Journal of International Money and Finance 32 (2013) 214–233

Contents lists available at SciVerse ScienceDirect

Journal of International Money and Finance

journal homepage: www.elsevier.com/locate/jimf

Are fiscal deficits inflationary?

Hsin-Yi Lin*, Hao-Pang Chu

Department of Economics, National Chengchi University, No. 64, Section 2, Zhi-nan Road, Taipei, Taiwan

JEL classification:
E31
E60

Keywords:
Autoregressive distributional lag
Dynamic panel data
Fiscal deficits
Inflation
Quantile regression

A B S T R A C T

This paper applies the dynamic panel quantile regression (DPQR) model under the autoregressive distributional lag (ARDL) specification, and examines the deficit–inflation relationship in 91 countries from 1960 to 2006. The DPQR model estimates the impact of deficits on inflation at various inflation levels and allows for a dynamic adjustment with the ARDL specification. The empirical results show that the fiscal deficit has a strong impact on inflation in high-inflation episodes, and has a weak impact in low-inflation episodes. The results imply that fiscal consolidation would be more effective in price stabilization the higher the inflation rate is, and are consistent with the theoretical model of Catão and Terrones (2005).

1. Introduction

This paper seeks to investigate whether fiscal deficits are inflationary. In a monetarist economy, the monetary authority independently determines seigniorage and can control inflation. However, Sargent and Wallace (1981) argue that the monetary authority's control over inflation is limited. Namely, if the fiscal authority dominates the monetary authority, then the fiscal authority independently announces all current and future deficits, such that the monetary authority is constrained by the demand of government bonds and monetizes the deficit. Accordingly, the government runs persistent deficits with seigniorage and produces inflation, and fiscal deficits and inflation are dynamically correlated. In a recent article by Catão and Terrones (2005), they propose an intertemporal optimization model to show that equilibrium inflation is proportional to the fiscal deficit scaled by narrow money. In high-inflation episodes, the average real money holdings are lower and the stock of transaction money is

* Corresponding author.
E-mail address: linh@nccu.edu.tw (H.-Y. Lin).

0261-5606/$ – see front matter
doi:10.1016/j.jimonfin.2012.04.006

narrower (Barro, 1970), and the impact of fiscal deficits on inflation is therefore large, with inflation heterogeneously related to fiscal deficits.[1]

Despite the theoretical view that fiscal deficits are inflationary, empirical studies have yet to provide a strong and statistically significant connection between fiscal deficits and inflation across a broad range of countries and inflation rates (Blanchard and Fischer, 1989; Catão and Terrones, 2005). For example, empirical studies of the United States (Hamburger and Zwick, 1981; Dwyer, 1982; Darrat, 1985; Ahking and Miller, 1985; King and Plosser, 1985), and those of other industrial or developed countries (King and Plosser, 1985; Giannaros and Kolluri, 1986; Protopapadakis and Siegel, 1987; Barnhart and Darrat, 1988) have not yielded conclusive results on the deficit–inflation relationship. Meanwhile, empirical studies of developing countries, such as those of De Haan and Zelhorst (1990), Metin (1998), Loungani and Swagel (2003), and Domaç and Yücel (2005), generally indicate that the inflationary effect of deficit financing is insignificant, but do find a significant causality of fiscal deficits on inflation in high-inflation countries.

Several studies have exploited both the time and cross-sectional dimensions of data to examine the relationship between fiscal deficits and inflation. Karras (1994) investigates the relationship using the panel estimation and finds that deficits are not inflationary in 32 countries. Cottarelli et al. (1998) note a significant impact of fiscal deficits on inflation in industrial and transition economies by using the dynamic panel data model. Fischer et al. (2002), using the data set of 94 developing and developed countries from 1960 to 1995, find that the relationship between fiscal deficits and inflation is only strong in high-inflation countries during high-inflation episodes, and weak in low-inflation countries and in high-inflation countries during low-inflation episodes. Catão and Terrones (2005) apply the pooled mean group estimation method to a data set spanning 107 countries over the 1960–2001 period. It is shown that, empirically, deficits have an impact on inflation and such an impact is stronger in high-inflation or developing countries. As mentioned by Catão and Terrones (2005), developing countries with less efficient tax collection, political instability, and limited access to external borrowing tend to have a lower relative cost of seigniorage and thus a higher inflation tax.

The existing empirical literature divides a sample into sub-groups of countries based on long-run average annual inflation, to learn about the deficit–inflation relationship. As Catão and Terrones (2005, p. 540–541) argue: "*since the overlapping between such groups is far from perfect, and given that other studies have considered high- and low-inflation countries as relevant sub-groups in their own right, it seems important to consider such a breakdown of the panel.*" However, it is known that the heterogeneous relationship between deficits and inflation is sensitive to the selection of an unconditional division of the sample. Therefore, it is important and desirable to have an econometric method to accommodate key features of the theory and to describe the heterogeneous relationship across different levels of inflation without sample selection. Accordingly, this paper suggests a quantile regression technique for a dynamic panel data model, henceforth the dynamic panel quantile regression (DPQR) model that estimates the impact of fiscal deficits on inflation at different quantiles of inflation, in order to expose multiple forms of the conditional heterogeneity of inflation. It is noted that quantile regression ideally uncovers the relationship between fiscal deficits and inflation without slicing the data into sub-groups; rather, it investigates the deficit–inflation relationship at various inflation levels. By using the DPQR model, the impact of deficits on inflation in high-, middle-, and low-inflation episodes can be estimated without sample selection bias.

This paper applied the DPQR model under an autoregressive distributed lag (ARDL) specification. The ARDL specification allows for lags of the dependent and explanatory variables to affect the dependent variable of interest and permits for intrinsic dynamic adjustment. However, the lagged dependent variable in the dynamic panel data model is endogenous due to the existence of fixed effects. Thus, a two-stage estimation procedure of the DPQR model is proposed in Lin (2011) to reduce the dynamic bias in the DPQR model. In the estimation, the fitted value of the lagged dependent variable is obtained in the first step. This fitted value is used to replace the endogenous variable in the

[1] One other theory of the deficit–inflation relationship is the fiscal theory of the price level (Leeper, 1991; Sim, 1994; Woodford, 1994, 1995, 2001; McCallum, 2001; Cochrane, 2005).

model, and the penalized quantile regression for panel data of Koenker (2004) is implemented in the second step.

This paper provides a comprehensive empirical examination of the relationship between deficits and inflation on an extensive panel data set. The panel data, spanning 91 countries over the 1960–2006 period, extends the data of Fischer et al. (2002) and Catão and Terrones (2005), and is the most extensive data set. The empirical results show that the DPQR estimates of the impact of deficits on inflation vary across different quantiles of inflation. Fiscal deficits are inflationary in high- and middle-inflation episodes, and are weakly or insignificantly related to inflation in low-inflation episodes. It is interesting to see that the inflationary consequences of deficits come from the unexpected monetary shock (De Haan and Zelhorst, 1990); in high-inflation episodes, a given deficit-to-GDP ratio is followed by faster money creation and the impact of deficits on inflation is higher.[2] The empirical results support the theoretical model of Catão and Terrones (2005) and are consistent with many empirical studies. Therefore, the results suggest that considering the heterogeneous effects of deficits on inflation is important in resolving the puzzle between theoretical and empirical studies. The results also imply that fiscal consolidation would be more effective in price stabilization the higher the inflation rate is.

We further explore the robustness of the DPQR results by adding other inflation-related variables such as the growth rate of GDP per capita, oil price inflation, and openness. In addition, the exchange rate is an important factor of inflation, and the exchange rate regimes of Reinhart and Rogoff (2004) are considered in the model. The DPQR results are robust with respect to the inclusion of a variety of other variables. The DPQR results are also robust to deficits scaled by the stock of narrow money or by GDP. Other robustness checks show that the impact of deficits on inflation is generally weaker in OECD countries than in non-OECD countries. Also, the impact of fiscal deficits on inflation is more heterogeneous in non-OECD countries than that in OECD countries.

The remainder of this paper is organized as follows. Section 2 discusses the literature review. Section 3 introduces the empirical approach and defines the data. Section 4 discusses the results and the robustness check. Section 5 concludes. A list of the countries used in this paper is provided in the Appendix.

2. Literature review

The celebrated paper of Sargent and Wallace (1981) discusses the “monetary dominance” and “fiscal dominance” regimes in the relationship between fiscal deficits and inflation. Given that the budget deficit is jointly determined by bond sales to the public and seigniorage created by a monetary authority, if the monetary authority implements a monetary policy independently, then the fiscal authority faces a budget constraint imposed by the monetary authority when it formulates the fiscal policy. Under this circumstance, the monetary authority can control the money supply, and fiscal deficits do not lead to inflation. In contrast, in a fiscal dominance regime, the monetary authority cannot control the money supply, and fiscal deficits lead to inflation under such fiscal dominance. In the theoretical model of Catão and Terrones (2005), sustained fiscal deficits might cause inflation by means of money creation, and equilibrium inflation is related to the fiscal deficit scaled by the stock of narrow money which stands for an inflation tax base. From their model, inflation is proportional to the product of the deficit-to-GDP ratio by the ratio of GDP to narrow money. Thus, given a change in the deficit-to-GDP ratio, an economy at a higher inflation level would be more strongly impacted by an increase in the deficit, because its inflation tax base would typically be narrower. Note that the deficit–inflation relationship is dynamic since governments allocate seigniorage intertemporally by borrowing, and fiscal deficits play a key role in the present value for the monetary accommodation of financing government bonds (Sargent and Wallace, 1981; Catão and Terrones, 2005).

From other perspectives, the fiscal theory of the price level claims that the price level can be determined by the fiscal policy (Leeper, 1991; Sim, 1994; Woodford, 1994, 1995, 2001; McCallum, 2001; Cochrane, 2001, 2005; Leeper and Yun, 2006). In a non-Ricardian model, both fiscal and monetary

[2] The authors thank the referee for this suggestion.

policies are exogenously determined by the government. When the government adjusts the present value of its future primary surpluses, the price level will rise to lower the real value of the debt. Fiscal policy is directly linked to the price level through the present value budget constraint (Minford and Peel, 2002). The conventional view of debt also provides another channel by which to interpret why an increase in debt may cause inflation. Elmendorf and Mankiw (1999) conclude that an increase in debt has a positive wealth effect on households. Thus the demand for goods and services will raise and inflate the economy.

There are many empirical studies on the relationship between fiscal deficits and inflation. For the United States, Hamburger and Zwick (1981) examine the deficit–money relationship from the period of 1954–1976, and conclude that budget deficits are inflationary. In particular, the relationship becomes stronger in the "Keynesian period" (1961–1974). Dwyer (1982) uses quarterly data covering the 1953–1978 period to test the relationship between debt, price, and money. There is no evidence that debt plays a role in determining price level and money stock. Ahking and Miller (1985) also examine quarterly data from the period of 1947–1980, and present that the deficit–inflation relationship of the United States does exist during some specific periods. Darrat (1985) shows that fiscal deficits and money growth are significantly inflationary from 1958 to 1979. King and Plosser (1985) investigate the deficit–seigniorage relationship in terms of neoclassical macroeconomic models. They find little connection between fiscal deficits and seigniorage in the 1953–1982 period in the United States. King and Plosser (1985) also estimate the deficit–seigniorage connection of 12 other industrial and developing countries, but still fail to demonstrate that the relationship is significant.

Furthermore, Giannaros and Kolluri (1986), who utilize data from 10 industrial or developed countries from 1950 to 1981, show that the impact of fiscal deficits on money supply and inflation is insignificant. Protopapadakis and Siegel (1987) examine the debt–money and the debt–inflation connections for 10 major advanced countries during the period of 1952–1987, and note that the association between debt growth and inflation is very weak. Barnhart and Darrat (1988) test causality between fiscal deficits and money growth across 7 industrial countries from 1960 to 1984, and reject the hypothesis that the deficit Granger causes an increase in money growth and they also reject the reverse causality.

De Haan and Zelhorst (1990), investigating 17 developing countries from 1961 to 1985, find no evidence to support the "fiscal dominance hypothesis", and discover that deficits are correlated to inflation during acute inflation periods. Using the cointegration analysis, Metin (1998) reveals that deficits lead directly to inflation in Turkey during the period of 1954–1986. However, Komulainen and Pirttilä (2002) use the data from three transition economies (Russia, Bulgaria and Romania), and find that the deficit does not play an inflationary role. Loungani and Swagel (2003) show that the fiscal balance weakly correlates to inflation in 53 developing countries from 1964 to 1998, but the correlation becomes stronger in countries with higher average inflation. In addition, they find a non-linear relationship between deficits and inflation, and the impact of deficits on inflation is significant when the deficit-to-GDP ratio is above 5%. Domaç and Yücel (2005) investigate 15 emerging markets from 1980 to 2001 by pooled probit estimation and discover that government deficits are a significantly positive factor of high inflation.

Several studies have exploited both the time and cross-sectional dimensions of data. For example, Karras (1994) investigates the relationship using the panel estimation and finds that deficits are not inflationary in 32 developed and developing countries during the 1950s to 1980s. Click (1998) uses cross-country data of 90 countries from 1971 to 1990 and presents that domestic debt is not a determinant of seigniorage. Cottarelli et al. (1998) examine data of 47 countries from 1993 to 1996 and show that fiscal deficits play a significant role in inflation. Additionally, the relationship between past inflation rates and current inflation is persistent and dynamic. Fischer et al. (2002) investigate the relationship between inflation, money growth, seigniorage and fiscal deficits on a large data set containing 94 countries during 1960–1995. Their cross-sectional result indicates that fiscal deficits are significantly positive to seigniorage and inflation. In addition, their panel data show that, in countries with high average inflation, fiscal deficits play a significant role in seigniorage and inflation. Also, fiscal deficits are positively related to inflation during high-inflation episodes.

Catão and Terrones (2005) collect data from 107 countries over the period of 1960–2001, and use the pooled mean group estimation to reveal the short- and long-run influences of deficits on inflation.

They show that the inflationary effect of deficits to inflation depends on the financial depth of a country, the inflation tax bases and the credibility of monetary authorities. Fiscal deficits are inflationary in developing and high-inflation countries, but not in low-inflation and developed countries. Kwon et al. (2009) examine the debt–inflation connection on a panel data of 71 countries from 1962 to 2004 to measure the effect of debt on inflation. Their result shows that debt growth is strongly inflationary in indebted developing countries, and less so in other developing countries. In advanced countries, debt growth is less inflationary. In light of the aforementioned theoretical and empirical studies, fiscal deficits are generally inflationary in countries with high average inflation and high-inflation episodes, as well as in developing countries. Otherwise, deficits play a weak role in the determination of inflation.

3. Model and data

3.1. The autoregressive distributional lag specification

Since fiscal deficits and inflation are dynamically correlated, we consider a general ARDL(p, q) specification of the DPQR model to characterize the stylized fact of inflation,[3] given quantile $\tau \in (0,1)$:

$$\pi_{it} = \sum_{k=1}^{p} \pi_{it-k}\alpha_k(\tau) + \sum_{j=0}^{q} x'_{it-j}\beta_j(\tau) + \eta_i + u_{it,\tau}, \quad \forall i = 1,\dots,N, t = 1,\cdots,T, \tag{1}$$

where π_{it} is defined as log (1 + inflation/100) and represents the annual inflation rate, $\alpha_k(\tau)$,$\beta_j(\tau)$ are parameters at the τ-th quantile, π_{it-k} is the lagged inflation rate, x_{it-j} are vectors of (lagged) explanatory variables, η_i represents the individual fixed effects and $u_{it,\tau}$ is the error term. It is noted that in model (1), parameters $\alpha_k(\tau)$ and $\beta_j(\tau)$ represent the effect of regressors on different levels of inflation and are functions of quantile. Thus, the DPQR model can be used to model the heterogeneous inflationary effects of regressors. In addition, fixed effects are parameters identifying individual effects, and when T is in a moderate size, the fixed effects do not have a distribution shift. Thus, the fixed effects η_i do not depend on the quantile.

This paper applied the estimation method of Lin (2011) to estimate the model (1) with $p = 1$, i.e. an ARDL(1, q) specification as follows:

$$\pi_{it} = \pi_{it-1}\alpha_1(\tau) + \sum_{j=0}^{q} x'_{it-j}\beta_j(\tau) + \eta_i + u_{it,\tau}, \tag{2}$$

where the lagged inflation rate is correlated with the error term due to the existence of the fixed effects. Lin (2011) suggests a two-stage estimation method for the DPQR model to solve the endogeneity problem. The first stage obtains the fitted value of lagged inflation, $\widehat{\pi}_{it-1} = z'_{it}\hat{\gamma}$, by regressing π_{it-1} on instrumental variables z_{it}. Possible instrumental variables are further lags of the first-differenced inflation. The second stage is carried out via the penalized quantile regression of Koenker (2004) for

$$\pi_{it} = \alpha_1(\tau)(z'_{it}\hat{\gamma}) + \sum_{j=0}^{q} x'_{it-j}\beta_j(\tau) + \eta_i + u_{it,\tau},$$

where π_{it-1} is replaced by its estimated value $\hat{\pi}_{it-1}$.

The asymptotics of DPQR estimators $\hat{\beta}_j(\tau)$ of the regressors have been proven in Lin (2011). The limiting distribution of $\hat{\beta}_j(\tau)$ is normal. The DPQR estimator is two-stage, and the estimation of the first stage affects the asymptotic variance of the estimator from the second stage. Lin suggests the cross-sectional bootstrap to estimate the variance of the estimator. The number of bootstrap replications is 1000. For more details on this DPQR model, see Lin (2011).

---

[3] The dynamic specification with the ARDL structure has been considered in several papers, such as Darrat (1985), Barnhart and Darrat (1988), De Haan and Zelhorst (1990), Karras (1994), Metin (1998), and Catão and Terrones (2005).

3.2. Data

The main data set consists of a panel of 91 countries (see Appendix) over the period of 1960–2006. The data set is the most up-to-date and broadest in inflation studies including Fischer et al. (2002) from 1960 to 1995 and Catão and Terrones (2005) over the period of 1960–2001. The main sources are the IMF's International Financial Statistics (IFS), the Penn World Table (PWT) version 6.3, and Reinhart and Rogoff (2004). The variables used in the paper are inflation (IFS line 64), the central government deficit (IFS line 80), narrow money (IFS line 34), current GDP (IFS line 99), the growth of real GDP per capita (PWT 6.3 grgdpch), oil price (IFS line 76), the nominal exchange rate (PWT 6.3 XRAT), openness (PWT 6.3 openc), and exchange rate regimes (Reinhart and Rogoff, 2004). Some gaps in inflation are filled with data from Desai et al. (2003) and Mitchell (2007a, b, c).[4] Some gaps in the narrow money stock are filled with data from Mitchell (2007a, b, c). Some gaps in the current GDP are filled with data from the World Bank's World Development Indicator (WDI) as well as the United Nations' National Accounts Statistics.[5] A list of constituent countries is provided in the Appendix.

Inflation is measured by the annual change in the consumer price index. As in Catão and Terrones (2005), the fiscal deficit is measured by the nominal central government deficit scaled by narrow money. In addition, we use the fiscal deficit scaled by GDP to test the robustness of the empirical results. Narrow money stock is measured by M1. Money growth is the annual change in the money stock. The growth rate of real GDP per capita is the annual change in the real GDP per capita. Oil prices in the local currency are computed by the product of the average crude price of petroleum in dollars and the nominal exchange rate. Oil price inflation is the annual change in the oil prices. The benefit of measuring oil prices in local currency is that each country faces different oil prices. Openness is measured by the ratio of annual imports plus exports to GDP. Moreover, the exchange rate regimes of Reinhart and Rogoff (2004) are used as an additional control variable.[6] The exchange rate regime index ranges from 1 (complete inflexibility) to 6 (extreme floating) and the smaller the index, the more fixed the exchange rate is.

Table 1 provides basic summary statistics of the data. In panel (A) of Table 1, the median and the third quartile of inflation are 6.11% and 12.80%, respectively. Yet, the mean is 26.86%, which is much larger than the third quartile of inflation. Clearly, the distribution of inflation is right-skewed and the mean is sensitive to extremely large values. The estimation result of the mean regression for dynamic panel data is sensitive to the extremely large value of inflation. One advantage of the DPQR model is that the estimation result is robust to extreme values. Furthermore, the variables of the deficit scaled by narrow money and the deficit scaled by GDP are symmetric, since their means and medians are so close. The distributions of the money growth rate and oil price inflation are both very right-skewed, while the growth of real GDP per capita and openness have symmetric distributions. The exchange rate regimes of Reinhart and Rogoff (2004) are also included in these regressions. As the index is not available for all countries in the data set, the panel size has been decreased to 81 countries. Panel (B) of Table 1 reports the summary statistics for data on 81 countries with exchange rate regimes. Panel (B) indicates similar statistical properties of variables to those in panel (A).

We next consider OECD and non-OECD countries in our empirical studies. The classification of country groups is based on the World Bank list of economies (July 2009), and a list of the constituent countries is provided in the Appendix. The lower two panels of Table 1 show very different properties of variables for different country groups. The inflation in OECD countries, ranging from -13.85% to 84.22%, has a symmetric distribution and a low standard error. However, the inflation in non-OECD countries is volatile and its mean is affected by extreme values. The standard errors of all variables in OECD countries are smaller than those in non-OECD countries. The economies of OECD countries are more stable than the economies of non-OECD countries.

[4] We thank Dr. Raj M. Desai for generously sharing his data set.

[5] The condition is imposed that a country is included in the data only if there are at least 24 (half of the period) annual observations during the 1960–2006 period for each of the six variables including inflation, the central government deficit, narrow money, real GDP per capita, oil price, openness, and nominal exchange rate. Consequently, 91 countries were selected.

[6] The exchange rate regime data of Reinhart and Rogoff (2004) have been updated to 2007. Please see the web page of Professor Reinhart for details.

Table 1
Summary statistics.

	Mean	Q1	Median	Q3	S.E.	Min	Max
(A) All 91 countries							
Inflation rate (%)	26.86	2.60	6.11	12.80	310.33	−100.00	10945.70
Deficits/Money	0.234	0.042	0.167	0.335	0.427	−1.81	10.57
Deficits/GDP	0.033	0.007	0.025	0.050	0.061	−0.222	2.05
Money growth rate (%)	30.23	6.36	12.85	21.87	284.08	−99.90	11673.40
Growth of real GDP per capita (%)	2.38	−0.101	2.46	4.98	5.94	−42.95	68.87
Oil price inflation (%)	84.64	−0.538	4.87	24.36	3273.49	−63.42	213153.20
Openness (%)	33.94	19.15	27.73	41.93	24.53	0.154	228.47
(B) 81 countries with exchange rate regimes							
Inflation rate (%)	28.94	2.71	6.27	13.07	327.67	−13.85	10945.70
Deficits/Money	0.227	0.038	0.157	0.319	0.428	−1.81	10.57
Deficits/GDP	0.032	0.006	0.024	0.048	0.061	−0.222	2.05
Money growth rate (%)	31.98	6.56	12.90	21.99	299.27	−99.90	11673.40
Growth of real GDP per capita (%)	2.41	0.044	2.53	4.92	5.58	−42.95	68.87
Oil price inflation (%)	92.95	−0.435	5.11	24.92	3469.60	−63.42	213153.20
Openness (%)	32.49	19.05	26.84	38.21	23.91	0.154	228.47
Exchange rate regime	2.23	1.00	2.00	3.00	1.32	1.00	6.00
(C) 24 OECD countries							
Inflation rate (%)	6.36	2.33	4.12	7.92	7.07	−13.85	84.22
Deficits/Money	0.146	0.018	0.095	0.232	0.237	−0.724	1.60
Deficits/GDP	0.025	0.004	0.019	0.043	0.042	−0.222	0.208
Money growth rate (%)	11.53	5.31	9.12	15.17	13.18	−62.55	192.09
Growth of real GDP per capita (%)	2.92	1.10	2.81	4.62	3.30	−13.56	21.37
Oil price inflation (%)	14.65	−2.49	2.70	19.42	44.95	−63.42	292.31
Openness (%)	30.06	20.69	28.36	36.30	14.70	4.63	92.15
(D) 67 non-OECD countries							
Inflation rate (%)	34.45	2.89	7.33	14.99	362.97	−100.00	10945.70
Deficits/Money	0.268	0.058	0.198	0.377	0.477	−1.81	10.57
Deficits/GDP	0.036	0.008	0.028	0.052	0.066	−0.220	2.046
Money growth rate (%)	37.03	7.18	14.50	24.68	331.40	−99.90	11673.40
Growth of real GDP per capita (%)	2.19	−0.779	2.22	5.15	6.64	−42.95	68.87
Oil price inflation (%)	109.71	−0.073	5.96	28.44	3814.75	−60.09	213153.20
Openness (%)	35.33	18.59	27.32	45.62	27.08	0.154	228.47

Source: the International Financial Statistics, Mitchell (2007a, b, c), the Penn World Table, Desai et al. (2003), the World Development Indicators and, the National Accounts Statistics and Reinhart and Rogoff (2004).

4. Empirical results

4.1. Deficits to inflation

We first investigate the relationship between deficits and inflation for 91 countries during the 1960–2006 period, wherein the fiscal deficit is scaled by M1.[7] Note that in the DPQR model for an ARDL specification, the summation of the coefficients in model (2), $\sum_{j=0}^{q}\beta_j(\tau)$, which represents the cumulated impacts of fiscal deficits on inflation, is computed. Most empirical studies report that the number of time lags q is chosen smaller or equal to 3, $q \leq 3$. For example, Karras (1994) chooses $q = 3$, Fischer et al. (2002) choose $q = 2$ and Catão and Terrones (2005) choose $q \leq 3$. Thus, q is chosen as 3 in this paper. Moreover, to eliminate the dynamic bias, a two-stage estimation is considered in the DPQR

[7] Data for the full sample are all stationary over the period of 1960–2006. For inflation, the deficit-to-M1 ratio, the deficit-to-GDP ratio, money growth, growth of real GDP per capita, oil price inflation, and openness, the t-ratios of the Levin et al. (2002) (LLC) test (one lag) are −29.95, −25.93, −25.45, −29.68, −41.73, −42.71 and −13.73, respectively; the t-*bar*s of the Im et al. (2003) (IPS) test (one lag) are −3.11, −2.95, −2.88, −3.10, −4.50, −4.33 and −1.77, respectively.

model where the instrumental variables are used. Here, the instrumental variable is one lag of first-differenced inflation, $\Delta\pi_{it-1}$.[8] Table 2 presents the empirical results of a DPQR model for an ARDL specification with 9 quantiles. In the following tables, the dynamic generalized method of moment (DGMM) model of Arellano and Bond (1991) is considered for comparison. DGMM denotes the results of the DGMM model with instrumental variables π_{it-l}, $l \geq 2$.

Table 2 shows that the DPQR estimates of current and lagged deficits on inflation are positive, except that of the current deficit at the 0.1 quantile, which indicates that deficits are inflationary. The DPQR estimates of deficits also increase monotonically, along with quantiles, in magnitude and significance. That is, the DPQR estimates are higher and significant at high- and middle-quantiles of inflation, whereas they are smaller and insignificant at low-quantiles of inflation. The summation of coefficients of deficits on inflation shows a similar pattern. For example, the values of summation of the coefficients at the 0.1–0.9 quantiles are 0.0094, 0.0165, 0.0236, 0.0272, 0.0312, 0.0369, 0.0452, 0.0660, and 0.1128, and the values are insignificant at the 0.1 quantile, significant at the 5% level at the 0.2 quantile and significant at the 1% level at the 0.3–0.9 quantiles.

The summation of coefficients of deficits on inflation, $\sum_{j=0}^{q}\beta_j(\tau)$, is plotted in Fig. 1. In the figure, the horizontal and vertical axes correspondingly indicate the quantile and the summation of coefficients of deficits to inflation. The black solid line represents the regression estimates of the DPQR model and the black dotted lines are their 95% confidence interval. The grey solid line is the DGMM estimate. From Fig. 1, it is evident that the impact of deficits on inflation presents a clear trend. The deficits are inflationary in high-inflation episodes and less so in low-inflation episodes. The DPQR results show the heterogeneous and non-linear relationship between inflation and deficits with the whole data set, and without sample selection bias.

The empirical results of the DPQR model for an ARDL specification show that in high-inflation episodes, the inflationary effect of deficits is higher because of faster money creation. The results support the theoretical results of Catão and Terrones (2005), who point out that a given change in the deficit-to-GDP ratio has a stronger impact in higher-inflation economics. The results are consistent with the empirical studies of De Haan and Zelhorst (1990), Fischer et al. (2002), Catão and Terrones (2005), and Domaç and Yücel (2005).

The DPQR estimates of lagged inflation range from 0.2266 to 0.5687 and increase along with quantiles. Furthermore, the DPQR estimates of lagged inflation are significant at the 5% level at the 0.2 and 0.3 quantiles, and significant at the 1% level from the 0.4 to 0.9 quantiles. Hence, lagged inflation is significant and positively related to the current inflation, and the relationship between the lagged and the current inflation tends to be stronger when inflation is high. This implies that inflation is more persistent in high-inflation episodes.

4.2. Oil price inflation, openness and growth

To fully investigate the relationship between deficits and inflation, several inflation-related variables are taken into consideration. First, Ball and Mankiw (1995) propose a theoretical model to describe supply-side shocks, wherein an increase in the relative price of oil could affect the aggregate price level. Thus, the change in the price of oil is considered as a control variable in several empirical studies; see also Loungani and Swagel (2003), Catão and Terrones (2005).[9] Moreover, Romer (1993) argues that trade openness is negatively related to inflation because the time inconsistency problem of monetary policy is less critical in more open countries. Empirically, many studies have also concluded that the openness–inflation relationship is negative (Romer, 1993; Lane, 1997; Alfaro, 2005). In addition, economic growth is an important inflation-related factor. Thus, the growth rate of real GDP per capita is considered as an additional control variable. Following Fischer et al. (2002), for scaling purposes, we use the logarithmic form of oil price inflation and the growth rate of real GDP per capita.

[8] Lin (2011) compares results with different lags of first-differenced inflation as instrumental variables, and obtains similar results.

[9] Loungani and Swagel (2003) use oil prices in dollar terms, and each country has the same values for the price of oil in a particular year. This paper uses oil prices in the local currency, and each country faces different energy prices.

Table 2
The DPQR results.

Dependent variable: inflation										
	DGMM	Quantile								
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Intercept	0.0032*	0.4900	0.4970	0.5003	0.5024	0.5057	0.5110	0.5142	0.5232	0.5369
	(0.0016)	(3.1146)	(3.1148)	(3.1147)	(3.1147)	(3.1148)	(3.1147)	(3.1146)	(3.1147)	(3.1147)
Inflation_{t-1}	0.7567***	0.2266	0.3102**	0.3299**	0.3677***	0.3735***	0.3697***	0.4447***	0.4531***	0.5687***
	(0.0107)	(0.1669)	(0.1452)	(0.1318)	(0.1261)	(0.1188)	(0.1165)	(0.1234)	(0.1394)	(0.1342)
Deficits/M1_t	0.0847***	−0.0026	0.0025	0.0073*	0.0105**	0.0134***	0.0142**	0.0178**	0.0259***	0.0263*
	(0.0041)	(0.0063)	(0.0044)	(0.0044)	(0.0044)	(0.0050)	(0.0058)	(0.0077)	(0.0082)	(0.0135)
Deficits/M1_{t-1}	0.0036	0.0048	0.0073**	0.0073**	0.0074***	0.0090***	0.0114***	0.0129**	0.0119	0.0448***
	(0.0042)	(0.0058)	(0.0031)	(0.0031)	(0.0027)	(0.0030)	(0.0043)	(0.0051)	(0.0095)	(0.0135)
Deficits/M1_{t-2}	−0.0574***	0.0071	0.0030	0.0046	0.0036	0.0042	0.0015	0.0044	0.0121***	0.0145**
	(0.0041)	(0.0044)	(0.0031)	(0.0033)	(0.0032)	(0.0034)	(0.0038)	(0.0041)	(0.0045)	(0.0059)
Deficits/M1_{t-3}	0.0095**	0.0000	0.0037	0.0045	0.0056	0.0046	0.0098**	0.0102**	0.0161**	0.0272***
	(0.0038)	(0.0068)	(0.0039)	(0.0038)	(0.0039)	(0.0045)	(0.0049)	(0.0050)	(0.0068)	(0.0083)
$\sum_{j=0}^{3}\text{deficits/M1}_{t-j}$	0.0404***	0.0094	0.0165**	0.0236***	0.0272***	0.0312***	0.0369***	0.0452***	0.0660***	0.1128***
	(0.0060)	(0.0105)	(0.0075)	(0.0079)	(0.0087)	(0.0104)	(0.0127)	(0.0152)	(0.0203)	(0.0257)

Standard errors in parenthesis. ***, ** and * indicate the significant level of 1%, 5% and 10% respectively. Instrumental variable $\Delta\pi_{it-1}$ is used in the DPQR model. Instrumental variables π_{it-l}, $l \geq 2$ are used in the DGMM model with estimates represented as DGMM. $\sum_{j=0}^{3}\text{deficits/M1}_{t-j}$ is the summation of the coefficients of deficits.

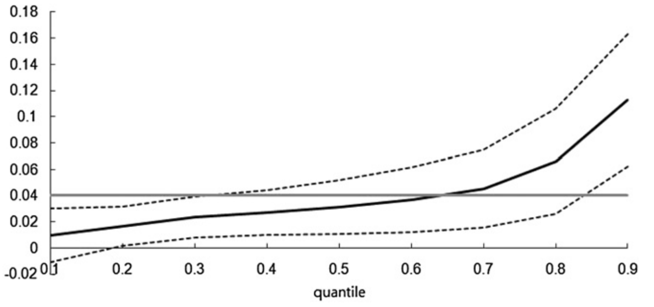

Fig. 1. The impact of deficits to inflation.

Table 3 reports the results of DPQR and DGMM methods. To shorten the length of the table, only the summations of coefficients of explanatory variables on inflation are reported. Several interesting properties can be found in Table 3. First, the impact of deficits on inflation is positive; it monotonically increases along with quantiles, and is robust to the inclusion of additional explanatory variables. Second, the DPQR and DGMM estimates of the growth of real GDP per capita are all negative; the DPQR estimates are insignificant at the 0.1 quantile, significant at the 10% level at the 0.2 quantile, significant at the 5% level at the 0.3 and 0.4 quantiles, and significant at the 1% level at the quantiles above median. Third, the DPQR and DGMM estimates of oil price inflation are all significantly positive. Thus, the oil price shock is an inflationary factor. In addition, the DPQR estimates of oil price inflation monotonically increase along with quantiles. Fourth, the DPQR and DGMM estimates of trade openness are all negative. The negative relationship is stronger in high-inflation episodes and is weaker in low-inflation episodes, supporting the argument of Romer (1993).

4.3. *Exchange rate regime*

The exchange rate is an important factor related to inflation. Existing studies argue that governments with fixed exchange rate regimes have more monetary discipline. Thus, many countries have used a fixed exchange rate as a nominal anchor for lowering inflation (Ghosh et al., 1997; Calvo and Végh, 1999; Alfaro, 2005). Yet, Tornell and Velasco (2000) and Fatás and Rose (2001) argue that no positive relationship exists between flexible exchange rates and inflation. Accordingly, we consider the effects of the exchange rate regimes of Reinhart and Rogoff (2004).[10] The index of exchange rate regimes ranges from 1 (complete inflexibility) to 6 (extreme floating).[11]

Table 4 reports the results of the DPQR and DGMM estimations, with the inclusion of exchange rate regimes. The table shows that there is a significantly positive relationship between deficits and inflation after controlling the exchange rate regimes. The DPQR estimates in Table 4 for the summation of the coefficients of deficits on inflation indicate results similar to the model without considering the exchange rate regimes; the DPQR estimates of deficits increase along with quantiles and are stronger in high-inflation episodes. Thus, the deficit–inflation relationship is robust to the inclusion of the exchange rate regimes. In addition, the DPQR estimates of exchange rate flexibility for the whole panel are significantly positive for all quantiles of inflation and are stronger when inflation is higher. Clearly, a less flexible exchange rate regime contributes to a reduction in inflation, and the impact of exchange

[10] Reinhart and Rogoff (2004) classify the exchange regimes according to data on market-determined parallel exchange rates, and their index is a de facto exchange regime classification rather than the official classification.

[11] Data from the sample are all stationary over the period of 1960–2006. For inflation, the deficit-to-money ratio, the growth of real GDP per capita, oil price inflation, openness and exchange rate regime, the *t*-ratios of the LLC test (one lag) are −28.32, −23.82, −38.98, −40.35, −12.80, and −14.09, respectively; the *t-bar*s of the IPS test (one lag) are −3.09, −2.84, −4.45, −4.34, −1.76 and −1.98, respectively.

Table 3
The DPQR results with additional explanatory variables.

Dependent variable: inflation										
	DGMM	Quantile								
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Intercept	0.0306***	2.5911	2.5959	2.6000	2.6036	2.6061	2.6088	2.6117	2.6144	2.6296
	(0.0070)	(2.2762)	(2.2761)	(2.2760)	(2.2760)	(2.2759)	(2.2759)	(2.2759)	(2.2757)	(2.2759)
Inflation_{t-1}	0.6743***	0.1927	0.2730**	0.2986***	0.3298***	0.3634***	0.3716***	0.4261***	0.5344***	0.6601***
	(0.0152)	(0.1396)	(0.1196)	(0.1143)	(0.1015)	(0.0942)	(0.0995)	(0.1197)	(0.1603)	(0.2052)
$\sum_{j=0}^{3}\text{deficits/M1}_{t-j}$	0.0442***	0.0130**	0.0198***	0.0230***	0.0251***	0.0267***	0.0287***	0.0348***	0.0461***	0.0615***
	(0.0057)	(0.0066)	(0.0060)	(0.0061)	(0.0065)	(0.0074)	(0.0081)	(0.0098)	(0.0106)	(0.0132)
$\sum_{j=1}^{3}\text{growth}_{t-j}$	−0.5040***	−0.1208	−0.1352*	−0.1727**	−0.1883**	−0.2366***	−0.2749***	−0.3520***	−0.5203***	−0.7461***
	(0.1179)	(0.0880)	(0.0755)	(0.0784)	(0.0848)	(0.0868)	(0.1023)	(0.1291)	(0.1707)	(0.2180)
$\sum_{j=0}^{3}\text{oil price inflation}_{t-j}$	0.1126***	0.1474***	0.1659***	0.1966***	0.2226***	0.2550***	0.2972***	0.3437***	0.4497***	0.5887***
	(0.0150)	(0.0243)	(0.0264)	(0.0272)	(0.0303)	(0.0371)	(0.0485)	(0.0656)	(0.0878)	(0.0970)
$\sum_{j=0}^{3}\text{openness}_{t-j}$	−0.0787***	−0.0173	−0.0219**	−0.0251**	−0.0285***	−0.0299***	−0.0281**	−0.0299***	−0.0310**	−0.0301
	(0.0195)	(0.0122)	(0.0108)	(0.0107)	(0.0110)	(0.0110)	(0.0112)	(0.0115)	(0.0131)	(0.0184)

Standard errors in parenthesis. ***, ** and * indicate the significant level of 1%, 5% and 10% respectively. Instrumental variable $\Delta\pi_{it-1}$ is used in the DPQR model. Instrumental variables π_{it-l}, $l \geq 2$ are used in the DGMM model with estimates represented as DGMM. $\sum_{j=0}^{3}\text{deficits/M1}_{t-j}$ is the summation of the coefficients of deficits.

Table 4
The DPQR results with exchange rate regimes.

Dependent variable: inflation										
	DGMM	Quantile								
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Intercept	−0.0197**	1.0394	1.0406	1.0409	1.0433	1.0452	1.0483	1.0427	1.0430	1.0450
	(0.0079)	(3.2144)	(3.2144)	(3.2143)	(3.2143)	(3.2143)	(3.2141)	(3.2141)	(3.2142)	(3.2143)
Inflation_{t-1}	0.6590***	0.3876***	0.4266***	0.4423***	0.4649***	0.4646***	0.4382***	0.5423***	0.5971***	0.7027***
	(0.0157)	(0.0606)	(0.0673)	(0.0591)	(0.0568)	(0.0561)	(0.0727)	(0.0958)	(0.1095)	(0.1523)
$\sum_{j=0}^{3}\text{deficits/M1}_{t-j}$	0.0350***	0.0138**	0.0229***	0.0271***	0.0286***	0.0290***	0.0305***	0.0336***	0.0393***	0.0391***
	(0.0057)	(0.0063)	(0.0072)	(0.0069)	(0.0073)	(0.0084)	(0.0095)	(0.0106)	(0.0108)	(0.0136)
$\sum_{j=0}^{3}\text{growth}_{t-j}$	−0.3734***	−0.0493	−0.0275	−0.0405	−0.0964	−0.1006	−0.1195	−0.1750*	−0.2996**	−0.5127***
	(0.1278)	(0.0779)	(0.0762)	(0.0783)	(0.0788)	(0.0776)	(0.0914)	(0.1009)	(0.1317)	(0.1746)
$\sum_{j=0}^{3}\text{oil price inflation}_{t-j}$	0.0852***	0.1314***	0.1771***	0.2040***	0.2222***	0.2496***	0.2617***	0.3018***	0.3795***	0.5216***
	(0.0152)	(0.0214)	(0.0260)	(0.0280)	(0.0304)	(0.0342)	(0.0451)	(0.0583)	(0.0762)	(0.1108)
$\sum_{j=0}^{3}\text{openness}_{t-j}$	−0.0673***	−0.0305**	−0.0343***	−0.0366***	−0.0396***	−0.0422***	−0.0437***	−0.0464***	−0.0465***	−0.0442***
	(0.0191)	(0.0130)	(0.0128)	(0.0126)	(0.0126)	(0.0125)	(0.0123)	(0.0125)	(0.0126)	(0.0130)
$\sum_{j=0}^{3}\text{exchange rate regime}_{t-j}$	0.0222***	0.0058***	0.0070***	0.0086***	0.0099***	0.0118***	0.0142***	0.0177***	0.0207***	0.0251***
	(0.0020)	(0.0017)	(0.0019)	(0.0021)	(0.0024)	(0.0027)	(0.0029)	(0.0028)	(0.0027)	(0.0031)

Standard errors in parenthesis. ***, ** and * indicate the significant level of 1%, 5% and 10% respectively. Instrumental variable $\Delta\pi_{it-1}$ is used in the DPQR model. Instrumental variables π_{it-l}, $l \geq 2$ are used in the DGMM model with estimates represented as DGMM. $\sum_{j=0}^{3}\text{deficits/M1}_{t-j}$ is the summation of the coefficients of deficits.

rate regimes on inflation is stronger in higher inflation episodes than in lower inflation episodes. The empirical result is consistent with the aforementioned literature.

4.4. OECD vs. non-OECD countries

According to previous empirical studies (Giannaros and Kolluri, 1986; Protopapadakis and Siegel, 1987; Barnhart and Darrat, 1988; De Haan and Zelhorst, 1990; Catão and Terrones, 2005; Kwon et al., 2009), the fiscal deficit has a stronger influence on inflation in developing countries than in developed countries. Thus, the deficit–inflation relationship is investigated for different country groups such as OECD and non-OECD countries.[12] The DPQR and DGMM estimates for the OECD and non-OECD countries are presented in Tables 5and 6, respectively.[13]

In Table 5, for OECD countries, the DPQR estimates of the summation of the coefficients of deficits are all positive and significant at the 5% level. The impact of deficits on inflation also increases along with quantiles. For non-OECD countries, the DPQR estimates of deficits increase monotonically along with quantiles in magnitude and significance. For example, the DPQR estimates are significant at the 10% level at the 0.1 quantile, significant at the 5% level at the 0.2 quantile, and significant at the 1% level at the quantiles above 0.3. One difference between the results of OECD and non-OECD countries is that the DPQR estimates of the deficit's impact on inflation are homogeneous across quantiles in OECD countries and are heterogeneous across quantiles in non-OECD countries. The result also corresponds to Table 1, which shows that inflation is symmetric in OECD countries and is right-skewed in non-OECD countries. In Table 5, we see that the OECD countries depend less on monetization. Yet, Table 6 shows that non-OECD countries tend to rely on monetary accommodation, which may be a result of a smaller taxable capacity, political instability, a less independent central bank, and limited access to domestic and external debt financing; see De Haan and Zelhorst (1990), Alesina and Summers (1993), and Aisen and Veiga (2008).

4.5. Robustness check

Following the theoretical results of Catão and Terrones (2005), narrow money is used as scaling factor for the deficit in the previous section. However, the deficit-to-GDP ratio is a more common measure of fiscal deficits (Karras, 1994; Loungani and Swagel, 2003; Fischer et al., 2002; Domaç and Yücel, 2005). Therefore, we also use fiscal deficits scaled by GDP to test the robustness of the empirical results. Table 7 reports the DPQR and DGMM estimates of deficits on inflation where the deficit is scaled by GDP instead of narrow money, indicating that the inference does not change. All the DPQR estimates of deficits on inflation are significantly positive at the 1% significance level. The DPQR estimates of deficits also increase along with quantiles, and are stronger in high-inflation episodes than in low-inflation episodes. Note that the estimates of deficits using a deficit-to-GDP ratio are generally much higher than those using a deficit-to-M1 ratio. The empirical results in the paper are robust with respect to different measures of deficits.

Next, following Darrat (1985), Giannaros and Kolluri (1986), Karras (1994), and Kwon et al. (2009), the money growth rate is added as an additional explanatory variable herein. Table 8 reports the resulting DPQR and DGMM results. As shown, the DPQR estimates of money growth on inflation are

[12] We use the classification of the World Bank list of economies (July 2009). The "OECD" classification is broadly consistent with the "advanced economies" of Catão and Terrones (2005). However, Cyprus is in their "advanced economies", but not in the "OECD" classification, and Hungary and Korea are not included in Catão and Terrones' evaluation, though are included in this paper.

[13] For OECD countries, the *t*-ratios of the LLC test of inflation, the deficit-to-money ratio, the growth of real GDP per capita, oil price inflation and openness, are −12.27, −11.90, −21.86, −20.54 and −5.56 respectively; the *t-bar*s of the IPS test are −2.83, −2. 55, −4.54, −4.43 and −1.41 respectively. For non-OECD countries, the *t*-ratios of the LLC test for inflation, the deficit-to-money ratio, the growth of real GDP per capita, oil price inflation and openness, are −25.95, −23.25, −36.86, −36.83 and −12.11, respectively; the *t-bar*s of the IPS test are −3.14, −3.05, −4.61, −4.36 and −1.86 respectively. All variables are stationary except for openness in OECD countries. The first-differenced value of openness is stationary with the *t*-ratio and *t*-bar at −23.21 and −4.63, respectively. Thus, the first-differenced openness is used in the regression.

Table 5
The DPQR results for OECD countries.

Dependent variable: inflation										
	DGMM	Quantile								
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Intercept	0.0002	3.0997**	3.0987**	3.0943**	3.0954**	3.0957**	3.0980**	3.1011**	3.1097**	3.1173**
	(0.0012)	(1.3369)	(1.3372)	(1.3372)	(1.3372)	(1.3372)	(1.3371)	(1.3373)	(1.3371)	(1.3371)
Inflation_{t-1}	0.7300***	−0.0280	0.0695	0.2856*	0.3210**	0.4260**	0.3987**	0.4068**	0.2640*	0.3615**
	(0.0239)	(0.1569)	(0.1803)	(0.1511)	(0.1553)	(0.1714)	(0.1744)	(0.1597)	(0.1419)	(0.1554)
$\sum_{j=0}^{3}\text{deficits/M1}_{t-j}$	0.0091***	0.0179***	0.0222***	0.0267***	0.0282***	0.0278**	0.0323***	0.0355***	0.0378***	0.0369**
	(0.0031)	(0.0052)	(0.0067)	(0.0081)	(0.0098)	(0.0114)	(0.0122)	(0.0120)	(0.0127)	(0.0163)
$\sum_{j=0}^{3}\text{growth}_{t-j}$	0.2718***	0.0728	0.1834	0.2758	0.2754	0.2654	0.3555*	0.3761**	0.3837*	0.2789
	(0.0674)	(0.1728)	(0.1829)	(0.1730)	(0.1810)	(0.1942)	(0.1904)	(0.1905)	(0.2221)	(0.3297)
$\sum_{j=0}^{3}\text{oil price inflation}_{t-j}$	0.0739***	0.0482***	0.0850***	0.1290***	0.1557***	0.1829***	0.1975***	0.2056***	0.2177***	0.2556***
	(0.0092)	(0.0168)	(0.0191)	(0.0198)	(0.0245)	(0.0260)	(0.0240)	(0.0244)	(0.0275)	(0.0441)
$\sum_{j=0}^{3}\text{openness}_{t-j}$	−0.1603***	−0.0915	−0.2139**	−0.3652***	−0.4103***	−0.4595***	−0.5081***	−0.5509***	−0.5912***	−0.4766*
	(0.0501)	(0.0689)	(0.1066)	(0.1170)	(0.1256)	(0.1347)	(0.1600)	(0.1824)	(0.2072)	(0.2704)

Standard errors in parenthesis. ***, ** and * indicate the significant level of 1%, 5% and 10% respectively. Instrumental variable $\Delta\pi_{it-1}$ is used in the DPQR model. Instrumental variables $\pi_{it-l}, l \geq 2$ are used in the DGMM model with estimates represented as DGMM. $\sum_{j=0}^{3}\text{deficits/M1}_{t-j}$ is the summation of the coefficients of deficits.

Table 6
The DPQR results for non-OECD countries.

Dependent variable: inflation										
	DGMM	Quantile								
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Intercept	0.0308***	0.2520	0.2525	0.2590	0.2603	0.2642	0.2642	0.2635	0.2698	0.2956
	(0.0087)	(9.6487)	(9.6488)	(9.6488)	(9.6486)	(9.6486)	(9.6485)	(9.6482)	(9.6478)	(9.6477)
Inflation$_{t-1}$	0.6606***	0.1487	0.2779**	0.2621**	0.3338***	0.3538***	0.4199***	0.5035***	0.6209***	0.6068***
	(0.0177)	(0.1512)	(0.1180)	(0.1096)	(0.1081)	(0.1069)	(0.1125)	(0.1317)	(0.1642)	(0.2138)
$\sum_{j=0}^{3}$deficits/M1$_{t-j}$	0.0399***	0.0155*	0.0205**	0.0259***	0.0284***	0.0276***	0.0323***	0.0401***	0.0437***	0.0549***
	(0.0063)	(0.0090)	(0.0084)	(0.0087)	(0.0087)	(0.0096)	(0.0104)	(0.0112)	(0.0108)	(0.0143)
$\sum_{j=0}^{3}$growth$_{t-j}$	−0.4348***	−0.1679	−0.1813	−0.2235***	−0.3077***	−0.3438***	−0.3968***	−0.5051***	−0.6776***	−0.8035***
	(0.1314)	(0.1024)	(0.0841)	(0.0834)	(0.0907)	(0.0973)	(0.1075)	(0.1396)	(0.1729)	(0.2601)
$\sum_{j=0}^{3}$oil price inflation$_{t-j}$	0.1390***	0.1650***	0.1988***	0.2325***	0.2695***	0.3097***	0.3639***	0.4539***	0.5663***	0.7044***
	(0.0181)	(0.0300)	(0.0355)	(0.0414)	(0.0480)	(0.0574)	(0.0718)	(0.0942)	(0.1045)	(0.1040)
$\sum_{j=0}^{3}$openness$_{t-j}$	−0.0772***	−0.0059	−0.0098	−0.0127	−0.0155	−0.0168	−0.0168	−0.0159	−0.0205	−0.0218
	(0.0233)	(0.0134)	(0.0128)	(0.0123)	(0.0123)	(0.0128)	(0.0136)	(0.0139)	(0.0168)	(0.0255)

Standard errors in parenthesis. ***, ** and * indicate the significant level of 1%, 5% and 10% respectively. Instrumental variable $\Delta\pi_{it-1}$ is used in the DPQR model. Instrumental variables π_{it-l}, $l \geq 2$ are used in the DGMM model with estimates represented as DGMM. $\sum_{j=0}^{3}$deficits/M1$_{t-j}$ is the summation of the coefficients of deficits.

Table 7
The DPQR results with the deficit-to-GDP ratio.

Dependent variable: inflation										
	DGMM	Quantile								
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Intercept	0.0227***	1.4299	1.4375	1.4399	1.4431	1.4470	1.4501	1.4562	1.4559	1.4753
	(0.0072)	(4.9387)	(4.9386)	(4.9386)	(4.9385)	(4.9385)	(4.9384)	(4.9382)	(4.9379)	(4.9385)
Inflation$_{t-1}$	0.6680***	0.2130	0.2550**	0.3227***	0.3684***	0.3813***	0.4174***	0.4271***	0.5696***	0.6119***
	(0.0149)	(0.1319)	(0.1073)	(0.1097)	(0.1093)	(0.1113)	(0.1228)	(0.1512)	(0.1951)	(0.2049)
$\sum_{j=0}^{3}$deficits/GDP$_{t-j}$	0.3516***	0.1176***	0.1443***	0.1661***	0.1591***	0.1575***	0.1569***	0.1723***	0.2619***	0.3858**
	(0.0444)	(0.0442)	(0.0402)	(0.0384)	(0.0386)	(0.0408)	(0.0481)	(0.0617)	(0.1015)	(0.1725)
$\sum_{j=0}^{3}$growth$_{t-j}$	−0.4882***	−0.0893	−0.1298*	−0.1734**	−0.1977**	−0.2378**	−0.3140***	−0.3985***	−0.5360***	−0.7463***
	(0.1161)	(0.0852)	(0.0763)	(0.0801)	(0.0835)	(0.0933)	(0.1053)	(0.1318)	(0.1626)	(0.2111)
$\sum_{j=0}^{3}$oil price inflation$_{t-j}$	0.0995***	0.1389***	0.1725***	0.1924***	0.2193***	0.2529***	0.2935***	0.3409***	0.4441***	0.6094***
	(0.0149)	(0.0255)	(0.0275)	(0.0275)	(0.0305)	(0.0379)	(0.0494)	(0.0653)	(0.0877)	(0.0877)
$\sum_{j=0}^{3}$openness$_{t-j}$	−0.0557***	−0.0140	−0.0189*	−0.0218**	−0.0246**	−0.0264**	−0.0264**	−0.0284**	−0.0266**	−0.0287
	(0.0195)	(0.0122)	(0.0110)	(0.0108)	(0.0110)	(0.0110)	(0.0110)	(0.0113)	(0.0128)	(0.0196)

Standard errors in parenthesis. ***, ** and * indicate the significant level of 1%, 5% and 10% respectively. Instrumental variable $\Delta\pi_{it-1}$ is used in the DPQR model. Instrumental variables π_{it-l}, $l \geq 2$ are used in the DGMM model with estimates represented as DGMM. $\sum_{j=0}^{3}$deficits/M1$_{t-j}$ is the summation of the coefficients of deficits.

Table 8
The DPQR results with the deficit-to-GDP ratio.

Dependent variable: inflation										
	DGMM	Quantile								
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Intercept	0.0074	0.1865	0.1803	0.1774	0.1765	0.1741	0.1730	0.1757	0.1820	0.1909
	(0.0075)	(4.6103)	(4.6104)	(4.6102)	(4.6103)	(4.6102)	(4.6102)	(4.6103)	(4.6104)	(4.6105)
Inflation$_{t-1}$	0.5609***	0.2096*	0.3301***	0.3805***	0.4271***	0.4938***	0.5474***	0.5366***	0.4829***	0.5378***
	(0.0190)	(0.1223)	(0.1146)	(0.1183)	(0.1092)	(0.1095)	(0.1107)	(0.1122)	(0.1195)	(0.1667)
$\sum_{j=0}^{3}$deficits/GDP$_{t-j}$	0.2333***	0.1037***	0.1163***	0.1368***	0.1459***	0.1432***	0.1493***	0.1559***	0.1805***	0.1814**
	(0.0470)	(0.0381)	(0.0369)	(0.0342)	(0.0337)	(0.0361)	(0.0381)	(0.0432)	(0.0581)	(0.0850)
$\sum_{j=0}^{3}$money growth$_{t-j}$	0.3161***	0.1734**	0.3258***	0.4119***	0.5091***	0.5921***	0.6802***	0.7491***	0.8242***	0.9060***
	(0.0278)	(0.0746)	(0.0761)	(0.0775)	(0.0882)	(0.0965)	(0.0953)	(0.0880)	(0.0925)	(0.1262)
$\sum_{j=0}^{3}$growth$_{t-j}$	−0.4975***	−0.0421	−0.1762**	−0.2586***	−0.3975***	−0.4618***	−0.5438***	−0.6182***	−0.7320***	−0.8990***
	(0.1210)	(0.0789)	(0.0779)	(0.0822)	(0.0829)	(0.0898)	(0.0965)	(0.0905)	(0.0985)	(0.1314)
$\sum_{j=0}^{3}$oil price inflation$_{t-j}$	0.0392**	0.1144***	0.1197***	0.1313***	0.1371***	0.1478***	0.1480***	0.1540***	0.1791***	0.2064***
	(0.0178)	(0.0181)	(0.0161)	(0.0133)	(0.0142)	(0.0138)	(0.0140)	(0.0165)	(0.0273)	(0.0543)
$\sum_{j=0}^{3}$openness$_{t-j}$	−0.0348*	−0.0261**	−0.0260**	−0.0239**	−0.0249**	−0.0257**	−0.0260**	−0.0244**	−0.0221**	−0.0207*
	(0.0203)	(0.0104)	(0.0102)	(0.0100)	(0.0101)	(0.0102)	(0.0102)	(0.0098)	(0.0101)	(0.0123)

Standard errors in parenthesis. ***, ** and * indicate the significant level of 1%, 5% and 10% respectively. Instrumental variable $\Delta\pi_{it-1}$ is used in the DPQR model. Instrumental variables π_{it-l}, $l \geq 2$ and are used in the DGMM model with estimates represented as DGMM. $\sum_{j=0}^{3}$deficits/M1$_{t-j}$ is the summation of the coefficients of deficits.

highly significant and increase along with quantiles, and so inflation is a monetary phenomenon. The deficit–inflation relationship is robust to the inclusion of money growth, whereas fiscal deficits are still inflationary when the inflation equation controls for the money growth rate. Interestingly, the results of deficits remain inflationary after controlling for the effect of money growth, which shows that inflation is at least equally a fiscal phenomenon.

5. Conclusions

The macroeconomic theory of Catão and Terrones (2005) suggests that the deficit–inflation relationship varies across countries with disparate inflation levels. Catão and Terrones argue that a suitable model should be capable of accommodating the non-linearity, and proper econometric techniques are required. This paper applies the DPQR model for an ARDL specification and examines the relationship between deficits and inflation. By exploiting an extensive panel data set, the results show that the deficit–inflation relationship is strong in high-inflation episodes, and weak in low-inflation episodes. The results imply that fiscal deficits are more inflationary the higher the inflation rate is because of faster money creation when inflation is higher. Thus, we can infer that the DPQR model shows a heterogeneous and non-linear relationship between inflation and deficits and can accommodate key features of the theory of Catão and Terrones without sample selection bias. The model supports the view that persistent fiscal deficits are inflationary in high- and middle-inflation economies and is less inflationary in low-inflation economies. The relationship between inflation and deficits becomes more convincing using the DPQR model for an ARDL specification.

Acknowledgement

We would like to thank the editor and two referees for very useful suggestions. The paper also benefited from data from Dr. Raj M. Desai and comments by Professor Shiu-Sheng Chen. All remaining errors are ours.

Appendix. List of countries

Argentina*	Fiji	Malaysia*	Rwanda
Australia* †	Finland* †	Maldives	Seychelles
Austria* †	France* †	Mali*	Sierra Leone
Bahamas*	Germany** †	Malta*	Singapore*
Bahrain	Ghana*	Mauritius*	South Africa*
Barbados*	Greece* †	Mexico*	Spain* †
Belgium* †	Guatemala*	Morocco*	Sri Lanka*
Bolivia*	Guyana*	Myanmar*	Swaziland*
Burkina Faso*	Haiti*	Nepal*	Sweden* †
Burundi*	Honduras*	Netherlands* †	Switzerland* †
Canada* †	Hungary* †	New Zealand* †	Syria*
Chad*	Iceland* †	Nicaragua*	Tanzania*
Chile*	India*	Nigeria*	Thailand*
China*	Indonesia*	Norway* †	Trinidad
Colombia*	Iran*	Oman	& Tobago
Costa Rica*	Ireland* †	Pakistan*	Tunisia*
Cyprus*	Israel*	Panama*	Turkey*
Denmark* †	Italy* †	Papua New Guinea	Uganda*
Dominican Rep.*	Japan* †	Paraguay*	United Kingdom* †
Ecuador*	Jordan*	Peru*	United States* †
Egypt*	Kenya*	Philippines*	Uruguay*
El Salvador*	Korea* †	Portugal* †	Venezuela*
Ethiopia	Malawi*	Romania*	Zambia*

Note 1. * indicates the countries with data of exchange rate regime.
Note 2. Countries with † are OECD countries; Countries without † are non-OECD countries.

References

Ahking, F.W., Miller, S.M., 1985. The relationship between government deficits, money growth and inflation. Journal of Macroeconomics 7 (4), 447–467.

Aisen, A., Veiga, F.J., 2008. The political economy of seigniorage. Journal of Development Economics 87 (1), 29–50.

Alesina, A., Summers, L.H., 1993. Central bank independence and macroeconomic performance: some comparative evidence. Journal of Money, Credit and Banking 25 (2), 151–162.

Alfaro, L., 2005. Inflation, openness, and exchange-rate regimes: the quest for short-term commitment. Journal of Development Economics 77 (1), 229–249.

Arellano, M., Bond, S., 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Review of Economic Studies 58 (2), 277–297.

Ball, L., Mankiw, N.G., 1995. Relative-price changes as aggregate supply shocks. Quarterly Journal of Economics 110 (1), 161–193.

Barnhart, S.W., Darrat, A.F., 1988. Budget deficits, money growth and causality: further OECD evidence. Journal of International Money and Finance 7 (2), 231–242.

Barro, R., 1970. Inflation, the payments period, and the demand for money. Journal of Political Economy 78 (6), 1228–1263.

Blanchard, O., Fischer, S., 1989. Lectures on Macroeconomics. MIT Press, Cambridge, MA.

Calvo, G.A., Végh, C.A., 1999. Inflation stabilization and BOP crises in developing countries. In: Taylor, J.B., Woodford, M. (Eds.), 1999. Handbook of Macroeconomics, vol. C, pp. 1531–1614. North-Holland, Amsterdam.

Catão, L.A.V., Terrones, M.E., 2005. Fiscal deficits and inflation. Journal of Monetary Economics 52 (3), 529–554.

Click, R.W., 1998. Seigniorage in a cross-section of countries. Journal of Money, Credit and Banking 30 (2), 154–163.

Cochrane, J.H., 2001. Long-term debt and optimal policy in the fiscal theory of the price level. Econometrica 69 (1), 69–116.

Cochrane, J.H., 2005. Money as stock. Journal of Monetary Economics 52 (3), 501–528.

Cottarelli, C., Griffiths, M.E.L., Moghadam, R., 1998. The Nonmonetary Determinants of Inflation: A Panel Data Study. IMF Working Paper, No. 98/23.

Darrat, A.F., 1985. Inflation and federal budget deficits: some empirical results. Public Finance Review 13 (2), 206–215.

De Haan, J., Zelhorst, D., 1990. The impact of government deficits on money growth in developing countries. Journal of International Money and Finance 9 (4), 455–469.

Desai, R.M., Olofsgård, A., Yousef, T.M., 2003. Democracy, inequality, and inflation. American Political Science Review 97 (3), 391–406.

Domaç, I., Yücel, E.M., 2005. What triggers inflation in emerging market economies? Review of World Economics 141 (1), 141–164.

Dwyer, G.P., 1982. Inflation and government deficits. Economic Inquiry 20 (3), 315–329.

Elmendorf, D.W., Mankiw, N.G., 1999. Government debt. In: Taylor, J.B., Woodford, M. (Eds.), 1999. Handbook of Macroeconomics, vol. C, pp. 1615–1669. North-Holland, Amsterdam.

Fatás, A., Rose, A., 2001. Do monetary handcuffs restrain leviathan? Fiscal policy in extreme exchange rate regimes. IMF Staff Papers 21, 40–61.

Fischer, S., Sahay, R., Végh, C.A., 2002. Modern hyper- and high inflations. Journal of Economic Literature 40 (3), 837–880.

Ghosh, A., Gulde, A.-M., Ostry, J.D., Wolf, H., 1997. Does the Nominal Exchange Rate Regime Matter?. NEBR Working Papers 5874.

Giannaros, D.S., Kolluri, B.R., 1986. Deficit spending, money, and inflation: some international empirical evidence. Journal of Macroeconomics 7 (3), 401–417.

Hamburger, M.J., Zwick, B., 1981. Deficits, money and inflation. Journal of Monetary Economics 7 (1), 141–150.

Im, K.S., Pesaran, M.H., Shin, Y., 2003. Testing for unit roots in heterogeneous panels. Journal of Econometrics 115 (1), 53–74.

Karras, G., 1994. Macroeconomics effects of budget deficit: further international evidence. Journal of International Money and Finance 13 (2), 190–210.

King, R.G., Plosser, C.I., 1985. Money, deficits, and inflation. Carnegie-Rochester Conference Series on Public Policy 22 (1), 147–196.

Koenker, R., 2004. Quantile regression for longitudinal data. Journal of Multivariate Analysis 91 (1), 74–89.

Komulainen, T., Pirttilä, J., 2002. Fiscal explanations for inflation: any evidence from transition economies? Economics of Planning 35 (3), 293–316.

Kwon, G., McFarlane, L., Robinson, W., 2009. Public debt, money supply, and inflation: a cross-country study. IMF Staff Papers 56 (3), 476–515.

Lane, P.R., 1997. Inflation in open economies. Journal of International Economics 42 (3), 327–347.

Leeper, E.M., 1991. Equilibria under 'active' and 'passive' monetary and fiscal policies. Journal of Monetary Economics 27 (1), 129–147.

Leeper, E.M., Yun, T., 2006. Monetary-fiscal policy interactions and the rice level: background and beyond. International Tax and Public Finance 13 (4), 1573–6970.

Levin, A., Lin, C.F., Chu, C.S., 2002. Unit root tests in panel data: asymptotic and finite-sample properties. Journal of Econometrics 108 (1), 1–24.

Lin, H.Y., 2011. Dynamic Panel Quantile Regression with an Application to Deficit and Inflation. Working Paper.

Loungani, P., Swagel, P., 2003. Sources of inflation in developing countries. In: Razin, A., Helpman, E., Sadka, E. (Eds.), Economic Policy in the International Economy: Essays in Honor of Assaf Razin. Cambridge University Press, Cambridge, pp. 207–232.

McCallum, B.T., 2001. Indeterminacy, bubbles, and the fiscal theory of price level determination. Journal of Monetary Economics 47 (1), 19–30.

Metin, K., 1998. The relationship between inflation and the budget deficit in Turkey. Journal of Business and Economic Statistic 16 (4), 412–422.

Minford, P., Peel, D., 2002. Advanced Macroeconomics: A Primer. Edward Elgar, Cheltenham.

Mitchell, B.R., 2007a. International Historical Statistics: Europe 1750–2005, sixth ed. Macmillan, London.

Mitchell, B.R., 2007b. International Historical Statistics: The Americas 1750–2005, sixth ed. Macmillan, London.

Mitchell, B.R., 2007c. International Historical Statistics: Africa, Asia and Oceania 1750–2005, fifth ed. Macmillan, London.

Protopapadakis, A.A., Siegel, J.J., 1987. Are money growth and inflation related to government deficits? Evidence from ten industrialized economies. Journal of International Money and Finance 6 (1), 31–48.
Reinhart, C.M., Rogoff, K.S., 2004. The modern history of exchange rate arrangements: a reinterpretation. Quarterly Journal of Economics 119 (1), 1–48.
Romer, D., 1993. Openness and inflation: theory and evidence. Quarterly Journal of Economics 108 (4), 869–903.
Sargent, T.J., Wallace, N., 1981. Some unpleasant monetarist arithmetic. Federal Reserve Bank of Minneapolis Quarterly Review 5, 1–17.
Sim, C.A., 1994. A simple model for study of the determination of the price level and the interaction of monetary and fiscal policy. Economic Theory 4 (3), 381–399.
Tornell, A., Velasco, A., 2000. Fixed versus flexible exchange rates: which provides more fiscal discipline? Journal of Monetary Economics 45, 399–436.
Woodford, M., 1994. Monetary policy and price level determinacy in a cash-in-advance economy. Economic Theory 4 (3), 345–380.
Woodford, M., 1995. Price-level determinacy without control of a monetary aggregate. Carnegie-Rochester Conference Series on Public Policy 43 (1), 1–46.
Woodford, M., 2001. Fiscal requirements for price stability. Journal of Money, Credit and Banking 33 (3), 669–728.