with microfoundations highlight the use of contemporaneous real variables; see the seminal work of Gali and Gertler (1999).

In addition, the inclusion of lags of the dependent variable in Model (1) provides characterization of the inflation dynamic adjustment process. However, the specification of lag order for lags of inflation in the equations in most existing studies is ad hoc, in nature. An inappropriate lag order specification, however, may invalidate estimation results because insufficient lag order in the Phillips curve models is likely to lead to autocorrelation of the residuals. This autocorrelation not only distorts standard error estimates, as correctly pointed out by Ihrig et al. (2010), but also invalidates coefficient estimates permanently, no matter which estimation methods are used, given that the model is specified with lagged dependent variables on the right side of the equations. In our specification, therefore, the optimal lag order n is specified by Akaike Information Criteria (AIC) and diagnosed by autocorrelation test, from general-to-specific, with a maximum 8 lags to allow the dynamics to take effect within two years' time.

Several econometric issues deserve discussion prior to empirical estimations. First, the right-hand side of Model (1) contains lagged dependent variables which are uncorrelated with contemporaneous residuals. Hence, ordinary least squares (OLS) estimates are consistent. Second, the baseline estimations are verified through Breuch–Godfrey LM serial correlation test.

Based on the preceding discussion, Table 3 reports OLS estimation results of Model (1) for coefficients on inflation inertia, the domestic and foreign output gap measures, in conjunction with the diagnostic statistics. The diagnostic test statistics in Table 3 indicate that the specification of Model (1) is free from significant serial correlation and has a fair level of goodness of fit.

The results in Table 3 show that the foreign output gap drives domestic inflation significantly with the coefficient estimate of 0.351 for the trade-weighted measure and 0.362 for the GDP-weighted measure, while the coefficient estimate on the domestic output gap is comparatively small (0.146 for the trade-weighted measure and 0.150 for the GDP-weighted measure) and insignificant. The comparison between the coefficient estimates on the domestic and foreign output gaps clearly shows that the foreign output gap has played a more prominent role than its domestic counterpart has in the domestic inflation process of China over the underlying period.

Note that the insignificance of the coefficient of domestic output gap suggests that the Phillips curve for China is close to being flat with only foreign output gap driving it. This finding is consistent with Gerlach and Peng (2006), who estimate traditional

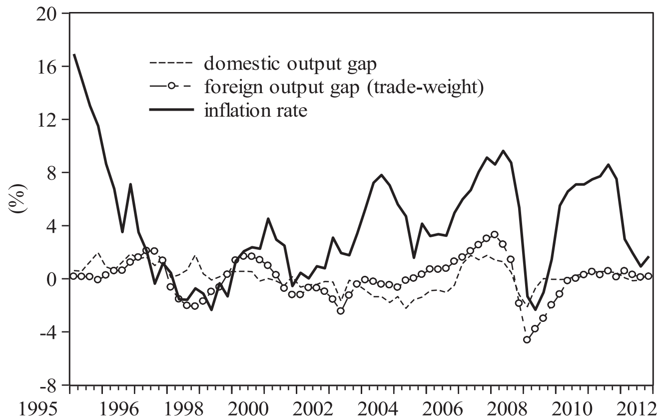


Fig. 2. Domestic and foreign output gap and China's inflation: 1995Q1–2012Q4. Data sources: CEIC, Datastream, and the author's calculations.

Table 3
OLS estimation results for Model (1)

	β	δ_d	δ_f	p-auto	adj R^2	lag
Trade-weighted gap	0.711*** (0.064)	0.146 (0.203)	0.351** (0.140)	0.137	0.77	3
GDP-weighted gap	0.728*** (0.060)	0.150 (0.250)	0.362* (0.201)	0.180	0.75	4

Note: Sample spans 1995Q1–2012Q4 prior to lag adjustment. The Bartlett kernel with Newey–West (fixed bandwidth) HAC-robust standard errors are reported in parentheses (lag specification with AIC). p-auto refers to p-value of Breusch–Godfrey serial correlation LM test (up to two lags) and *lag* refers to optimal lag order specified by autocorrelation test and AIC. ***, **, and * denote statistical significance at 1%, 5%, and 10% levels, respectively..

Phillips curve models for China over the period of 1982–2003 (annual data) and find that the coefficient estimate of China's domestic output gap is 0.177 and statistically insignificant. Gerlach and Peng (2006) attribute their finding to omitted variable problem and try to solve the problem by introducing an unobserved component to the traditional Phillips curve. To some extent, our results complement the existing study by augmenting the traditional Phillips curve with a specific variable (i.e. foreign output gap) rather than arbitrarily assuming an unobserved component model to fit Chinese data.

3.2. Further evaluation: a competition (nonnested) test

Because the domestic and foreign output gaps are correlated to some extent, the results that the foreign output gap is significant and the domestic output gap is not might be caused by the collinearity between the two variables. One way to check this possibility is to compare the relevant estimates for a Phillips curve model with domestic output gap without foreign output gap and vice versa. The results of such exercises, however, may not be interpreted straightforwardly due to possible impact of collinearity between the domestic and foreign output gaps. In fact, there is a possibility that the drastic fall of the coefficient estimate of the domestic slack when we include foreign slack may reflect that the domestic and foreign slacks in the sample period are highly correlated as we can imagine from the global credit cycle upturn and subsequent economic stagnation.

To overcome possible impact of collinearity on the empirical results, we conduct a nonnested hypothesis testing over the two competing models which contain the domestic output gap without the foreign output gap and contain the foreign output gap without the domestic output gap, respectively. Specifically, we utilize Davidson and MacKinnon's (1993) *J*-test of nonnested models. The test was developed within the framework of Gauss–Newton regression, but it is straightforward to extend the test to the present setting of our model.

Suppose the two different implementations of what is basically the same theoretical model, both of which purport to explain the same dependent variable, yield the two regression models:

$$H_1 : y = x(\eta) + u_1 \tag{3}$$

and

$$H_2 : y = z(\gamma) + u_2 \tag{4}$$

where η and γ denote parameter vectors of lengths k_1 and k_2, respectively. These models are nonnested if it is in general impossible to find restrictions on η such that, for arbitrary γ, $x(\eta)$ equals $z(\gamma)$, and impossible to find restrictions on γ such that, for arbitrary η, $z(\gamma)$ equals $x(\eta)$. In the case of linear regression models like ours, what is required is that each of the two regression functions contains at least one regressor that is not in the other.

This setting is very much relevant to the exercise of regressions that we are trying to conduct. The two regression models we are comparing are

$$\pi_t = c + \beta\pi_{t-1} + \sum_{i=1}^{n-1} \alpha_i \Delta\pi_{t-i} + \delta_d y_t^d + u_{1t} \tag{5}$$

and

$$\pi_t = c' + \beta'\pi_{t-1} + \sum_{i=1}^{n-1} \alpha_i' \Delta\pi_{t-i} + \delta_f' y_t^f + u_{2t}. \tag{6}$$

Davidson and MacKinnon (1993) propose that the easiest nonnested tests to perform are those based on artificial nesting. The basic idea is to embed both of the two competing regression functions in a more general one and then to test one or both of the original models against it. However, the artificial model will not be estimable unless all parameters are separately identifiable.

One solution to the problem is to construct a regression model in which the unknown parameters of the model that are not being tested are replaced by estimates of those parameters what would be consistent if the data-generating process actually belonged to the model for which they are defined. There are many ways to do so, but the simplest and asymptotically attractive

Table 4
The results of the Davidson–MacKinnon *J*-test (*p* values)

	δ_{zd}	δ_{zf}
Trade-weighted gap	0.238	0.015
GDP-weighted gap	0.191	0.021

Note: The table reports *p*-values of Davidson–MacKinnon *J*-tests for Models (7) and (8).

solution is to replace η by the estimate of η, and replace γ by the estimate of γ in the regression Models (3) and (4). In turn, the nonnested hypothesis testing can be implemented in compound regressions with fitted values of (3) and (4), respectively.

Following this vein, the Davidson–MacKinnon's *J*-test in the case of our models can be implemented by running the following two regressions, viz.

$$\pi_t = c' + \beta'\pi_{t-1} + \sum_{i=1}^{n-1} \alpha'_i \Delta\pi_{t-i} + \delta'_f y_t^f + \delta_{zd} Z_t^d + v_{2t} \tag{7}$$

and

$$\pi_t = c + \beta\pi_{t-1} + \sum_{i=1}^{n-1} \alpha_i \Delta\pi_{t-i} + \delta_d y_{t-1}^d + \delta_{zf} Z_t^f + v_{1,t} \tag{8}$$

where Z^d and Z^f refer to the fitted values of π_t pertaining to the regression Models (5) and (6), respectively. To conduct the *J*-test is then to evaluate statistical significance of the tests for $\delta_{zd} = 0$ in (7) and $\delta_{zf} = 0$ in (8), respectively. By construction, if the null hypothesis $\delta_{zd} = 0$ is rejected and the null $\delta_{zf} = 0$ is not, then it is reasonable to pick (8) as the preferred model. Alternatively, if the null hypothesis $\delta_{zf} = 0$ is rejected and the null $\delta_{zd} = 0$ is not, then it is reasonable to pick (7) as the preferred model. Of course, the *J*-test may generate another two possible outcomes (both models, or neither model may be rejected), since each pair of the null hypothesis may or may not be rejected. We will have to evaluate the specific estimation results then.

The results of the *J*-tests pertaining to (7) and (8) are summarized in Table 4, which show that the null hypothesis $\delta_{zd} = 0$ cannot be rejected whereas the null $\delta_{zf} = 0$ is rejected at 5% significance level. These results suggest that from model competition perspective, the regression with the foreign output gap is the preferred model. Therefore, the results of the Davidson and MacKinnon *J*-test reinforce the baseline finding that the foreign output gap plays a predominant role in driving domestic inflation in the sample period.

4. Robustness

To assess the robustness of the baseline finding that the global slack hypothesis holds true for China, we carry out three sets of sensitivity exercises. Since the foreign output gap measures with different weighting methods produce very similar results, in what follows, we only report results pertaining to trade-weighted output gap measure. First, we investigate whether the finding is robust to alternative output gap measures. That is, we estimate Model (1) by using the growth rate of real GDP and quadratically detrended log real GDP to approximate real output gap.

Second, we augment the baseline Model (1) by taking into account the possible impact of exchange rate on inflation, viz.

$$\pi_t = c + \beta\pi_{t-1} + \sum_{i=1}^{n-1} \alpha_i \Delta\pi_{t-i} + \delta_d y_t^d + \delta_f y_t^f + \delta_s \Delta \mathrm{eer}_t + \eta_t \tag{9}$$

where Δeer denotes growth rate of effective exchange rate and all other notations follow those in (1). By construction, Model (9) considers explicitly possible pass-through of exchange rate on inflation. It may mitigate a concern that the pass-through effect might be squeezed into the foreign output gap when exchange rate variable is omitted. There is also a theoretical reason to consider this specification. For instance, Martinez-Garcia and Wynne (2010) shows that the open-economy Phillips curve can be expressed in terms of a domestic gap and a gap on terms of trade (or the real exchange rate).

Third, we examine recursive estimates of the coefficients on the domestic and foreign output gaps to assess whether changes occurred over time in the relation between Chinese inflation and the foreign output gap in order to draw a conclusion on the importance of a growing globalization. Specifically, we estimate both Model (1) and Model (9) with recursive samples to obtain the corresponding recursive coefficient estimates of δ_d and δ_f.[4]

Table 5 summarizes the results for the first and second exercises. The corresponding results show that the baseline finding generally has no substantial change when alternative real variables are used. In addition, the estimation results pertaining to the augmented Model (9) (the lower two panels in Table 5), with both real and nominal effective exchange rates, provide a

[4] Real effective exchange rate is used in the recursive estimations of Model (9).

Table 5
Robust estimation results of the inflation dynamics model for China

	β	δ_d	δ_f	δ_s	p-auto	adj R^2	lag
(1) $y = qdgap$	0.645***	−0.032	0.423***		0.496	0.78	3
	(0.085)	(0.092)	(0.118)				
(2) $y = gdpgr$	0.702***	0.376***	0.264***		0.799	0.82	3
	(0.048)	(0.129)	(0.052)				
(3) add *reergr*	0.820***	0.274	0.405***	−0.135**	0.668	0.80	3
	(0.049)	(0.205)	(0.133)	(0.042)			
(4) add *neergr*	0.756***	0.218	0.399***	−0.163***	0.978	0.83	3
	(0.049)	(0.157)	(0.120)	(0.028)			

Notes: OLS estimates are reported with sample spanning 1995Q1 to 2012Q4 prior to lag adjustment; *qdgap* denote quadratically detrended real GDP gap, while *gdpgr*, *reergr*, and *neergr* denote growth rates of real GDP, real and nominal effective exchange rates, respectively. Other notations follow Table 3.

similar conclusion. In most regressions of the robustness analysis (except for the case of real GDP growth rate was used as a real economic slack), the coefficient estimates on the foreign real economic activity outweigh the domestic counterparts, with the coefficient estimates on the foreign output variables ranging from 0.264 to 0.423 vs. −0.032 to 0.376 relevant to the domestic output variables. Another interesting finding is that the pass-through effect of exchange rate on inflation is statistically significant. These results reinforce the conclusion that the foreign economic activity plays a quantitatively important and statistically significant role in affecting China's inflation over the period from 1995 to 2012.

The design of the third exercise provides a useful evaluation on the robustness of the baseline finding over recursive samples. Since globalization has an important time dimension to be considered, it is crucial to assess whether changes occurred over time in the relation between inflation and the foreign output gap. The identification of time variations, or the lack of any change, would be a valuable contribution per se (see, for instance, Bianchi & Civelli, 2013). By construction, the recursive estimations produce coefficient estimates on the domestic and foreign output gaps over the recursive samples starting from 1995 onwards with the end period fixed.[5]

Fig. 3 plots the results of the recursive estimations of Model (1) and Model (9), respectively. The first and obvious conclusion from the recursive estimates is that the coefficient estimates on the foreign output gap (i.e. delta_f in the graphs) are stable over the forward recursive samples, with the magnitude ranging around 0.4 to 0.6. The coefficients on the domestic output gap (i.e. delta_d in the graphs); however, witness notable variations when the sample changes recursively.

Second, as Fig. 3 strikingly illustrates, in most periods of the recursive samples, the coefficients on the foreign output gap are larger than the coefficients on the domestic output gap. These results are consistent with our finding of the important role of the foreign economic slack in affecting the domestic inflation. Although the recursive estimates might not be very accurate by nature, the results corroborate the finding of a great deal of the baseline empirical work.[6]

5. Policy implications

The finding for the important and significant role of global slack in affecting China's domestic inflation dynamics suggests that the high-growth and low-inflation Eden in China since the late 1990s is likely to be attributed to favorable global economic environment rather than to the sound policies of the central bank. Although the finding is not necessarily to imply that Chinese monetary policy is (in)effective, this raises a realistic concern that the problems facing the Chinese central bank are likely to be complicated by the rising economic globalization of Chinese economy, which will make the central bank's job of controlling inflation more difficult than before.

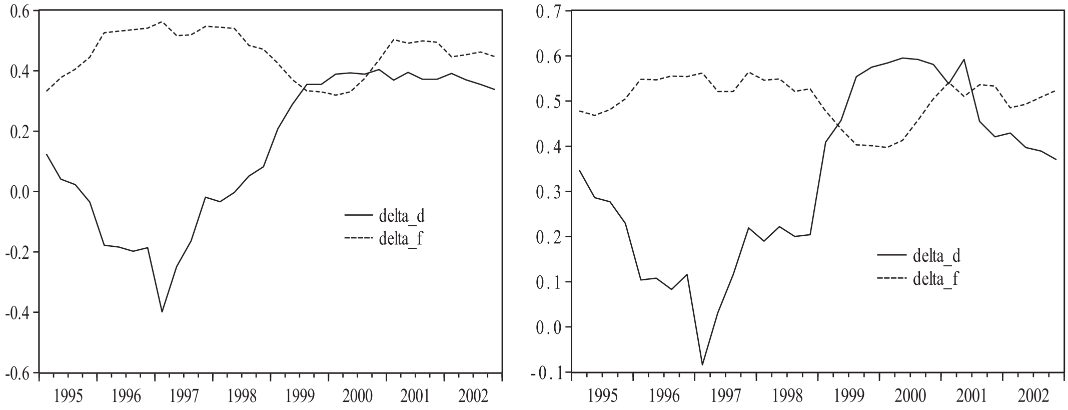
Since the Phillips curve is an indispensible component in monetary policy analysis framework, it is natural that the impact of globalization factor on inflation can also transmit to other macroeconomic variables in policy analysis frameworks. Suppose we analyze the issue in a standard, three-equation model with an investment-and-saving (IS) curve, a Phillips curve, and a policy reaction function. The impact of globalization on inflation will transmit to domestic real output through the IS curve and to monetary policy via the policy reaction function.

Interestingly, however, Woodford (2007) carries out a formal theoretical analysis on the possible impact of globalization on this traditional monetary policy transmission process and his simulation results appear to suggest that increased globalization engenders no substantial reduction of the effects of domestic monetary policy on domestic economy. Through the theoretical designs, Woodford provides a comprehensive and valuable discussion on a wide range of ways that globalization might weaken the central bank's ability to influence the economy.

The results in Woodford (2007) mainly suggest that increased globalization should not eliminate the influence of domestic monetary policy over domestic inflation, but it does not mean that global economic slack is of no significance for the conduct of monetary policy. In particular, increased international trade in consumer goods and factors of production should lead to quantitative changes in the magnitudes of various key response elasticities relevant to the transmission mechanism for monetary

[5] We use the last quarter of 2002 as the end period to allow a minimum sample size of 10 years in the recursive estimations.

[6] Note that the reduction of the sample sharply decreases the degrees of freedom and thus increases the probability of a bias in the estimation. For this reason, the results should be interpreted with caution.



(a) recursive estimates for model (1) **(b) recursive estimates for model (9)**

Fig. 3. . Recursive estimates of δ_d and δ_f for Models (1) and (9).

policy (Woodford, 2007). Changes in the degree of goods market integration, for example, affect the quantitative specification of both the aggregate-demand and aggregate-supply blocks in Woodford's analysis.

At the very least, our finding calls attention to the rising globalization that may engender material forces for central bankers to confront more practical issues than the traditional issues in a closed economy. The changing degree of globalization also makes the issue of change over time in the correct quantitative specification of the models used in a central bank a more pressing one to consider (Woodford, 2007).

6. Conclusions

The global dimension of domestic inflation is attracting attention from both academics and policymakers. Globalization may have altered short-run inflation dynamics through various channels. However, verifying the effect of globalization on inflation has proven challenging, and the existing literature has provided mixed results for industrial countries. There is little empirical evidence on the global slack hypothesis for developing countries.

This paper aims to contribute to a strand of the empirical international macro-literature that has investigated the empirical relevance of the global slack hypothesis in recent years (also to the literature on China and its economy). The empirical approach of the paper follows in the tradition of the existing literature, but proposes a different strategy for the evaluation of the global slack hypothesis focusing on the experience of one country, China. China's emergence as a major player in the global economy over the past 20 years has been viewed as an essential part and a catalyst of this new wave of globalization. So, as our argument goes, Chinese inflation dynamics should have become more responsive to slack from its major trading partners according to the global slack hypothesis. We evaluate the hypothesis in a traditional Phillips curve framework. Traditional studies using such a framework typically explain inflation with domestic demand and supply conditions such as the output gap and cost push terms capturing productivity developments, but neglect that these factors are not only determined nationally but also globally.

Our empirical investigations provide robust evidence that inflation in China responds significantly to the global slack over the period from 1995 to 2012. This finding indicates that the prescription that central banks should specifically react to developments in global economic performance is justified for China. The finding also indicates that the low and stable inflation period in China over the past decade may be attributed to the rising globalization of Chinese economy through which China benefited from the stable economic slack in its trading partners.

While the higher level of globalization may help subdue and stabilize domestic inflation by, for example, stable global economic slack, during world tranquil time, negative global economic environment can also exert extra challenges for the domestic policy-makers. A notable case is the recent crisis in 2007–2008, which has caused China to be affected by weaker demand from its trading partners. In addition, the consequences for domestic inflation also depended on how foreign real incomes changed and how domestic monetary policy reacted. Therefore, studies that neglect the role of global economic slack are likely to underestimate the impact of globalization on domestic inflation dynamics.

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