Imperfect Competition, Controls on Capital Inflows, and the Phillips Curve: Experiences from Taiwan and Brazil

Yi-Chi Chen and Fuhmei Wang

Department of Economics
National Cheng Kung University

Abstract

Based on a two-country model, incorporating imperfect competition, country sizes, and controls on capital inflow, this research investigates the trade-off between inflation and unemployment rates. We find that the slope of the Phillips curve increases with the degrees of substitution between goods, the intensity of capital controls but decreases with the country size of domestic country. Especially, when domestic economy is absolutely large, controls on capital inflow might bring stagflation. Based on country experiences of Taiwan and Brazil, from 1989 to 2000, the empirical evidence lends support to our analytical results. With the constructed capital control index, we estimate the effects of capital control intensity on the slope of the Phillips curve over time. Regression results further establish the robustness of our theoretical validity. In that sense, this work provides a new insight into the effects of controls on capital inflows on macroeconomic performance in the context of the Phillips curve

Keywords: Imperfect competition, Controls on capital inflows, Country sizes, the Phillips curve.

JEL classification: F32, F41

Correspondence to: Yi-Chi Chen, Department of Economics, National Cheng Kung University, Tainan, Taiwan 701, R.O.C. TEL: 06-2757575 ext. 50228, FAX: 06-2766491, E-mail address: yichi@ncku.edu.tw. The financial supports from National Science Council in Taiwan, under Contract NSC93-2415-H-006-003, NSC92-2415-H-006-003 are herewith gratefully acknowledged.

1. Introduction

The primary goal of government's macroeconomic policy is to stabilize inflation rate and to decrease unemployment rate. The unemployment rate reflects a country's output. When output is below expected output or the full-employment level, the unemployment is expected to occur. A moderate inflation rate is beneficial to economic growth because it provides investors profitable incentives and hence spurring investment. Based on the job market in UK from 1861 to 1957, the economist, A. W. Phillips, had put forward the substitution between changes of nominal wage rate and unemployment rate, also known as the Phillips curve.

Lucas (1973) and Ball (1994) examined the effect of several factors on the tradeoff between the inflation and the unemployment in the Phillips curve, within the new classical and the new Keynesian framework, respectively; however, they are still limited to a closed economy. In a closed economy, the tradeoff relationship depends on factors such as aggregate demand and expected inflation rate. In the recent literature, Ghironi and Giavazzi (1998) extended to an open economy setup to investigate the changes in the slope of the Phillips curve, specifically, they explored if the country size affects the substitution between nominal wage and unemployment rates in the Phillips curve. They concluded that, in a relatively small economy, the flatter the slope of the Phillips curve is, the larger the tradeoffs between nominal wage rate and unemployment rate is.

The majority of the existing literature has only focused on the impact of the capital controls on either the inflation rate, or unemployment rate exclusively. Leung and Zhang (2000) have pointed out that in a small open economy, the rising price level tends to increase taxes on capital gains. Gruben and McLeod (2002) studied the relationship between the openness of the capital account and inflation rate. Their empirical evidence shows that a more liberal capital account could curb inflation rate. With country experiences of temporary capital inflow controls, Reinhart and Smith (2002) evaluated the impact and the effectiveness of capital controls on macroeconomy. They suggested that capital inflow taxes should only be imposed when the domestic interest rate is relatively higher than the foreign level as well as the tax rate is fairly high; such controls are less detrimental to the domestic real economy.

The research on the relationship between capital controls and the slope of the Phillips curve is scarce. Loungain, Razin and Yuen (2001) considered that the

degrees of the capital mobility on the slope of the curve and discovered that the perfect capital controls make the Phillips curve steeper. Razin and Yuen (2002) based on the new Keynesian model with imperfect competition to consider if capital mobility in goods determines the slope of a Phillips curve. Their theoretical framework predicts that an open economy is expected to have a smooth Phillips curve. In the sense that the improvement of the unemployment situation via a higher inflation rate can be effective. Their study provided the basis for macroeconomic policy making in both a close and an open economy. On the other hand, their analytical framework does not consider several potentially important factors that could also affect the slope of a Phillips curve, such as distinction between controls on capital inflows and outflows, the intensity of capital controls, the country size.

A government in favor of stabilizing inflation should deliberate the policy which makes a Phillips curve steeper. This study aims to address the role of the capital controls in the tradeoff between inflation rate and unemployment rate. In particular, the direction of capital controls is specifically differentiated to analyze its impact on a Phillips curve. Specifically, the capital controls here are defined as the taxes that the government imposes on interest income earned by foreigners from domestic bond purchases, that is, exercising restraints on capital inflows.

Unlike most of existing literature that mainly studies on a single open economy, we attempt to conduct a broader analysis by extending to a two-country model and further incorporating the imperfect competition framework which has been paid much attention to in open macroeconomics theory since the 1980s. Thus, we will look into the factors pertinent to unemployment such as consumers' preference, imperfect competition in goods market, the strength of capital controls, as well as the size of a country. Our results should shed light on shaping policy for regional cooperation and coordination between economies. In general, this research combines theoretical analysis, numerical examples, along with country historical data to investigate the effects of capital inflow controls on the substitution between inflation rate and unemployment rate in order to fill the gap in the literature only with either theoretical or empirical analysis.

This paper is organized as follows. Section 2 details a theoretical model to discuss the significance of capital inflow controls in the context of a Phillips curve. Section 3 provides numerical examples associated with our theoretical predictions. Section 4 presents our empirical findings based on the country experiences. Section

5 offers concluding remarks.

2. The Theoretical Model

Based on a two-country, one differentiated good, and monopolistic competition model, there exists capital control on capital inflow in domestic economy. Domestic government taxes interest income on foreigners holding domestic bonds. The cost of capital control increases with the control degrees. The economy consists of both household and government sectors. The economy is a capital-inflow country or a debtor. Population distribution is standardized and j represents both individuals and products distributed over the range [0,1]. The interval [0, n] is the distribution of domestic household; (n, 1) is the distributions of foreign household. The bigger the n, the bigger the domestic country size is. Households provide labor to produce the products. The household derives utility from consumption and production.

$$\sum_{s=t}^{\infty} \delta^{s-t}[(C_s - \gamma C_{s-1}) - \frac{1}{2}\mu(y_s - \gamma y_{s-1})^2] \qquad \gamma \in [0,1] \qquad (1)$$

Consumers maximize the discounted utility; γ is the preference parameter.[1] When γ is equal to 1, the consumer's utility obtains from the changes in the related variables exclusively. When γ is equal to 0, consumer's utility comes from the current level of consumption wholly. Generally, the parameter is between 0 and 1. The first item in the utility function comes from intertemporal consumption, and $C_s - C_{s-1} = (1-\gamma)C_s + \gamma(C_s - C_{s-1})$. The representative consumer pursues the maximum of the average of the level and the variation of consumption. The second item in the utility function presents negative utility, since consumers put labor into product. The parameter μ presents productive parameter. Negative utility increases with the product. The parameter δ in equation (1) describes households' time preference and the discounting rate for future utility. Foreign economy has analogously behavior and with "*" in relevant variables. We assume labor is the only input of product. Consider goods market is imperfect competition, the first item of consumption index of utility function follows the definition of Obstfeld and Rogoff (1995):

$$C = \left[\int_0^1 c(j)^{\sigma} dj\right]^{\frac{1}{\sigma}}, \ 0 < \sigma < 1 \qquad (2)$$

[1] For the construction and the significance of consumers' preference, refer to Gruber (2004).

In equation (2), $c(j)$ presents the household j's consumption; C is the consumption index; σ presents the substitution elasticity between goods. Because of the symmetry in households, the domestic consumption price index P can be represented by equation (3). The corresponding consumption price index P^* in foreign economy is given by equation (4).

$$P = \left[\int_0^1 p(j)^{\frac{1}{\theta}} dj \right]^{\theta} = \left\{ \int_0^n p(j)^{\frac{1}{\theta}} dj + \int_n^1 \left[Ep^*(j) dj \right]^{\frac{1}{\theta}} \right\}^{\theta} \quad (3)$$

$$P^* = \left[\int_0^1 p^*(j)^{\frac{1}{\theta}} dj \right]^{\theta} \quad (4)$$

In equations (3) and (4), $p(j)$ is domestic output price and $p^*(j)$ is foreign output price. The law of one price holds for consumer price index. The demand function of domestic households is then solved as:

$$c_t(j) = C_t[P_t / p_t(j)]^{1/1-\sigma} \qquad j \in [0, n] \quad (5)$$

The demand function of foreign households is solved as:

$$c_t^*(j) = C^*{}_t[P_t^* / p_t^*(j)]^{1/1-\sigma} \qquad \mathrm{j} \in [n, 1] \quad (6)$$

Consumers pursue the discounted utility maximization but are subject to the following budget constraint:

$$-P_t b_t = p_t y_t - P_t C_t - P_t \tau_t - P_{t-1} i_{t-1} b_{t-1} \quad (7)$$

In equation (7), τ denotes the real lump-sum taxes that consumers pay to domestic government. After deducting consumption expenditure, lump-sum tax, and the interest payment to foreigners from output revenue, the domestic economy still needs capital inflows, being loans from foreign country. Government expenditure,

including government consumption expenditure and implementation cost on capital inflows, is financed through lump-sum taxes and taxation on interest income of foreigners holding domestic bonds. From equation (8) below, φ is an index of capital controls and the condition, $0 \le \varphi \le 1$, holds. When φ is equal to 0, capital mobility is free. When φ is equal to 1, no capital inflows are allowed. Government preferences are the same as those of consumers. Combining private and governments' demand functions, we get the world demand for domestic good *j*:

$$y_t^d(j) = \left(\frac{p_t}{P_t}\right)^{\frac{1}{\sigma-1}} \left(C_t^w + G_t^w\right) \tag{9}$$

In equation (9), C^W is the world private demand, and G^W is the world government demand. Similarly, the world demand for foreign goods is:

$$y_t^{*d}(j) = \left(\frac{p_t^*}{P_t^*}\right)^{\frac{1}{\sigma-1}} \left(C_t^w + G_t^w\right) \tag{10}$$

Equations (1) to (10) construct the theoretical model. The policy implications of capital controls on the tradeoffs between employment and inflation along with empirical studies of country experiences from Taiwan and Brazil are based on this structure. Combining the consumer's utility function with its budget constraint, the optimal condition of domestic economy includes equations (11) to (14) and the consumer's budget constraint.

$$C_{t+1} = \frac{\delta(1+r_t)}{1+\gamma\delta(1+r_t)} C_t \tag{11}$$

$$C_{t+1}^* = \frac{\delta(1+r_t)}{1+r\delta(1+r_t)} C_t^* \tag{12}$$

$$\mu y_t = C_t^{-1} \frac{p_t}{P_t} (1-\gamma)^{-1} \tag{13}$$

$$\mu y^*_t = C^*_t{}^{-1} \frac{p^*_t}{P^*_t} (1-\gamma)^{-1} \tag{14}$$

In absence of inflation rate and capital inflows, per capita output as well as per capita

consumption in the static equilibrium are solved, being used t-1, t, t+1 as the initial condition, short-run, and long-run, respectively.

$$\bar{y} = \bar{y}^* = \mu(1-\gamma)^{-\frac{1}{2}}$$

$$\overline{C} = \frac{\overline{p}}{\overline{P}}\bar{y} - \overline{G}$$

$$\overline{C}^* = \frac{\overline{p}^*}{\overline{P}^*}\bar{y}^* - \overline{G}^*$$

Now what we are interested in is how capital controls affect the slope of the Phillips curve. Assuming that consumers enter the economy in period t and the output prices are sticky, after linearization and differentiating equations (3), (4), (7)-(10), and the world private demand function, we get:

$$\hat{P} = \pi = (1-n)\hat{E} \tag{15}$$

$$\hat{P}^* = \pi^* = -n\hat{E} \tag{16}$$

$$\hat{C} = \hat{y} - \pi - (\varphi - 1)\hat{b} \tag{17}$$

$$\hat{C}^* = \hat{y}^* - \pi^* - \hat{b} \tag{18}$$

$$\hat{y} = \frac{\pi}{1-\sigma} + \hat{C}^W \tag{19}$$

$$\hat{y}^* = \frac{\pi^*}{1-\sigma} + \hat{C}^W \tag{20}$$

$$\hat{C}^W = n\hat{C} + (1-n)\hat{C}^* \tag{21}$$

Then, the dynamic system is composed of seven equations to solve the seven variables, $\hat{E}$, $\hat{C}$, $\hat{C}^*$, $\hat{y}$, $\hat{y}^*$, $\hat{b}$ and $\hat{C}^W$. Among them, the "^" above any variable stands for the short-run changes deviating from long-run equilibrium. Following Loungain, Razin and Yuen (2001), define the unemployment as the deviation of current output from full-employment output, the output in period t-1. Incorporating the rigidity of output prices and the rational expectations, from the above dynamic system, we obtain the schedule of the Phillips curve as:

$$u = 2\left\{ n - 1 - \frac{1}{1-\sigma}\left[1 - \frac{1-\varphi}{2(2-\varphi)(1-n)} \right] \right\} \pi \qquad (22)$$

Thus, the slope of the Phillips curve can be affected by controls of capital inflows through the following channels. Consumption of domestic household decreases as capital inflows diminish. Controls on capital inflows cause the supply of foreign currency to drop, which in turn results in the depreciation of domestic currency. The level of consumption index and the inflation rate of domestic economy increases. From equation (22), we learn that the slope of the Phillips curve increases with the degrees of capital controls and the substitution elasticity between goods, but decreases with the size of domestic economy. In other words, to effectively raise the tradeoffs between unemployment and inflation rates only when the goods market approaches monopoly, or the degrees of capital controls lessen, or the domestic economy is small as opposed to the foreign economy. Finally, our analytical results can further be verified from numerical examples as well as country experiences of Taiwan and Brazil.

3. The Impact of Capital Inflow Controls on the Slope of the Phillips Curve: Numerical Examples.

Equation (22) implies that the slope of a Phillips curve varies with the substitution rate between goods, the country size, and the strength of capital inflow controls. Thus, in the presence of capital controls, the tradeoffs between inflation rate and unemployment rates will be changed, which is graphically illustrated in figure 1:

[place Figure 1 here]

To better understand the relationship in the effects on the slope of a Phillips curve for a given parameter of a core variable, numerical examples are presented with a set of proper values. First, when the home country is relatively small, or $n = 0.4$, and the strength of capital controls assumes to be $\varphi = 0.5$, as shown in figure 2, the slope of a Phillips curve increases with the degrees of goods substitution. In other words, for a given country size and the magnitude of capital controls, only if the

goods market becomes imperfectly competitive can a government policy be effective to alter the relationship between employment and inflation by capital inflow controls. Second, with a modest rate of capital controls and goods substitution, e.g., $\varphi = 0.5$, $\sigma = 0.1$, the capital inflow controls installed would flatten a Phillips curve as the scale of the home economy enlarges; i.e., the bigger substitution relationship between inflation rate and unemployment rate. However, figure 3 also indicates that if the home country is absolutely large, $n \geqq 0.9$, imposition of capital inflow controls may lead to stagflation. Third, suppose that the country is relatively small with monopolistic competition of goods market, or $n = 0.4$, $\sigma = 0.1$, the more intense capital inflow controls are, the steeper a Phillips curve is, as is displayed in figure 4. In summary, these numerical examples along with graphical demonstrations of figures 2 to 4 lead to the conclusion that if a government wishes to maneuver the relationship between unemployment and inflation through the measures of capital controls, such policies are expected to be effective only when the domestic market is large and its country scale reaches to the degrees given in the second example, or the goods market is highly monopolistic, or the restrictions of capital mobility are low. In particular, if the government highly regulates capital inflows, and hence the value of φ is bigger, a Phillips curve tends to be steeper, which brings about a smaller substitution relationship between inflation rate and unemployment rate. If a policy maker aims to improve the job-loss situation, then a flatter Phillips curve should be desirable, to some extent that that the unemployment can be improved substantially at the expense of inflation.

[place Figures 2 to 4 here]

On the basis of theoretical predictions and numerical examples, the following proposition can be made:

Proposition 1: With the imperfect competition of goods market, the measure of capital inflow controls is considered to be effective to vary the tradeoffs implied by the Phillips curve if the goods market is highly monopolistic, or capital inflow controls are less stringent, or the country size is relatively larger. Furthermore, when the country size is significantly large, such as $n \geqq 0.9$, the imposition of the capital inflow controls will adversely bring about stagflation.

4. Empirical Findings

From theoretical analysis and numerical examples, we learn that controls on capital inflows may result in changes of the tradeoffs between unemployment rate and inflation rate. In this section, we use the cases of Taiwan and Brazil that are closely fit the profiles of our analytical framework to examine our theoretical predictions.[2] For example, Taiwan had completely lifted the controls on capital inflows after January 1991 as foreign institutional investors were allowed to directly invest the stock market. Thus, it is desirable to use the Taiwan's data before and after capital inflow controls to explore the impact of capital controls on a Phillips curve. We begin with summary of the time-series characteristics of the variables of interest, and then empirically corroborate the theoretical propositions with a regression model.

4.1. Econometric Model

To further verify the theoretical predictions developed in this study and to determine the macroeconomic variables those related to the Phillips curve, we use a linear regression model as the basis of econometric analysis. Equation (22) suggests that unemployment rate (u) is a function of the elasticity of goods substitution (σ), country size (n), capital control index (φ), and inflation rate (π). Suppose the elasticity of goods substitution remains unchanged in the short-run, the country experiences can be employed to analyze the effects of the intensity of capital inflow controls on the slope of a Phillips curve. Accordingly, the regression model for empirical analysis can be written as:

$$u_t = \beta_0 + \beta_1 \pi_t + \beta_2 \varphi_t + \kappa \left(\pi \times \varphi\right)_t + \varepsilon_t, \quad t = 1, 2, \ldots, T, \tag{23}$$

In equation (23), β_0 is constant , β_i , i = 1,2 and κ is the slope coefficients, ε_t is the random error in time t, it is assumed that equation (23) satisfies the ideal conditions of the classical linear regression model.

In particular, in order to estimate the impact of capital control strength on the

[2] We also explore Chile's macroeconomic data for empirical analysis, but there's obvious structural changes detected in the series, which is not appropriate to estimate by a linear regression model. Thus, the results are not listed.

slope of a Phillips curve, we use inflation rate and capital control index as an interaction term ($\pi \times \varphi$) to capture such an effect. From equation (22), the parameter k is expected to be negative as the impact of capital controls on the slope of a Phillips curve is given by:

$$\frac{\partial^2 E(u)}{\partial \pi \partial \varphi} = \kappa \tag{24}$$

Equation (24) implies that as the degrees of capital controls increase, the slope of a Phillips curve increases. In other words, the more stringent capital controls are, the steeper the curve is.

4.2. Data Source

The data used in this study mainly retrieve from the AREMOS database for Taiwan's macroeconomic variable, and Brazil country data are taken from Datastream. The data range from January 1989 to December 2000, amounting to 144 monthly observations. In accord with the specification in equation (23), the variables include unemployment rate (u_t), inflation rate calculated by the consumer price index (π_t), and the complied capital control index (φ_t).

To properly present the development of capital inflow controls within a country over time, we have to resort to an appropriate measure as the proxy of the capital controls. Specifically, we will use the capital control index constructed by Edison and Warnock (2003) for our empirical analysis. The methodology and significance of the index will be briefly explained in the next section. The main descriptive statistics of each variable are summarized in Table 1.

[place Table 1 here]

4.3. Capital Control Index

Edison and Warnock (2003) compiled the capital control index for 29 emerging markets including Taiwan and Brazil. The monthly measure is based on restrictions on foreign ownership of equities imposed by the country of interest during 1989 to 2001. To the extent that the index reflects the intensity and the content of capital controls during the period.

Edison and Warnock (2003) criticized that the common practice to construct capital control index is to rely on dichotomy of occurrence of capital controls with qualitative dummy variables. Alternatively, treating financial market liberalizations as the one-time events or structural changes. Neither can properly describe the intensity of constraints or regulations on capital mobility. In contrast, Edison and Warnock proposed a better measure of capital controls from Global index (IFCG) and Investable index (IFCI) maintained by Standard and Poor's/International Finance Corporation (SP/IFC). Basically, the ratio of these two indices for a particular country gives the proportion of the equity market available to foreign investment, and hence 1 minus the ratio indicates the strength of capital inflow controls. When the figure is closer to 1 the portion of the equities that foreigners can own is smaller; that is, the intensity of capital inflow controls and the extent of limitations is rising. IFCG and IFCI are under monthly reviews of a country's restrictions on foreign investment. Thus, the capital inflow control index constructed by Edison and Warnock not only reflects the degrees of capital liberalizations of each country, but also its developments over time. In order to deal with the relative price changes induced by asymmetric effect of restrictions across sectors, Edison and Warnock also adjust the measure to account for such price shocks.

In the case of Taiwan, since 1983 the government allowed foreigner indirectly invest in stock market, Taiwan has gradually loosened its controls on capital account and foreign exchange in the following ten years. Until January 1991 foreign institutional investors can invest directly in the stock market.[3] For Brazil, the country was plagued by sustained inflation in early 1990s. In the meantime, in order to curb government deficits, the interest rate differential continues to rise. Because of the influx of the short-term foreign capital, Brazil's government initiated a series of capital control policies from 1993 to 1997.[4] The progression of capital liberations facilitates us to evaluate the impact of capital inflow controls on the slope of a Phillips curve. Figure 2 shows the capital control indices traced from the developments of financial liberalizations in Brazil and Taiwan from 1989 to 2000.

[3] The evolutions of financial system in Taiwan after 1976, refer to the following website: http://www.duke.edu/~charvey/Country_risk/chronology/taiwan.htm

[4] The background and the details about the regulations in Brazil are summarized in Ariyoshi et al. (2000).

[place Figure 5 here]

Several salient features of the trends can be seen in Figure 5. First, Taiwan was highly regulated on capital inflows in 1989 before it officially removed the restrictions gradually after 1991. Second, although Taiwan was in the progress of gradual liberalization plans, the unexpected shocks from the Asian financial crisis in 1997/1998 had accelerated the speed of Taiwan's financial liberalizations. Third, the movement of unadjusted and adjusted indices for Taiwan is almost identical, which implies the capital inflow restrictions do not discriminate across sectors. The impact of the economy as a whole is uniform, and hence the (unadjusted) capital control index for Taiwan's market is free of asymmetric price shocks. Likewise, figure 5 also shows that the South American countries, such as Brazil, had started earlier to liberalize its capital account with a strong and comprehensive approach.

4.4. Regression Results

We apply the country data to a regression model in which the effects of capital controls can be measured, and table 2 summarizes the estimated results. We attempt to evaluate the effectiveness of capital controls in the context of the Phillips curve, and the results in table 2 show that, most coefficients, including the interaction between inflation rate and capital control index, are statistically significant at a 5% significance level. For example, the second column in table 2 exhibits the coefficient on the interaction term is about -0.0196, and the corresponding *t* value is -1.9641. At a 5% significance level of the one-tail test, the interaction effect is significant on the Taiwan's unemployment situation.[5] The similar results can be obtained from the case of Brazil. Therefore, the significant value of interaction variables suggests that inflation exercises its influence on the changes of unemployment rate through the channel of capital controls, and whereby it can affect the slope of a Phillips curve. Inclusion of the lag terms of unemployment is to reduce the impact of autocorrelation present in the regression model.

[place Table 2 here]

[5] Under a 5% level and the degrees of freedom of 137, the corresponding critical value of *t*-test is about 1.656.

The significant and negative coefficients on the interaction terms in the model are consistent with our theoretical predictions (equation (22)): When the intensity of a country's capital inflow controls is higher, the Phillips curve becomes steeper, and the substitution between unemployment and inflation is smaller.[6]

Finally, to verify the econometric model employed in this study is free of specification errors, several diagnostic tests are performed. The Jarque-Bera normality test in table 2 suggests that the residuals do not deviate from a normal distribution. We also test for serial correlation and heteroskedasticity in the regression. The Durbin-Watson statistic values in table 2 indicate serial correlation is not present. In addition, table 2 also presents the Breusch-Godfrey Lagrange multiplier test for a second-order serial correlation.[7] Under a 5% or 10% significance level, we cannot reject the null hypothesis of the while-noise errors. In view of possible heteroskedasticity in the sample, the White's heteroskedasticity (henceforth White) test and the Engle's autoregressive conditional heteroskedasticity (ARCH) LM (henceforth ARCH) are adopted. The statistics of both tests do not indicate the residual terms are heteroskedastic. In general, the model specification tests have validated the regression results in table 2.

5. Conclusion

This study is based on the two-country model with imperfect competition in goods market, in which we examine whether the country size, consumers' preference, product differentiation and controls on capital inflows play a role in determination of the slope of a Phillips curve. From the analytical predictions and empirical study, we find that given that the home country is relatively small, as the size of home country is smaller, or the goods market is more perfectly competitive, or capital inflow controls are more intensified, a Phillips curve tends to be steeper. This conclusion well accords to Razin and Yuen (2002) findings that an open economy tends to have a flat Phillips curve. The model proposed by Razin and Yuen (2002) is founded on the new Keynesian framework under an open and a closed economy to analyze the effectiveness of a higher inflation rate on improving unemployment. Their research can serve as valuable references in refining a country's macroeconomic policy.

[6] When we use the adjusted capital control index instead, the regression results are similar to those in table 2. For brevity, the output is available upon request.

[7] We have explored to add the first and the other high order serial correlations, but results do not differ generally.

However, they do not specifically consider the impact of the capital inflow controls, the intensity of controls, and the country size on the slope of a Phillips curve. Our study should provide deep insights on the effectiveness of capital controls in the context of the Phillips curve.

Furthermore, the country experiences of Taiwan and Brazil from 1989 to 2000 have empirically validated our theoretical predictions. Our results derived from analytical reasoning and empirical evidence suggest several important facts: First, an extensive capital controls in place could lead to a steep Phillips curve, and hence smaller tradeoffs between unemployment rate and inflation rate. In other words, restrictions on capital mobility may deteriorate unemployment situation of a country. Second, with the interaction between inflation and capital control index in a regression model, we find the coefficients are negative and significant at sensible levels, which further lends support for the theoretical model proposed in this study. Third, if a government is inclined to stabilize its unemployment, it is desirable to have a flatter Phillips curve which allows to reduce substantial unemployment rate at the expense of a higher inflation. It should be more preferable. The conclusion reached in this study should provide useful guideline for a government in face of huge capital inflows.

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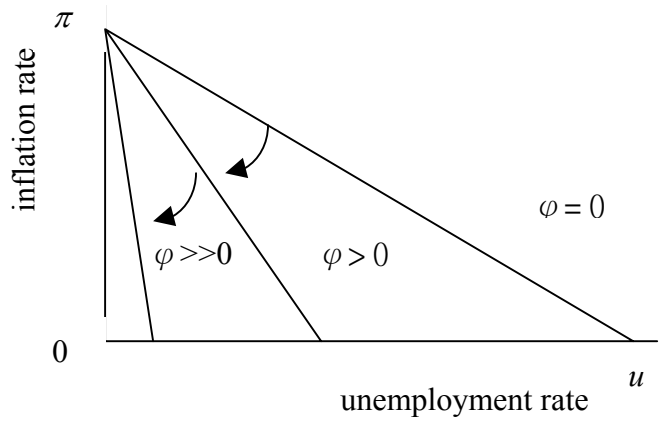
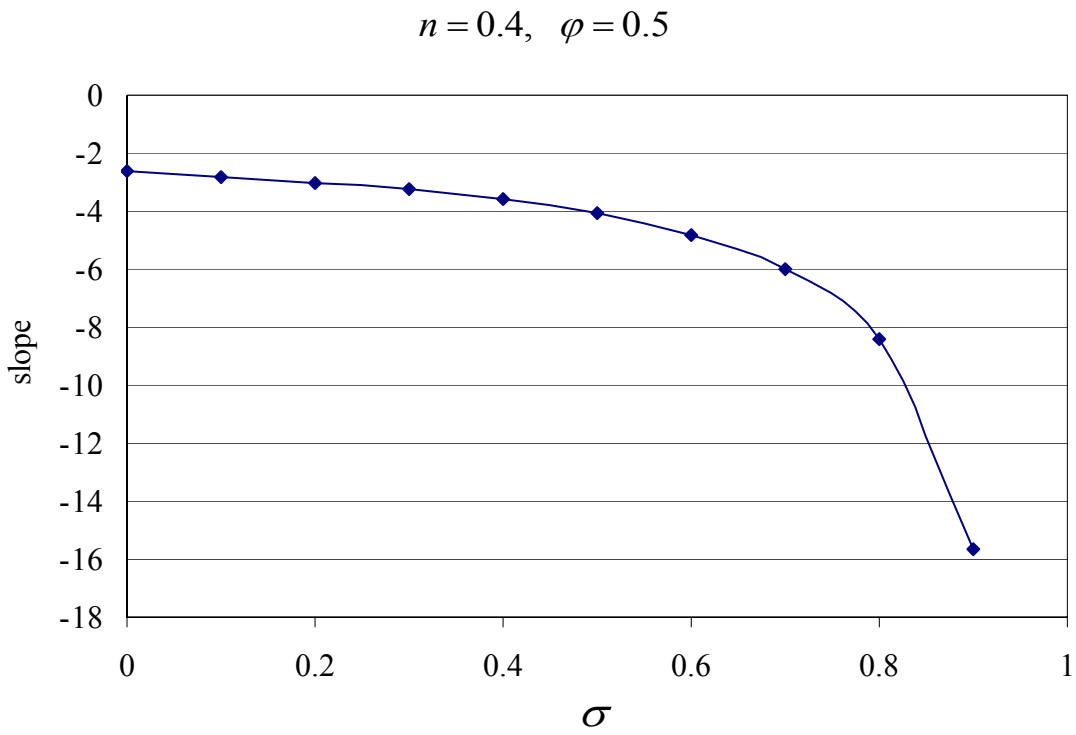
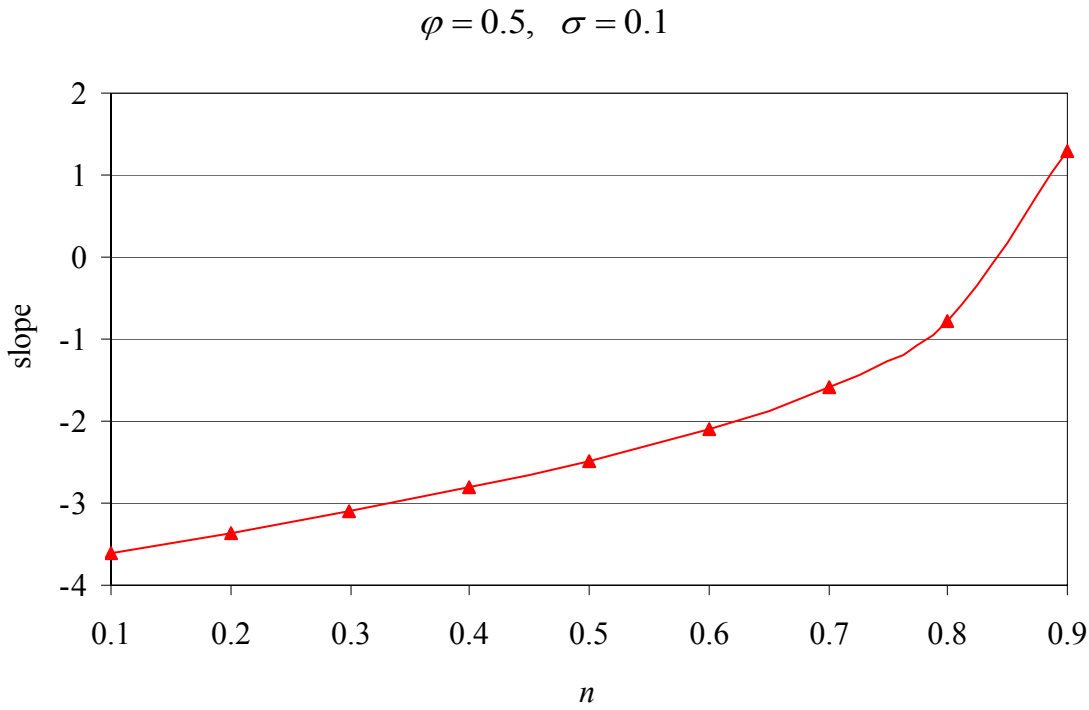


Figure 1. The Effect of Capital Controls (φ) on the Phillips Curve



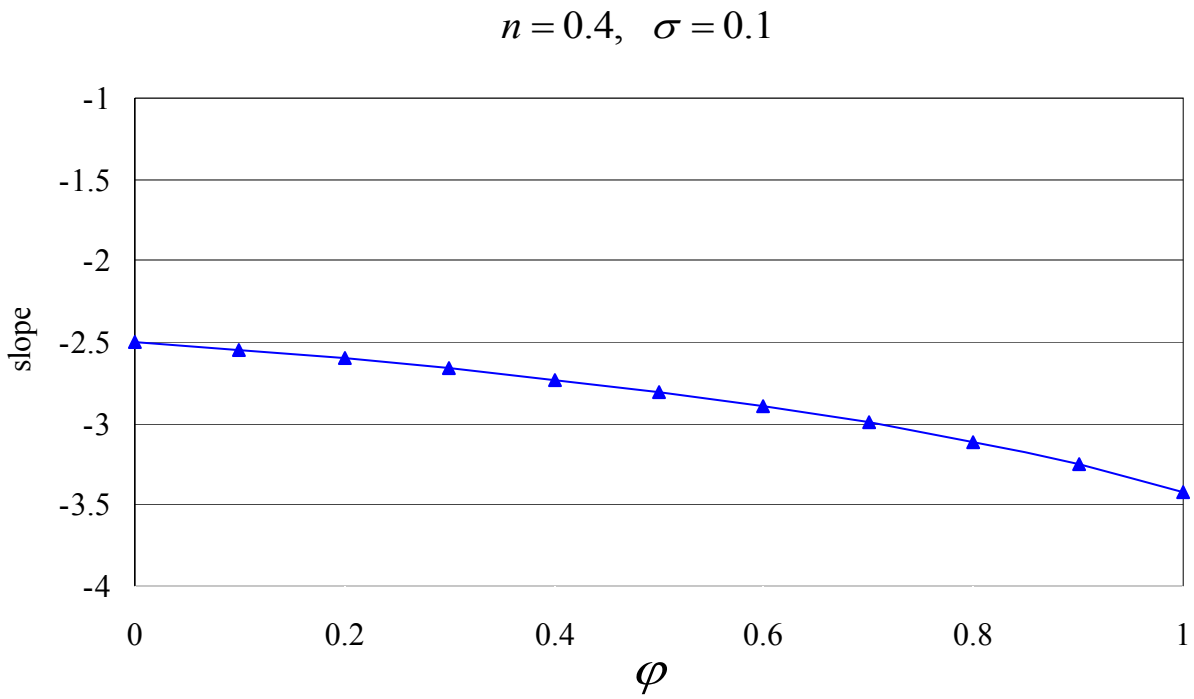
Note: n denotes country size; φ measures the intensity of capital controls. The value of the particular parameter is set in a reasonable range.

Figure 2. The Effect of Goods Substitution (σ) on the Slope of a Phillips Curve



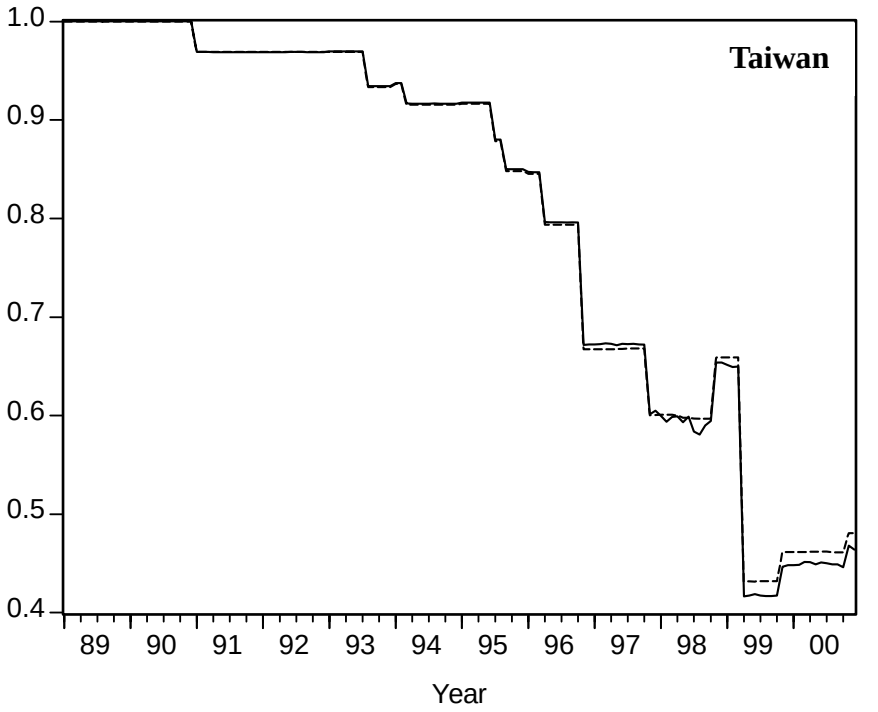
Note: φ measures the intensity of capital controls and σ denotes the degrees of substitution between goods. The value of the particular parameter is set in a reasonable range.

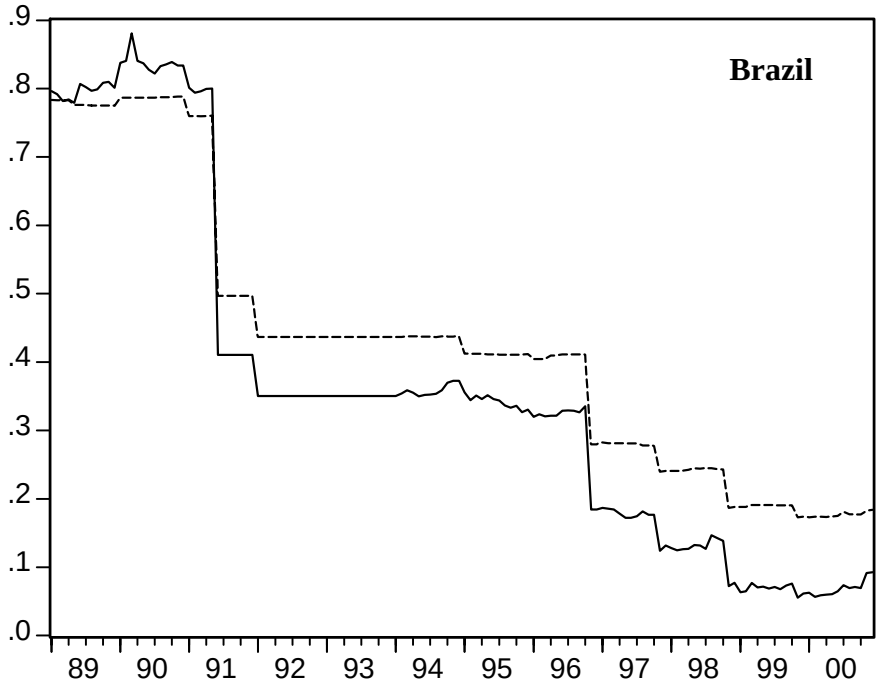
Figure 3. The Effect of Country Size (*n*) on the Slope of a Phillips Curve



Note: n denotes country size; σ measures the degrees of substitution between goods. The value of the particular parameter is set in a reasonable range.

Figure 4. The Effect of the Intensity of Capital Controls (φ) on the Slope of a Phillips Curve





Note: 1. The solid line denotes the unadjusted capital control index; the dotted line denotes the adjusted capital control index.
2. Source: Edison and Warnock (2003)

Figure 5. Capital Control Index for Taiwan and Brazil (December 1989—December 2000)

Table 1. Descriptive Statistics (December 1989—December 2000)

Taiwan	Unemployment	Inflation	Capital Control Index (unadjusted)	Capital Control Index (adjusted)
mean	2.0813	2.6668	0.8072	0.8090
median	1.8900	2.7038	0.9166	0.9156
max	3.2700	29.8632	1.0000	1.0000
min	1.2000	-22.6707	0.4166	0.4316
std. deviation	0.6512	6.6443	0.2005	0.1966
observation	144	144	144	144

Brazil	Unemployment	Inflation	Capital Control Index (unadjusted)	Capital Control Index (adjusted)
mean	5.5454	134.5417	0.3618	0.4293
median	5.4035	44.9436	0.3506	0.4244
max	8.2090	665.2250	0.8808	0.7881
min	2.3600	-58.4025	0.0554	0.1729
std. deviation	1.3915	160.2358	0.2543	0.2023
observation	144	144	144	144

Note:

1. Inflation: changes in consumer price index.
2. Capital Control Index: Edison and Warnock (2003) constructed the measure based on the contents and regulations of limits of foreign ownership of a country's equities. As the measure is close to 1, the capital controls are higher.
3. Source: AREMOS database, Datastream, Edison and Warnock (2003) and the authors' calculations.

Table 2. Summary of Regression Results (December 1989—December 2000))

	Taiwan	**Brazil**
explanatory variable	estimate	estimate
constant	0.7158	1.8215
	[3.1728]	[3.7052]
unemployment $_{t\text{-}1}$	1.1230	0.8051
	[13.5788]	[7.9607]
unemployment $_{t\text{-}2}$	-0.3291	0.0004
	[-2.8493]	[0.0032]
unemployment $_{t\text{-}3}$	0.0407	-0.1546
	[0.4960]	[-1.4851]
inflation	0.0167	0.0013
	[1.8700]	[1.7546]
capital control index	-0.4471	-0.1262
	[-2.8332]	[-0.3450]
inflation*capital control	-0.0196	-0.0028
index	[-1.9641]	[-1.9314]
R^2	0.9488	0.7228
Durbin-Watson	2.0366	2.0087
Jarque-Bera	1.2579	3.5556
	(0.5331)	(0.1690)
Serial Correlation LM Test	0.9487	0.8987
	(0.6223)	(0.6380)
ARCH Test	0.7132	2.5992
	(0.3984)	(0.1069)
White Test	16.0041	27.0440
	(0.1910)	(0.4070)

Note:

1. The numbers in brackets represents *t* statistics; those in parentheses are *p*-value.
2. Serial Correlation LM Test: Breusch-Godfrey Serial Correlation LM Test for the second order of serial correlation.
3. ARCH Test: Engle's ARCH (autoregressive conditional heteroskedasticity) Test.
4. White Test: White's Heteroskedasticity Test. To conserve the degrees of freedom, the test specification does not include cross terms.
5. Source: AREMOS database, Datastream and the authors' calculations.