TRANSMITTED UNEMPLOYMENT AND EXCHANGE RATE EFFECT ON LABOR MARKET

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by
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ABSTRACT

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This thesis examines the link between exchange rate and unemployment. The unemployment problem in an open economy has mostly been discussed at the micro level. Previous studies focus on job losses from trade by the manufacturing industries. However, the macro level relationship between exchange rate and unemployment has been largely ignored. The aims of this study are twofold. Firstly, a simple theoretical relationship between exchange rate and unemployment is established by the PPP and Phillips curve. The model shows that, under the linked exchange rate system, the unemployment in currency-linked country is a function of the unemployment in the base country, the changes in the exchange rate, the rate of price change differential between the two countries, and the natural rate of unemployment differential between the two countries. By using Hong Kong data, we find that one percent increase in the U.S. unemployment rate transmits 0.53 percent increase in Hong Kong.

Under the floating system, we analyze this problem in the United Kingdom, Germany, and France, which predominantly represent Europe. We investigate the magnitude of the transmitted unemployment and the exchange rate impact among those countries before and after the new currency. We find that the transmission effects are significant, which partially explain the severity of this long-lasting problem. To shed new light, we construct a three-sector model comprising goods market, labor market, and money market. We postulate that domestic product market faces import competition. Thus the exchange rate comes into play, intrinsically affecting the labor demand. In the meantime, we extend the standard money demand function by including both the domestic and foreign money balances. We believe that this extension better reflects the reality. We then solve the general equilibrium model to get the reduced-form solution with our focus on the relationship between exchange rate and employment. We find that the exchange rate effect is unconditional in that home currency depreciation benefits employment and alleviates the unemployment problem.

DECLARATION

I declare that this is an original work based primarily on my own research, and I warrant that all citations of previous research, published or unpublished, have been duly acknowledged.

(ZHOU Youqing)

Date

CERTIFICATE OF APPROVAL OF THESIS

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Chapter 1 Introduction

Unemployment is a central subject in economics and a pressing issue in many countries. Traditionally, economics look at this problem as a domestic issue. But countries have become increasingly interdependent through the process of globalization. A small but growing literature has developed to address the unemployment issue from an international perspective by considering the potential consequences of exchange rate movements on labor markets. Previous studies have made substantial advances at micro level investigations. Many focus on job losses from trade by the manufacturing industries in the United States. Branson and Love (1988), Revenga (1992), Campa and Goldberg (2001), find that dollar movements have significant implications for manufacturing employment in the United States. Burgess and Knetter (1998) compare employment adjustment to exchange rate fluctuations among G-7 countries. Klein et al (2003) associates dollar appreciation with job flows in U.S. manufacturing[1].

However, the macro level relationship between exchange rate and unemployment has been largely ignored. I intend to fill this gap. Specifically, I ask: Does exchange rate affect aggregate employment in an open economy? And if so, how does it happen? What is the link between unemployment and exchange rate under the peg and under the float?

The aims of this study are twofold. Firstly, I establish a simple theoretical relationship between exchange rate and unemployment by the Purchasing Power

[1] See literature review in Chapter 2.

Parity and Phillips curve. The model shows that, under the linked exchange rate system, the unemployment in currency-linked country is a function of the unemployment in the base country, the changes in the exchange rate, the rate of price change differential between the two countries, and the natural rate of unemployment differential between the two countries. This framework enables me to analyze the transmitted unemployment under different exchange rate regimes: the fixed and the float. Secondly, to shed new light, I construct a three-sector model comprising goods market, labor market, and money market. I have two novelties in this endeavor: first I postulate that a typical resident holds both domestic and foreign money balances; and second I consider import competition in domestic product market. I believe that this extension better reflects the reality. Thus the exchange rate comes into play, intrinsically affecting the labor demand. The primary emphasis in this model is on how exchange rate comes into play. I intend to examine the exchange rate impact on employment and unemployment separately. I do this by two theoretical assumptions, the first dealing with an equilibrium labor market and the second with disequilibrium between labor demand and supply.

My argument will proceed as follows. Chapter 2 reviews the literature. Chapter 3 (Part A) derives the first model by Purchasing Power Parity and Phillips curve, showing how the unemployment of currency base country is transmitted to currency-linked country. I carry out an empirical analysis of the transmitted unemployment, on Hong Kong and the United States, representing fixed regime. Chapter 4 (Part B) applies the same model by investigating into France, Germany, and the United Kingdom under the floating exchange rate system.

Chapter 5 (Part C) presents the second macro model comprising goods market, money market, and labor market. I solve the general equilibrium model to get the reduced-form solution with my focus on the relationship between exchange rate and employment. I will conclude in Chapter 6 with discussions for future studies of the unemployment problem.

Chapter 2 Review of Literature

A huge body of literature has been concerned with the impact of trade on employment. The simple message is that a move from autarky to trade leads to a reshuffling of labor distribution. Some domestic production will be replaced by imports and some other production will increase because of exports, which in turn alters employment. In general labor transfer from the import substitute industry to export sector[2]. This trade literature proves a useful starting point to relate exchange rate with employment. Still, not many scholars have discussed explicitly the role of exchange rate in labor market. Most of the relevant studies when documenting theoretical link associates the value of home currency with the competitiveness of domestic export in the international market or of local firms in an industry that faces import penetration. Theoretically, an appreciation of home currency will increase the relative production cost of local firms which results in higher prices of domestic goods. Higher prices will shift demand toward foreign goods, which in turn will lead to less domestic production and consequently lower level of employment. Therefore, a real appreciation of a nation's currency generally leads to a decline in local employment (Burgess & Knetter, 1998). I will summarize several studies in the following discussion.

Branson and Love (1988) first look at the exchange impact on manufacturing employment of the United States in the early 1980s. The theoretical discussion is

[2] For a recent literature, see Frankel & Romer, (1999), Davidson & Matusz, (2004), Dutt, Mitra, & Ranjan, (2009), Helpman & Itskhoki, (2010).

brief as the basic idea comes from trade and computable general equilibrium models that disaggregate industries into three sectors: exportables, import-competing goods, and nontraded goods. The authors also distinguish two types of workers. Production workers refer to those who are directly engaged in the physical processes of producing manufacturing goods. The non-production groups are the rest of the total employment. They find that, for the manufacturing sector as a whole, the appreciation of the dollar from 1980 to 1985 results in the loss of more than 1 million jobs. By dividing workers, they find that employment of production workers to the real exchange rate is more sensitive than that of non-production workers, especially in the durable goods sectors.

Revenga (1992) investigates the effect of increased import competition on U.S. manufacturing employment and wages over the 1977-1987 period when the ratio of manufacturing imports to total domestic supply doubled and the employment fell steadily. The author uses a competitive labor market model where wage adjusts to equate demand for labor and supply of labor. The key assumption is that import competition will shift demand for labor while labor supply is a typical function on wage. Exogenous variables include import price and a vector of observable factors that shift the demand or supply, such as real GDP and energy price. The dependent variables are wage and employment measured either in person-hours or production worker employment. There are two features in the empirical part. One is the previously unavailable industry-specific import prices. A panel data of 38 three- and four-digit SIC manufacturing industries is used. The second feature is the instrumental variable estimation strategy. Import prices are calculated in U.S. dollar value and might be correlates with unobservable demand shocks in the structural equation. The author thus brings up source-weighted exchange rates and industry index of foreign costs as instrumental variables. 2SLS regression confirms that there is simultaneous relationship between import prices and the endogenous variables, and the coefficients are significantly downward biased by OLS estimates. Concentrating on import-competing industries, the paper finds that the 40% real appreciation of the dollar between 1980 and 1985 in import price have lowered employment by 4.5-7.5% and wages by 2%. The relative size of employment and wage effects implies that labor is quite mobile across industries, with most of the adjustment to shocks occurring through employment. This result is consistent with theories of the unionized labor market. These conclusions distinguish this paper from previous ambiguously-resulted studies.

Using a cross-sectional dataset, Burgess & Knetter (1998) studies the changes in manufacturing industry employment across countries. They set up a framework in which the firm raises some market power and exchange rate enters as direct shifter of demand for product. Solving for firm's maximization problem gives the employment as a function of demand shock, wage, and rental rate. The key assumption that exchange rate is the source of demand shock while wage and rental rate are assumed to be determined by the world market, and thus can be substituted out. A frictionless optimal employment level is then derived. They further assume quadratic cost function of hiring and firing. Minimizing the cost gives an employment growth function depending on the disequilibrium in employment and the speed of adjustment to the optimal employment level. In the empirical analysis, the authors use balanced panel data across G-7 countries: the same 14 industries of each country for the period from 1972 to 1988. One thing special about the exchange variable is that, in contrast with the source-weighted industry exchange rate used by Revenga (1992), this paper generate real exchange rates for each country by simply averaging all its cross-rates. The authors argue that employment depends on both the exchange rate of the trading partner and those of the competing countries in the same market. They first estimate the unrestricted equation (using nonlinear least squares) for each country-industry pair to get a big picture. The problem is that there're only 17 observations in each regression. Then the authors impose the restriction that each coefficient is the sum of an industry effect and a country effect, running regression with simultaneous equations nonlinear least squares method. In testing further restrictions, it is found that neither effect can be excluded. However, the authors aim to make comparison between countries. The main findings are that France and Germany industries are much less influenced by exchange rate shocks and much slower to adjust to long-run steady states while the United States, Japan, Canada, the United Kingdom and Italy all appear to adjust more quickly. The authors relate the results to the pattern of the country differences with respect to trade and labor market regulations, i.e., exchange rate pass-through, pricing behavior, and nature of protection.

Along the same line of research, Dekle (1998) uses two-digit level data from 1975 through 1994 to empirically assesse the effects of Japanese yen's fluctuation on the nation's manufacturing employment. The author assumes that exchange rate plays into the movements in foreign industry-specific prices, which in turn affects employment. The paper finds that a 10% fall in foreign prices will reduce average manufacturing employment by ouve 4% in the long run. But there's no evidence on the difference between the high and low export sectors.

In the attempt to provide a unified account for contrasting labor market experiences of America and Europe, Davis (1998) develops a model of world trade between a flexible-wage economy and a minimum-wage one. The work starts from the classical Hechscher-Olin model where two countries are linked via commodity trade and solves for a general equilibrium. It confirms that national factor maket insititutions do matter in the global context. In the benchmark example, the introduction of free trade doubles the European unemployment rates and raises American wages to the high European level. Thus European unemployment does prop up American wages. Morever, a rigid European labor market may protect the Americans from external shock. This paper is among the few that consider simultaneously more than one country and the interaction going on between them.

Unlike the scholars who focus only on channel of import competition, Campa & Goldberg (2001) constructs a dynamic model of the labor market where exchange rates come into play through various channels. In their setting, a representative firm sells products in both domestic and international markets, maximizes expected present discounted profit with domestic labor and capital, foreign capital, and adjustment cost being the inputs. Thus exchange rates would affect export revenues, import inputs, and import competition. Demand for labor is then derived from the production function while labor supply is typically supposed to be increasing in wages and decreasing in aggregate demand. Using two-digit data for the interval 1972 through 1995, they find average real wage elasticity to exchange rates of 0.06. By categorizing industries according to the price-over-cost markup, the authors find that exchange rates have statistically significant effects on industry wages especially in industries with lower markups. They also decompose exchange rate fluctuations into the permanent and transitory components via Beveridge-Nelson procedure to determine the producers' response to shocks of different nature. The results show that overtime wages and overtime work hours are highly responsive to transitory exchange rates movements. This study has been the first one to document the significant effects of transitory exchange rate movements on overtime activity.

A last paper by Klein, Schuh, & Triest (2003) associates dollar appreciation with job flows in U.S. manufacturing. Their starting point is that factor reallocation reduces welfare gains from trade and thus the creation and destruction of jobs, in addition to the net employment change, should be examined. The model introduces a host of additional industry-specific variables and implies that the growth rate, instead of the level, of real exchange rates matters. They use data for all U.S. manufacturing industries over the 1973-1993 period and controls for heterogeneity in openness across industries. They find that cyclical real exchange rates have significant impact on employment through job destruction only.

As discussed above, most of the literature adopts a micro economic view concerned with individual industry, primarily manufacturing industries. Throughout these studies the appreciation of a currency is found to displace jobs in manufacturing industries. Nevertheless, there are possibilities that those lost jobs may be created elsewhere in the economy, so that the aggregate effect is uncertain. My study deviates from previous literature in that I intend to look at the problem from a macro perspective focusing on the aggregate economy. Macroeconomic view focuses attention not on individuals but on the factors of production and how they aggregate into output volume. If we look the economy as a whole we may see a different and interesting picture. How With this background in mind, this thesis joins the feature of macro and open economic methods. Moreover, I am thinking of the transmission of unemployment between countries. The next chapter derives a model by Purchasing Power Parity and Phillips curve, showing how the unemployment of currency base country is transmitted to currency-linked country. This will be an important complement to existing studies, which are either of individual countries or comparative. I hope my study could provide a theoretical reference point.

Chapter 3 Transmitted Unemployment under the Linked Exchange Rate System in Hong Kong

1. Introduction

In this part I look at the unemployment problem of one country in relation to another country through the bilateral exchange rate. Many small open economies link their currencies to the U.S. dollar. Some countries officially adopt a foreign currency, usually one of the major currencies such as the U.S. dollar and the euro, as the national currency. While policy makers and academic scholars focus on the implications for fiscal discipline and financial stability, the consequences in labor market have been largely ignored. I intend to investigate into the 'linked' unemployment problem of Hong Kong. Contemporary Hong Kong is a good economic experiment lab because it has been stably operating a currency board pegged to the U.S. dollar for three decades. While recent papers have studied Hong Kong economy in relation to mainland China[3], I argue that the U.S. economy, which is the currency base country, exerts influences at least through the linked exchange rate system.

Our discussion proceeds as follows. Section 2 describes the model. Section 3 provides an empirical analysis. Section 4 discusses the results.

[3] Hsieh and Woo (2005 AER)

2. Model

2.1. Building Block 1 – the Purchasing Power Parity

I try to establish the relationship between unemployment and exchange rate by two building blocks: the Purchasing Power Parity and the Phillips curve. The absolute form of PPP is as follows: $P_A = S_{AB} P_B$ (where P_A is price level in country A, P_B is price level in country B, S_{AB} is the bilateral exchange rate defined as the amount of currency A required to buy one unit of currency B). It states that the purchasing power of different currencies is equalized for a given basket of goods.

This form of PPP suffers from several problems. For instance, different countries use different baskets of goods to calculate price index due to different tastes. This means that even if the law of one price holds for each individual goods, it is not necessarily true for the general price index[4].

Therefore I consider the relative form of the PPP condition stated in terms of inflation of price index. By the product rule of differentiation I have

$$\frac{dP_A}{dt} = S_{AB} \cdot \frac{dP_B}{dt} + \frac{dS_{AB}}{dt} \cdot P_B$$

Dividing Equation (1) by the static PPP relation $P_A = S_{AB} P_B$ I get

$$(1) \qquad \frac{1}{P_A} \cdot \frac{dP_A}{dt} = \frac{1}{P_B} \cdot \frac{dP_B}{dt} + \frac{dS_{AB}}{dt} \cdot \frac{1}{S_{AB}}$$

[4] Rogoff (1996) points out that international goods market are far less integrated for the law of one price to hold.

Inflation rate is percentage change of price index, that is $\pi_A = \frac{1}{P_A} \cdot \frac{dP_A}{dt}$, $\pi_B = \frac{1}{P_B} \cdot \frac{dP_B}{dt}$.

And define $\dot{S}_{AB} = \frac{1}{S_{AB}} \cdot \frac{dS_{AB}}{dt}$.

Now I have

$$(2) \quad \pi_A = \pi_B + \dot{S}_{AB}$$

For the empirical analysis that follows, I add a second order term $\pi_B \cdot \dot{S}_{AB}$ to Equation (2), making it

$$(2') \quad \pi_A = \pi_B + \dot{S}_{AB} + \pi_B \cdot \dot{S}_{AB}$$

2.2. Building Block 2 – the Phillips Curve

Next I consider the Phillips curve. The original Phillips curve suggests an inverse relationship between the rate of unemployment and the rate of increase in money wages. However, expectations have been brought in, since the great inflation of the 1970s, to account for actual inflation: when people expect inflation, they contribute to it. The simplest form of standard Keynesian expectations-augmented Phillips curve may be given as $\pi_t = \pi_{t-1} - h(U_t - \overline{U})$ (Dornbusch & Fischer, 2002), where π is the inflation rate, U is the unemployment rate, $\overline{U}$ is the natural rate of unemployment, h is a positive parameter. The main idea is that actual inflation is determined by both unemployment and expected inflation which is represented by π_{t-1}.

Now I use a textbook augmented Phillips curve for both country A and B:

(3) $\pi_i = -h_i(U_i - \overline{U}_i) + \pi_i^e \qquad i = A, B$

I will explain later how I measure expectation.

I take Equation (3) as an identity. The coefficient h_i and natural unemployment rate $\overline{U}_i$ could vary from country to country and need to be empirically estimated.

2.3.The Model

I take country A as currency link (home) country and B as currency base (foreign) country. Substitute Equation (3) into Equation (2') and solve for U_A:

$$(4) \quad U_A = \frac{1}{h_A}[h_B U_B - (1 + h_B \overline{U}_B)\dot{S}_{AB} + (\pi_A^e - \pi_B^e) + (h_A \overline{U}_A - h_B \overline{U}_B) + h_B \dot{S}_{AB} U_B - \pi_B^e \dot{S}_{AB}]$$

This equation shows that the unemployment in home country (U_A) is a function of the difference in natural unemployment rates between the two countries ($h_A \overline{U}_A - h_B \overline{U}_B$), which I consider as constant, and unemployment in the foreign country U_B, the differential of expected inflation between the two countries ($\pi_A^e - \pi_B^e$), the change in the exchange rate ($\dot{S}_{AB}$), and the interaction terms ($\dot{S}_{AB} U_B$ and $\pi_B^e \dot{S}_{AB}$).

I eliminate the interaction terms for approximation:

$$(4') \quad U_A = \frac{1}{h_A}[h_B U_B - (1 + h_B \overline{U}_B)\dot{S}_{AB} + (\pi_A^e - \pi_B^e) + (h_A \overline{U}_A - h_B \overline{U}_B)]$$

This relationship offers a new angle to look at the unemployment problem and guides the empirical analysis later on. When home currency is pegged to a foreign currency, it's necessary that the foreign economy is big, stable, and influential to others. I predict that the transmission effect is positive so that there is unemployment contagion among countries. The second argument, the differential in expected inflation, is of special interest in the linked exchange rate system which I will discuss sooner. I postulate that the exchange rate change is negatively related with the unemployment. The intuition goes like this: the depreciation of home currency, which means the rise of exchange rate, benefits the export of home country and boosts economy that in turn increases employment.

I will first explore the Hong Kong case. Hong Kong announced its official link to the U.S dollar on October 17, 1983. Strictly speaking, the peg is not at one point but allows it to flow within the lower limit 7.85 and the upper limit 7.75. I believe the minor fluctuations are quantitatively negligible, what happens in the currency market stays in the currency market. Thus I impose $\dot{S}_{AB} = 0$ under the linked exchange rate system. So Equation (4) is shortened to

$$(5) \quad U_{At} = \alpha_0 + \alpha_1 U_{Bt} + \alpha_2(\pi^e_{At} - \pi^e_{Bt}) + \varepsilon_t$$

Now there are three components determining the unemployment rate of home country. The first one is a linear combination of the natural rates of unemployment in both economies (α_0). The second one is the foreign unemployment (U_{Bt}), the element that is of most importance in my analysis. For Hong Kong, the U.S. economy is definitely exogenous and acts as a leader. Third, as mentioned above, the inflation differential is especially interesting. Under the PPP and the exchange rate link, either the actual or the expected inflation between the two countries would be equal to each other. This differential term, if statistically significant, reflects the potential measurement errors or the possible breakdown of the link.

China provides an excellent and natural candidate to be analyzed together. In the first place Hong Kong has a free market and serves as an international financial center. Still, China remains a crucial trade partner and Hong Kong economy has become more closely linked with mainland China over the past decades, especially since the takeover in 1997. Moreover, the Chinese RMB was pegged to the U.S. dollar at 8.27 from 1997 through 2005. In the years after, the central bank managed to appreciate the renminbi gradually and slowly. Given that the Hong Kong dollar is officially linked to the U.S. dollar the RMB/HKD has been roughly stable spanning the same period. My model applies to any bilateral combination of China, the U.S., and Hong Kong.

However, I'm not including China in this study. The first thing is I couldn't obtain sufficient data on China's unemployment rate. Econometric rigor requires a minimum of 40 observations. By way of database, I could only find an annual series of less than two decades, which would render the results incompetent if adopted. More importantly, I believe the link between China and Hong Kong is integrated through a central United States in that Chinese RMB and Hong Kong dollar both target U.S. dollar. It is, in principle, equivalent to analyze the relationship between U.S. and Hong Kong in this case.

3. Methodology and Results

3.1. Data and Methodology

I use Hong Kong and U.S. monthly time series data from DataStream, covering the period from October 1983 to December 2009. The series are: the Hong Kong unemployment (U_{HK}), the Hong Kong CPI (P_{HK}), the U.S. unemployment (U_{US}), and the U.S. CPI (P_{US}). For Hong Kong CPI, I obtain three different types of data: Hong Kong CPI Hang Seng, Hong Kong CPI M, and Hong Kong CPI by International Financial Statistics.

Inflation rate π is calculated as percentage change in CPI ($\pi_t = 100(\frac{P_t - P_{t-1}}{P_{t-1}})$). Now I discuss how to measure expected inflation, which actually cannot be directly observed. As we know, there is no consensus on how people form expectations because they have much to do with psychology. However, it is reasonable to assume that people make forecasts by looking at the evolving path of the object. That is, expectation of future inflation depends on the current and past status. Therefore I try three measurements of expectation. The first method adopts the Rational Expectation approach such that people have perfect foresight: the expected π is equal to the actual π ($\pi_t^e = \pi_t$). The expected inflation differential between Hong Kong and the United States is denoted by $d\pi_1^e$. The second method is to use the difference between two consecutive time periods ($\pi_t^e = \pi_t - \pi_{t-1}$) and $d\pi_2^e$ stands for the expected inflation differential using this method. The third method is to consider the percentage change in π such that $\pi_t^e = \frac{\pi_t - \pi_{t-1}}{\pi_{t-1}}$ in Hong Kong and in the U.S. respectively so $d\pi_3^e$ stands for the expected inflation differential between the two countries.

3.2.Results

Having defined the variables in my model, I now have to enter the unit root analysis since most time series data may not be stationary. The implications of unit roots may be profound. I firstly check unit roots with augmented-Dicky-Fuller test. The idea of this method is that, if a series is characterized by a unit root, then the lagged level of the series will be irrelevant in predicting the change in itself[5]. Table 1 reports the time series code numbers and the ADF test results with time trend, intercept and optimal lags. The optimal lags are chosen by Schwarz Criterion. Some variables pass the diagnostic tests at 5% significant level, but others not. The order of integration is the number of times that a series needs to be differenced before it achieves stationarity. Since the majority of econometric theory is built upon the assumption of stationarity, the usual procedure then would be to transform the data by taking differences. But the problem with differencing is that lose valuable long run information in the data. One possible solution to this is cointegration methods. The economic interpretation of cointegration is that if two or more series are united to form a long run equilibrium relationship, they tend to move closely together over time. Their long run relationship is the equilibrium towards which the system converges. Therefore I need to check their cointegration. If these series are co-

[5] See Greene (2003).

integrated, I can use Error Correction Model to capture the correction effect without the differencing procedure before modeling.

I carry out the Johansen test on cointegration. Note that I have three types of CPI data and three methods for computing expected inflation, thus there are 3*3=9 regressions in total. The results are shown in the 6th column in Table 2. One or two stars indicate the standard 10% or 5% significance level in the trace test statistic of the Johansen cointegration test. The 6th column reports 5 significant cases out of 9, rejecting the null hypothesis that dependent variable and the explanatory variables are not co-integrated.

Once the co-integrated relationship is established among the variables in the first stage, In order to capture the long-run correction of the short-run effects, I apply Error Correction Model to capture the long-run correction of the short-run effects. The first step is to get the estimated residual from Ordinary Least Square regression and then to use the lagged term as an error correction mechanism in the dynamic, first-differenced regression as follows:

$$(6) \quad \Delta U_{At} = \alpha_0 + \alpha_1 \Delta U_{Bt} + \alpha_2 \Delta(\pi_{At}^e - \pi_{Bt}^e) + \alpha_3 \hat{e}_{t-1} + \varepsilon_t$$

When the coefficients of the lagged residual term from the first stage are significantly negative, it suggests that the system is coming back to the long-run path.

As Table 2 shows clearly[6], all estimated coefficients for α_1 are significant at 5% or 1% level. Further, the estimated α_1s are in the close vicinity of one another, ranging from 0.244 to 0.247. I see that this transmission effect is positive and robust. The positive sign is consistent with my prediction from the model in Section 2. The significant α_1

[6] I run EC model for all the 9 static regressions.

is consistent with the view that there are Phillips curve tradeoffs in both the currency base country and the currency link country. Furthermore, α_1 is significantly different from one, suggesting that the Phillips Curve slopes are not equal in both countries. The tradeoff is less in Hong Kong, which may be related to the fact that HK has a more open economy.

The 7th column in Table 2 reports the calculated Hong Kong unemployment elasticity with respect to the U.S. unemployment from five different estimations with significant Johansen testing results, which is obtained by $\eta_{U_{HK},U_{US}} = \frac{dU_{HK}}{dU_{US}}\frac{U_{US}}{U_{HK}} = \alpha_1 \frac{U_{US}}{U_{HK}}$from the computations of the original observations. I then take the averages as reported. I conclude from the monthly data that for one percent increase in the U.S. unemployment, there is about 0.53% increase in the Hong Kong unemployment. This transmission effect may be rather strong than one might could think of. However, since U.S. is the No. 1 economy, a leading importer, and has a most active financial market in the first place, there could be a variety of channels through which it affects other countries or regions. Methodologically, I have exhausted several possibilities to find a reliable estimate. Therefore I have good reasons to see this strong effect as realistic and robust.

Next I see that the nominal effect α_2 on the Hong Kong unemployment from the expected price change differential is insignificant, which suggests that there is no creditable belief that the link will fail in the near future.

The last estimated coefficient α_3 for the lagged residuals normally represents the short-run disequilibrium "correcting mechanism". The disturbance term can be interpreted as the disequilibrium error or the distance the system is away from equilibrium. In theory, this lagged short-run effect could either add to the severity or make mitigation of the long-run transmission effect. But they are all insignificant.

Chapter 4: Transmitted Unemployment in France, Germany, and Britain

1 Introduction

The framework in Part A has broader implications than for Hong Kong. It can be applied to other economies as well. The first and probably most interesting endeavor I intend to take is to look at the European story: with the single currency euro, and under the floating exchange rate system.

The euro is the official currency of the eurozone[7] and is the currency used by the EU institutions. The currency was launched at 0:00 on 1 January 1999, when the national currencies of participating countries ceased to exist independently. Their exchange rates were locked at fixed rates against each other. The notes and coins for the old currencies, however, continued to be used as legal tender until new euro notes and coins were introduced on 1 January 2002.

The unique context of Europe provides me an excellent opportunity to experiment with the previous model based on PPP and Phillips curve. Within the single currency system, worries about the minor fluctuations in exchange rate under the peg, such as Hong Kong dollar to the U.S dollar, completely vanishes away. Furthermore, countries that were not tightly linked together before have become more intrinsically interdependent since the introduction of euro. For example, France and Germany

[7] The eurozone consists of Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia and Spain.

both fixed the irrevocable conversion rate to euro on 1 January, 1999. Will there be any difference in the results? I hope to find evidences on the unemployment transmission.

I have selected three large advanced countries for empirical analysis: France, Germany, and the United Kingdom, which predominantly represent Europe. More importantly, as noted above I intend to compare the results of the same country pair before and after 1999. The discussion is organized as follows. Section 2 restates the fixed exchange rate equation and presents a float model applicable for countries before euro. Section 3 provides an empirical analysis.

2 Model

In the European context, I could explore both the fixed and the float exchange rate system.

2.1 Under the Single Currency

As in the previous chapter, the unemployment of currency link country depends on the unemployment of currency base country and the differential of expected inflation between the two countries.

(1) $U_{At} = \alpha_0 + \alpha_1 U_{Bt} + \alpha_2(\pi^e_{At} - \pi^e_{Bt}) + \varepsilon_t$

However, Eurozone countries are much closer in regard of economic scale and influence. I could have the interactions going both ways. On this account, I derive the equation form the other direction:

(2) $U_{Bt} = \beta_0 + \beta_1 U_{At} + \beta_2(\pi^e_{Bt} - \pi^e_{At}) + \epsilon_t$

Equation (1) and (2) are not essentially different from each other, but it helps to understand the mechanism of transmitted unemployment.

2.2 Under the Float Exchange Rate

Recall that the solution was (Equation 4 on Page 15):

$$U_A = \frac{1}{h_A}[h_B U_B - (1 + h_B \overline{U}_B)\dot{S}_{AB} + (\pi_A^e - \pi_B^e) + (h_A \overline{U}_A - h_B \overline{U}_B) + h_B \dot{S}_{AB} U_B - \pi_B^e \dot{S}_{AB}]$$

The unemployment in home country (U_A) is a function of the difference in natural unemployment rates between the two countries ($h_A \overline{U}_A - h_B \overline{U}_B$), the unemployment in foreign country U_B, the differential of expected inflation between the two countries ($\pi_A^e - \pi_B^e$), the change in the exchange rate ($\dot{S}_{AB}$), and the interaction terms ($\dot{S}_{AB} U_B$ and $\pi_B^e \dot{S}_{AB}$).

To recap, the regression equation fro country A is

(3) $$U_A = \alpha_0 + \alpha_1 U_B + \alpha_2(\pi_A^e - \pi_B^e) + \alpha_3 \dot{S}_{AB} + \alpha_4(\dot{S}_{AB} U_B) + \alpha_5(\pi_B^e \dot{S}_{AB}) + \varepsilon$$

For country B, it is

(3) $$U_B = \beta_0 + \beta_1 U_A + \beta_2(\pi_B^e - \pi_A^e) + \beta_3 \dot{S}_{BA} + \beta_4(\dot{S}_{BA} U_A) + \beta_5(\pi_A^e \dot{S}_{BA}) + \epsilon$$

3 Methodology and Results

3.1 Data and Methodology

I select three large advanced economies: France, Germany, and the United Kingdom. Monthly time series data are collected from DataStream, covering the period March 1978 – December 2009. The series are: the unemployment rate(U_{FR}, U_{BD}, U_{UK}); CPI (P_{FR}, P_{BD}, P_{UK})[8]. The exchange rate data is somewhat a little special. I have FRENCH FRANCS TO UK and GERMAN MARKS TO UK, denoted by S_{FR_UK} and S_{BD_UK} respectively. But I don't have French Francs to German Marks before 1999. Therefore I carry out the conversion by using the process of triangulation via the UK pound and denote by S_{BD_FR}, that is $S_{BD\_FR} = S_{BD\_UK}/S_{FR\_UK}$. I divide the whole sample into two sub periods: (1) March 1978 – December 1998 and (2) January 1999 – December 2009.

I compute $\dot{S}$ as the percentage change in the spot exchange rate. Inflation rate π is calculated as percentage change in CPI ($\pi_t = 100(\frac{P_t - P_{t-1}}{P_{t-1}})$). I again try three measurements of expectation. The first method adopts the perfect foresight: $\pi_t^e = \pi_t$. The expected inflation differential between two countries is denoted by $d\pi_1^e$. For example, $d\pi_{1,FR\_BD}^e = d\pi_{1,FR}^e - d\pi_{1,BD}^e$. The second method is to use the difference between two consecutive time periods ($\pi_t^e = \pi_t - \pi_{t-1}$) and $d\pi_2^e$ stands for the expected inflation differential using this method. The third method is to consider the

[8] FR=France, BD=Germany, UK=the United Kingdom.

percentage change in π such that $\pi_t^e = \frac{\pi_t - \pi_{t-1}}{\pi_{t-1}}$ so $d\pi_3^e$ stands for the expected inflation differential between the two countries.

Table 1 and 2 report the time series code numbers and the ADF test results with time trend, intercept and optimal lags. The optimal lags are chosen by Schwarz Criterion. I will carry out the Johansen test on cointegration before each regression and compute the elasticity for significant Johansen results as before.

One more issue here is, as mentioned before, Eurozone countries are much closer in regard of economic scale and influence. Literally, large industrialized economies neighboring each other may have enormous influence on one another. Especially in my focus, France and Germany are the closest partners in Europe. Their governments coordinate policies extensively and regularly. They are realistically affecting each other. However, I intend to discuss the endogeneity problem a little bit from an econometric point of view.

The method I use is Hausman specification test. Suppose we have two equations in a system, France and Germany unemployment rates being the (potential) endogenous variables. The idea of Hausman test is to compare an instrumental variable (IV) estimates to OLS estimates. An illustration is given in the Appendix. The reduced form regression makes an IV for one of the unemployment rates and the residual term represents the bias due to endogeneity. The latter one, if significant in explaining the other unemployment rate, indicates that we have endogeneity problem. The result of Hausman tests are reported before I proceed to each regression. If passed, I base the analysis on single equation estimation. If not, I will use lagged term as the proxy for the endogenous variable.

3.2 Result 1 – France and Germany after the euro

I use equation (1) and (2) for France and Germany after the introduction of euro.

(1) $U_{At} = \alpha_0 + \alpha_1 U_{Bt} + \alpha_2(\pi^e_{At} - \pi^e_{Bt}) + \varepsilon_t$

(2) $U_{Bt} = \beta_0 + \beta_1 U_{At} + \beta_2(\pi^e_{Bt} - \pi^e_{At}) + \epsilon_t$

where A=France and B=Germany.

I have two sets of equations and three types of calculating expected inflation and thus 2*3=6 regressions in total. Johansen tests show that there is cointegration relationship when France is on the left-hand side. Table 2a and 2b reports the result from Error Correction model. I conclude from the analysis that for one percent increase in the Germany unemployment, there is about 0.224% increase in the France unemployment. The nominal effect α_2 on the France unemployment from the expected price change differential is insignificant, which suggests that there is no creditable belief that either Germany or France will abandon euro in the near future.

3.3 Result 2 – France and Germany before the euro

I use equation (4) and (5) for France and Germany before the introduction of euro.

$$(3) \quad U_A = \alpha_0 + \alpha_1 U_B + \alpha_2(\pi_A^e - \pi_B^e) + \alpha_3 \dot{S}_{AB} + \alpha_4(\dot{S}_{AB} U_B) + \alpha_5(\pi_B^e \dot{S}_{AB}) + \varepsilon$$

$$(4) \quad U_B = \beta_0 + \beta_1 U_A + \beta_2(\pi_B^e - \pi_A^e) + \beta_3 \dot{S}_{BA} + \beta_4(\dot{S}_{BA} U_A) + \beta_5(\pi_A^e \dot{S}_{BA}) + \epsilon$$

where A=France and B=Germany.

Error Correction model is applied and Table 4a and Table 4b present the results. Interesting pattern shows up in Table 4b, with Germany unemployment being the dependent variable. The error correction term is significantly negative I conclude from the data that for one percent increase in the France unemployment, there is about 0.343% increase in the Germany unemployment.

Now I would like to compare the transmitted unemployment effects before and after the euro. Table 3a reports one significant Johansen result (elas $\alpha_1 = 0.091$); I can use it in parallel with Table 2a. The latter one shows that, after the introduction of euro, the average elasticity of α_1 is 0.224, which is bigger than 0.091. The euro is the key of explanation.

Single currency policy brings many benefits and costs. Not the least of the indirect benefits is that adopting a common currency results in greater price transparency. After the introduction of euro, goods in France and Germany are priced in the same currency. Say that if goods in France are more expensive than in Germany, demand will shift from the former country to the latter one. The following economic activities will lower the France price level and push up Germany prices. Their inflation rates are restricted to be at the same level. Discrepancy beyond a certain limit is automatically corrected. Given that I assume inflation-unemployment trade offs, France and Germany unemployment rates are now on the same boat. On the other hand, if we go back to 1998 or earlier, French francs were not locked against Deutsch marks. The exchange rate fluctuations were out there to absorb the constraining force on inflation entitled by the single currency. The collateral damage is that I lost some of the unemployment while transmitting. In a word, the transmission effect is intensified because of euro.

3.4 Result 3 – Britain in the picture

The same procedure is repeated for France and the UK before 1999. The national currencies of these two countries are never linked to each other: the UK pound always floats against the French franc before and against the euro which replaced the French franc in January, 1999. DataStream finds a synthetic exchange rate of French francs to UK pound spanning the whole period I are examining, but I use the euro/UK pound exchange rate after 1999. The same rule applies to Germany versus the UK.

Table 6 presents the results with UK unemployment being the dependent variable and Germany being the independent one. It shows that for one percent increase in the Germany unemployment, there is about 0.171 per cent increase in the UK unemployment. Table 7 places France on the right hand side but no significant cointegration is found.

Chapter 5: A Theory on Exchange Rate and Labor Market in an Open Economy

1. Introduction

Frequent violations are reported in either PPP or Phillips curve and there is an ever growing literature of debate on them. Still, my first model could be an important complement to the existing literature. I posit it provides a strong link between rich countries where PPP is more likely to hold up. This suggests the value of a second approach, which may be universally applicable, or at least to small open economy where a number of theories start with. It is, in the first instance, a general equilibrium story. I start with Mundell-Fleming model that is popular in macroeconomics and bring in the labor market. Thus I construct a three-sector model comprising goods market, labor market, and money market. Consistency is enforced by the simultaneous determination of equilibrium in all sectors, or disequilibrium in labor market when considering unemployment.

The exchange rate effects on total employment and unemployment are my main interests. The general assumption is that the background is a small open economy in the sense that it takes foreign variables as fixed. The goods market is characterized by a standard international IS curve. I extend the standard money demand function by including both the domestic and foreign money balances. I believe that this extension better reflects the reality of an open economy such as Hong Kong: A significant number of Hong Kong residents come from mainland China and overseas. They constitute a large group of foreign currency holders.

In order to examine the employment and unemployment separately, I set up two frameworks: firstly, assume that the labor market is in equilibrium and examine the employment link to exchange rate. In the second set-up, I define unemployment as the disequilibrium in labor market and look at the exchange rate impact on unemployment. Then I solve the general equilibrium model to get the reduced-form solution. Further, I postulate that an open economy faces import competition, which is measured by the import price. Thus the exchange rate comes into play, intrinsically affecting the labor demand. I hope that my theory could offer a new direction for policy implications.

The discussion is organized as follows. Section 2 describes the benchmark model comprising goods market, money market, and a labor market either in equilibrium or disequilibrium. Section 3 continues with the same goods market and money market settings as in Section 2 but introduces import competition. In both parts, matrix results are provided and I restrict my attention to exchange rate effects. Section 4 carries out an empirical analysis by applying the model to Hong Kong.

2. The Benchmark Model

My framework is a revised Mundell-Fleming model. Consider a small open economy. I follow the convention of letting a lower-case letter designate the natural log of the variable represented by the corresponding upper case letter, except for the interest rate.

2.1. Goods Market

An open-economy version of the IS curve shows the combinations of output, interest, and exchange rate at which there is equilibrium in the goods market. Equilibrium in the goods market means that the demand for domestic goods y^d, i.e. planned expenditure in real terms, is equal to the supply of output y^s. Planned expenditure comprises consumption, investment, and net export. First, consumption depends positively on income. Second, investment depends negatively on the interest rate, which is the price of borrowing. Third, since a rise in real exchange rate reduces the price of domestically produced goods relative to foreign goods, net export is positively related to the real exchange rate.

Nelson C. Mark (2001) gives the IS curve:

(1) $y = \delta e - \sigma r + h,$

where y is log real domestic output, e is log real exchange rate, h is an exogenous shift parameter. $\delta, \sigma, h > o$.

By definition, is based on the GDP deflator measurement of the price level in the domestic and foreign countries:

(2) $e = s + p_f - p_h,$

where s is the nominal exchange rate defined as the amount of home currency required to buy one unit of foreign currency, p_f is log foreign goods price, and $p_h$is log price of home goods.

2.2. Money market

LM curve describes the equilibrium in the money market at which the money supply is equal to money demand. Traditionally, it shows all combinations of interest rates and levels of income such that the demand for real balances is equal to the supply. My first novelty is to introduce domestic holdings of foreign money. The reason is as follows. In an open economy such as Hong Kong, a peculiar characteristic is its high degree of international mobility and diversity in a range of sectors. One feature is the large number of residents coming from mainland China and overseas. They work in Hong Kong, live in Hong Kong, and hold a significant amount of RMB or other foreign money in addition to Hong Kong dollars. Further, given the fact that Hong Kong is primarily an international financial center and its daily life is highly globalized, even the local population would demand for some foreign currency for the purpose of oversea expenditure like traveling and shopping.

In order to capture the feature discussed already, it is useful to introduce the concept of preference for foreign currency: the proportion that domestic residents hold for foreign currency, τ. Normally τ lie between 0 and 1. However, there are extreme cases where τ reaches the upper limit 1: when dollarization occurs unofficially, the inhabitants of one country abandon domestic currency and use foreign money only.

Like traditional LM curve, money demand function now goes $\frac{M^{1-\tau}(SM^f)^\tau}{P_c} = k(Y,r)$. M and M^f are domestic holdings of home and foreign money, respectively. P_c is Consumer Price Index used to calculate real money balance. Domestic residents make adjustments in their holdings while acknowledging whatever the spot rate is. I conceptually convert the foreign currency holdings M^f into the domestic equivalence SM^f because residents calculate their total balances in domestic currency whenever people receive bank statement notice on foreign currency holdings (as Hong Kong banks report foreign currency balances in local currencies automatically). The Cobb-Douglas form of money demand on the left-hand side is for tractability. I make log liner specification to simplify algebra.

A second novelty is P_c. I postulate that P_c is a weighted average of domestic and foreign prices, P_h and P_f, respectively.

(3) $p_c = (1-\gamma)p_h + \gamma\left(s + p_f\right)$,

where γ measures the relative importance of foreign goods in domestic market. Or like τ mentioned above, γ can be thought of as a preference parameter: the more domestic consumers favor import goods, the bigger γ is. $0 \leq \gamma \leq 1$. $\gamma = 0$ indicates a closed economy.

To substitute s out, I use the definition of real exchange rate in Eq (2). That is

$$(4) \quad p_c = p_h + \gamma e$$

In logarithm, money market equilibrium is given as

$$(5) \quad (1-\tau)m + \tau(s + m^f) - p_c = \alpha y - \beta r, \qquad \alpha, \beta > 0.$$

2.3. Labor Market

Labor market comprises two sides: the demand for labor is derived from production while the supply of labor is a typical upward sloping curve.

2.3.1 Labor Demand

The demand for labor is a derived demand. Employer's demand for labor is a function of the characteristics of demand in the product market. It is also a function of the characteristics of the production process. The standard model of labor demand is the marginal productivity theory of demand. In a perfect competitive product market, firms sell their products at price P and pay workers a wage rate W. The goal is to maximize profit $PY - WN$, where Y is output and N is labor employed. Further assume that the production function takes Cobb-Douglas form with labor being the only input. According to the marginal decision rule, firms should hire additional workers as long as the marginal revenue exceeds the marginal cost on labor. That is

$P\frac{\partial Y}{\partial N} - W > 0$, given that firms have no control over product price. The theory predicts that the optimal level of employment should be when real wage equates marginal product of labor. Since marginal product of labor ($\frac{\partial Y}{\partial N}$) is decreasing in labor employed, the explicit solution for employment is usually expressed as $N = f(W/P)$ with $f^{'}(\cdot) < 0$. Graphically, it's a typical downward sloping demand curve.

As argued above, one key factor is the price that firms can charge for their product. Here I postulate that firms take in two prices: P_h in home currency for domestic sales and the international price P_f for exports respectively. This is consistent with my premise of an 'open' economy. For simplicity, I use p_c as defined above. Now demand for labor takes the following form:

$$(6)\ n = -\theta(w - p_c),\ \theta > 0$$

where n is log total employment. w is log domestic money wage. θ is own wage elasticity defined as the absolute value of percentage change in employment given a 1% change in the wage rate. The negative sign is implied by the fact that n and w move in opposite directions. Normally there are three possibilities: if $\theta > 1$, then labor demand is elastic and is very responsive to wage changes; if $\theta = 1$, then labor demand changes the exact percent that wage changes; if $\theta < 1$, then labor demand is said to be inelastic. I rule out the extreme cases of perfectly inelastic and infinitely elastic demand. The magnitude of θ is of special interest to policy makers. It follows naturally to ask what determines the value of θ, namely, the wage elasticity of labor demand. Generally, labor demand will be more elastic when: the substitution effect is large, and/ or the scale effect is large. Hicks-Marshall laws of derived demand identifies four factors affecting θ The laws state that other things being equal, labor demand is high under the following conditions: 1. when the price elasticity of product being produced with labor is high (through the scale effect); 2. when there are close substitutes available (through the substitution effect); 3. when the supply of other factors of production is highly elastic (through the substitution effect); 4. when the labor costs are a large share of the total cost of production (through the scale effect). For detailed summaries of empirical work on labor demand, see Hamermesh (1993).

2.3.2 Labor Supply

The supply-side of markets for labor describes total quantities offered on the market at various prices. Although many individual labor supply curves might be backward bending, the aggregate supply curve will generally be positively sloped.

Following Revenga (1992), I assume that the labor supply is represented by a smooth upward supply curve:

$$(7) \quad l = b_0 + b_1(w - p_h) \qquad b_0, b_1 > 0$$

The idea of deflating wage by domestic price is that workers take real wage into consideration when offering labor.

I intend to substitute p_h for y in order to consider the relationship between the labor demand and the aggregate income in this open economy context. According to Dornbusch and Fischer (1994), inflation rate π responds in proportion to excess output $y - \bar{y}$ where $\bar{y}$ is the full-employment level of output. To get the focus, I define π as log price of domestically produced goods. Thus

(8) $p_h = \lambda(y - \bar{y}) \qquad \lambda > 0$

2.4. Exchange Rate Impact on Employment

First I examine the exchange rate impact on employment when labor market is in equilibrium. That is

(9) $n = l$

Before proceeding further, it is helpful to restrict attention to key variables and organize the model into four equations for three markets respectively. Using four structural equations

(1) $y = \delta e - \sigma r + h$

(5) $(1 - \tau)m + \tau(s + m^f) - p_c = \alpha y - \beta r$

(6) $n = -\theta(w - p_c)$

(7) $l = b_0 + b_1(w - p_h)$

and three identities

(2) $e = s + p_f - p_h$

(3) $p_c = (1-\gamma)p_h + \gamma(s + p_f)$

(8) $p_h = \lambda(y - \bar{y})$

(9) $n = l$

I describe the system as follows:

$y = \delta e - \sigma r + h$

$(1-\tau)m + \tau[e + \lambda(y - \bar{y}) - p_f] + \tau m^f - [\lambda(y - \bar{y}) + \gamma e] = \alpha y - \beta r$

$n = \theta[\lambda(y - \bar{y}) + \gamma e] - \theta w$

$n = b_0 + b_1 w - b_1 \lambda(y - \bar{y})$

In order to see how this model operates, I first list the exogenous variables, namely, e, m, p_f, m^f. Given these, the first two equations determine output y and interest rate r. Total employment n and wage rate w is then given by the labor market.

Take total differential of them and arrange them in matrix forms. I get

$$\begin{bmatrix} 1 & \sigma & 0 & 0 \\ \alpha + (1-\tau)\lambda & -\beta & 0 & 0 \\ -\theta\lambda & 0 & 1 & \theta \\ -b_1\lambda & 0 & -1 & b_1 \end{bmatrix} \begin{bmatrix} dy \\ dr \\ dn \\ dw \end{bmatrix} = \begin{bmatrix} \delta & 0 & 0 & 0 \\ \tau - \gamma & 1-\tau & -\tau & \tau \\ \theta\gamma & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} de \\ dm \\ dp_f \\ dm^f \end{bmatrix}$$

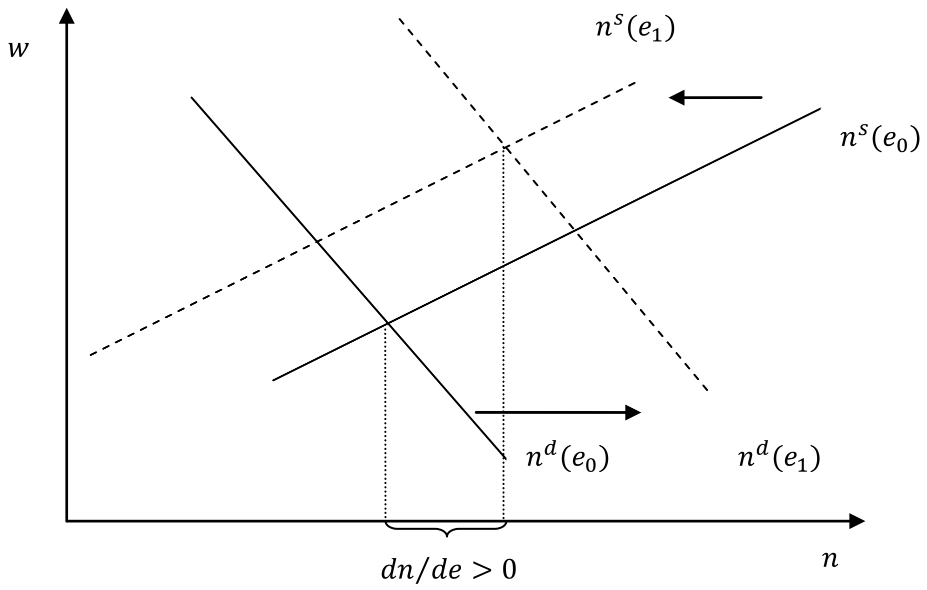
First consider the exchange rate impact on total employment. By Cramer's rule, I have

$$\frac{\partial n}{\partial e} = \frac{\begin{vmatrix} 1 & \sigma & \delta & 0 \\ \alpha + (1-\tau)\lambda & -\beta & \tau - \gamma & 0 \\ -\theta\lambda & 0 & \theta\gamma & \theta \\ -b_1\lambda & 0 & 0 & b_1 \end{vmatrix}}{\begin{vmatrix} 1 & \sigma & 0 & 0 \\ \alpha + (1-\tau)\lambda & -\beta & 0 & 0 \\ -\theta\lambda & 0 & 1 & \theta \\ -b_1\lambda & 0 & -1 & b_1 \end{vmatrix}} = \frac{-\gamma b_1 \theta[\beta + \sigma\alpha + \sigma(1-\tau)\lambda]}{-[\beta + \sigma\alpha + \sigma(1-\tau)\lambda](b_1 + \theta)}$$

$$= \frac{\gamma b_1 \theta}{b_1 + \theta}$$

I could conclude that $\frac{\partial n}{\partial e} > 0$. Thus the exchange rate effect on total employment is unconditionally positive.

Intuitively, a rise in real exchange rate (the real depreciation of home currency) will promote export which contributes to domestic output. Thus firms ask for more labor input and increase total employment. Or I could tell from the system: the two equations describing goods and money markets are self contained and can solve for (y, r). Since the interest rate doesn't enter the labor market equations and there are no exogenous shifters in labor supply, I have two channels for exchange rate to alter labor: (1) domestic price p_h determined by output y which is affected by e; and (2) the γe component of p_c in demand for labor. It is clear that both domestic price and real exchange rate shifts out labor demand while the former one shifts the supply curve inward. However, the exchange rate impact on labor demand dominates that on labor supply. Thus I have a final positive effect on total employment. Graphically,



I will present other results derived from the matrix in the Appendix. Although they are not the focus of the paper, they give a complete picture of the discussion.

2.5. Exchange Rate Impact on Unemployment

Now I don't have equality between labor demand and supply anymore. The unemployment rate is defined as

(9) $u = l - n$

The question remains what determines wage if it does not adjust to equate labor demand and supply. I propose that wage is generated through a collective bargaining process. I look at two major sets of models in the micro foundations of the wage-setting process in an imperfectly competitive labor market. The first one assumes that wages are set though bargaining between labor unions and employers. In this framework, union members maximize the expected utility through choosing real wages and employment. They bargain with the firm in the knowledge that the firm will set the level of employment on the demand-for labor curve. Or the two parties could choose to bargain over both the wage and the level of employment. Second, a strand of theories, known as efficiency wages, has developed to account for unemployment in a non-union environment. The essence of such models is that real wages directly affects productivity and therefore the firm's profit. Thus the employer is motivated to pay a premium wage over the market-clearing level for a variety of reasons: to reduce turnover costs (Salop, 1979), to reduce the incentive to shirk on work (Shapiro and Stiglitz, 1984), or else.

The central idea of these micro models is that wage payment depends on a mixture of internal and external pressures[9]. I draw on the key results from them in an intuitive manner. Wage setting is given as

$$(10) \quad w - p_h = c_0 - c_1 u \qquad c_0, c_1 > 0$$

This equation reflects two facts:

(1) while bargaining, workers are concerned with their real wage rather than nominal wage, about how much they could consume within their income budget constraint. This is the intuition for using $w - p_h$.

(2) a key determinant is the state of the labor market, and in particular the unemployment rate, since the higher and rampant unemployment reduces the bargaining power on real wage.

[9] For example, in Shapiro and Stiglitz (1984), market wages are an increasing function of any variable that shifts out the labor demand curve, and a decreasing function of the unemployment.

Of special importance is c_1, i.e., the unemployment impact on money wage. Marx first developed the concept of reserve army of labor in his analysis of capitalism. He argues that the unemployment exerts a disciplinary influence on workers and undermines the bargaining power of unions. Here I refer unemployment to the state of labor market. When unemployment rises, workers become more concerned about retaining their current jobs than raising wages, so less emphasis is placed on wage demand. On the other side, since firms have a larger pool of employable workers, their wages offers can be expected to decline. Or conversely, a tight labor market is typically brought by a booming product market. In such a case, strike actions organized by the union would pose a credible threat to business viability. Thus, It is usually with this awareness that firms agree to the union's higher wage claim. Either way, the wage is negatively related to unemployment.

The system is now

$$y = \delta e - \sigma r + h$$

$$(1-\tau)m + \tau\left[e + \lambda(y-\bar{y}) - p_f\right] + \tau m^f - [\lambda(y-\bar{y}) + \gamma e] = \alpha y - \beta r$$

$$u + \theta[\lambda(y-\bar{y}) + \gamma e] - \theta w = b_0 + b_1 w - b_1\lambda(y-\bar{y})$$

$$w - \lambda(y-\bar{y}) = c_0 - c_1 u$$

Again, the first two equations determine output y and interest rate r. Total employment n and wage rate w is then given by the labor market.

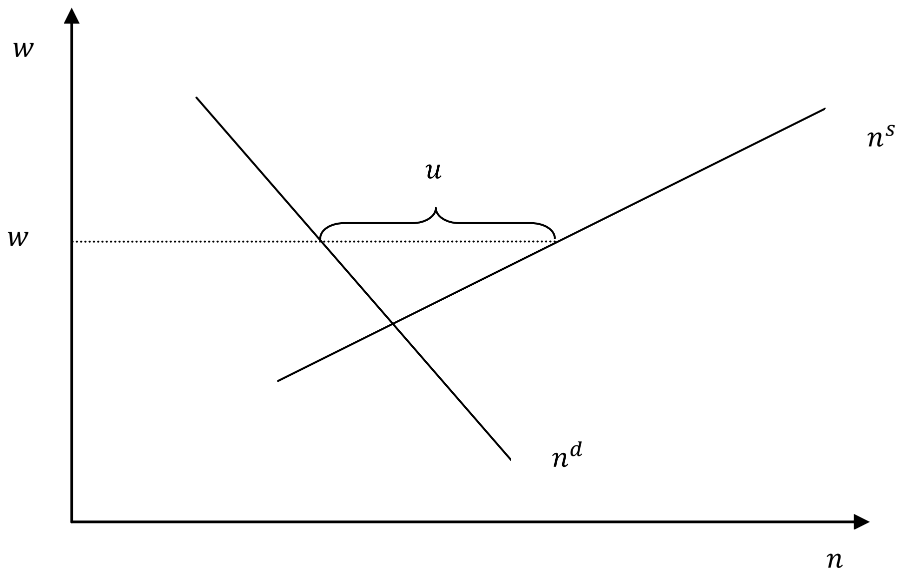
The matrix:

$$\begin{bmatrix} 1 & \sigma & 0 & 0 \\ \alpha+(1-\tau)\lambda & -\beta & 0 & 0 \\ (\theta+b_1)\lambda & 0 & 1 & -(b_1+\theta) \\ -\lambda & 0 & c_1 & 1 \end{bmatrix} \begin{bmatrix} dy \\ dr \\ du \\ dw \end{bmatrix} = \begin{bmatrix} \delta & 0 & 0 & 0 \\ \tau-\gamma & 1-\tau & -\tau & \tau \\ -\theta\gamma & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} de \\ dm \\ dp_f \\ dm^f \end{bmatrix}$$

By Cramer's rule, I have

$$\frac{\partial u}{\partial e} = \frac{\begin{vmatrix} 1 & \sigma & \delta & 0 \\ \alpha+(1-\tau)\lambda & -\beta & \tau-\gamma & 0 \\ (\theta+b_1)\lambda & 0 & -\theta\gamma & -(b_1+\theta) \\ -\lambda & 0 & 0 & 1 \end{vmatrix}}{\begin{vmatrix} 1 & \sigma & 0 & 0 \\ \alpha+(1-\tau)\lambda & -\beta & 0 & 0 \\ (\theta+b_1)\lambda & 0 & 1 & -(b_1+\theta) \\ -\lambda & 0 & c_1 & 1 \end{vmatrix}} = -\frac{\theta\gamma}{c_1(b_1+\theta)+1}$$

Unemployment is negatively related to real exchange rate. This result is consistent with previous positive exchange rate effect on employment. Only this time, wages are determined by negotiation and do not fall to clear labor market.



3. Import Competition in the Model

3.1. How Import Competition Affects Labor Demand

I continue to adopt all the same equations in goods and money markets. But I focus my attention on unemployment. One of the most hotly debated subjects facing economic policymakers is the issue of imports and, in particular, the threat of foreign competition to domestic jobs. As suggested by Revenga (1992), the link between import competition and domestic labor market is straightforward: in principle, a change in import competition shifts industry product demand, which will in turn shift labor demand in the same direction. When foreign producers charge higher prices for goods imported to 'our' country, they will be partly pricing themselves out of the domestic market. Local firms therefore will gain a greater share of business and ask for more labor input. Conversely, a cut in the import price may harm local business and exert a negative effect on labor demand. In a word, $N = f(P^M, W)$ with $\frac{\partial f}{\partial P^M} > 0$.

For my study, I specify labor demand depends positively on home currency value of imports and negatively on money wage:

$$(6)\ n = \theta_1(s + p_f) - \theta_2(w - p_c), \quad \theta_2 > \theta_1 > 0$$

where n is log total employment. w is log domestic money wage. θ_1 measures the labor responsiveness to import competition according to Revenga (QJE 1992). θ_2 is the own wage elasticity . It is natural to assume that θ_2 dominates θ_1.

3.2. Exchange Rate Impact on Total Employment

I have 5 equations describing the markets:

(1) $y = \delta e - \sigma r + h$

(5) $(1 - \tau)m + \tau(s + m^f) - p_c = \alpha y - \beta r$

(6) $n = \theta_1(s + p_f) - \theta_2(w - p_c)$

(7) $l = b_0 + b_1(w - p_h)$

and four identities

(2) $e = s + p_f - p_h$

(3) $p_c = (1 - \gamma)p_h + \gamma(s + p_f)$

(8) $p_h = \lambda(y - \bar{y})$

(9) $l = n$

Substituting prices away and I describe the system as follows:

$$y = \delta e - \sigma r + h$$

$$(1 - \tau)m + \tau[e + \lambda(y - \bar{y}) - p_f] + \tau m^f - [\lambda(y - \bar{y}) + \gamma e] = \alpha y - \beta r$$

$$n = \theta_1[\lambda(y - \bar{y}) + e] - \theta_2 w + \theta_2[\lambda(y - \bar{y}) + \gamma e]$$

$$n = b_0 + b_1 w - b_1\lambda(y - \bar{y})$$

We again put them into

$$\begin{bmatrix} 1 & \sigma & 0 & 0 \\ \alpha+(1-\tau)\lambda & -\beta & 0 & 0 \\ (\theta_1+\theta_2)\lambda & 0 & -1 & -\theta_2 \\ b_1\lambda & 0 & 1 & -b_1 \end{bmatrix} \begin{bmatrix} dy \\ dr \\ dn \\ dw \end{bmatrix} = \begin{bmatrix} \delta & 0 & 0 & 0 \\ \tau-\gamma & 1-\tau & -\tau & \tau \\ -(\theta_1+\theta_2\gamma) & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} de \\ dm \\ dp_f \\ dm^f \end{bmatrix}$$

As before, the two equations describing goods and money markets are self contained and can solve for (y, r). The interest rate doesn't enter the labor market equations either.

$$\frac{\partial n}{\partial e} = \frac{\begin{vmatrix} 1 & \sigma & \delta & 0 \\ \alpha+(1-\tau)\lambda & -\beta & \tau-\gamma & 0 \\ (\theta_1+\theta_2)\lambda & 0 & -(\theta_1+\theta_2\gamma) & -\theta_2 \\ b_1\lambda & 0 & 0 & -b_1 \end{vmatrix}}{\begin{vmatrix} 1 & \sigma & 0 & 0 \\ \alpha+(1-\tau)\lambda & -\beta & 0 & 0 \\ (\theta_1+\theta_2)\lambda & 0 & -1 & -\theta_2 \\ b_1\lambda & 0 & -1 & b_1 \end{vmatrix}}$$

$$= \frac{b_1[\beta+\sigma\alpha+\sigma\lambda(1-\gamma)+\beta\delta\lambda]\theta_1 + b_1[\beta+\sigma\alpha+\sigma(1-\tau)\lambda]\gamma\theta_2}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda](b_1+\theta_2)}$$

$$= \frac{b_1[\beta+\sigma\alpha+\sigma\lambda(1-\gamma)+\beta\delta\lambda]\theta_1}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda](b_1+\theta_2)} + \frac{\gamma b_1\theta}{b_1+\theta}$$

Although this complex result makes it difficult to get the economic information, I can tell that it is unconditionally positive. I also find that the second component of this result, namely, $\frac{\gamma b_1\theta}{b_1+\theta}$ is exactly the exchange rate effect on employment when there is no import competition. A real depreciation of home currency is even more beneficial to labor market than before.

3.3. Exchange Rate Impact on Unemployment

As in Section 2.5, unemployment is the disequilibrium between supply and demand:

(7) $n = \theta_1 p_f - \theta_2 w$

The system now is

$$y = \delta e - \sigma r + h$$

$$(1-\tau)m + \tau\left[e + \lambda(y - \bar{y}) - p_f\right] + \tau m^f - [\lambda(y - \bar{y}) + \gamma e] = \alpha y - \beta r$$

$$u + \theta_1[\lambda(y - \bar{y}) + e] - \theta_2 w + \theta_2[\lambda(y - \bar{y}) + \gamma e] = b_0 + b_1 w - b_1\lambda(y - \bar{y})$$

$$w - \lambda(y - \bar{y}) = c_0 - c_1 u$$

In matrix:

$$\begin{bmatrix} 1 & \sigma & 0 & 0 \\ \alpha + (1-\tau)\lambda & -\beta & 0 & 0 \\ (\theta_1 + \theta_2 + b_1)\lambda & 0 & 1 & -(b_1 + \theta_2) \\ -\lambda & 0 & c_1 & 1 \end{bmatrix} \begin{bmatrix} dy \\ dr \\ du \\ dw \end{bmatrix} =$$

$$\begin{bmatrix} \delta & 0 & 0 & 0 \\ \tau - \gamma & 1-\tau & -\tau & \tau \\ -(\theta_1 + \theta_2\gamma) & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} de \\ dm \\ dp_f \\ dm^f \end{bmatrix}$$

By Cramer's rule,

$$\frac{\partial u}{\partial e}=\frac{\begin{vmatrix}1 & \sigma & \delta & 0\\ \alpha+(1-\tau)\lambda & -\beta & \tau-\gamma & 0\\ (\theta_1+\theta_2+b_1)\lambda & 0 & -(\theta_1+\theta_2\gamma) & -(b_1+\theta_2)\\ -\lambda & 0 & 0 & 1\end{vmatrix}}{\begin{vmatrix}1 & \sigma & 0 & 0\\ \alpha+(1-\tau)\lambda & -\beta & 0 & 0\\ (\theta_1+\theta_2+b_1)\lambda & 0 & 1 & -(b_1+\theta_2)\\ -\lambda & 0 & c_1 & 1\end{vmatrix}}$$

$$=-\frac{\theta_1[\beta+\sigma\alpha+\sigma\lambda(1-\gamma)+\lambda\beta\delta]+\theta_2\gamma[\beta+\sigma\alpha+\sigma(1-\tau)\lambda]}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda][c_1(b_1+\theta_2)+1]}$$

$$=-\frac{\theta_1[\beta+\sigma\alpha+\sigma\lambda(1-\gamma)+\lambda\beta\delta]}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda][c_1(b_1+\theta_2)+1]}-\frac{\theta_2\gamma}{c_1(b_1+\theta_2)+1}$$

I conclude that $\frac{\partial u}{\partial e}<0$. The $-\frac{\theta_2\gamma}{c_1(b_1+\theta_2)+1}$ component is the result in section 2.5 where no import exists. I see a more significant exchange rate impact on unemployment.

4. Data and Results

In this section, I apply the model to analyze the empirical case of Hong Kong. Based on the solution from Section 2, I run regression on the following two equations:

$$n = \alpha_0 + \alpha_1 e + \alpha_2 m + \alpha_3 p_f + \alpha_4 m^f + \varepsilon$$

$$u = \beta_0 + \beta_1 e + \beta_2 m + \beta_3 p_f + \beta_4 m^f + \epsilon$$

The key coefficients that I are interested in are α_1, the effect of exchange rate on employment, and β_1, the impact on unemployment. To summarize what I would expect from estimating these two equations with Hong Kong data: (1) α_1 should be positive as the theory predicts; and (2) β_1 should be negative.

Monthly data on Hong Kong (1997M04-2009M09) are collected from DATASTREAM. n is overall employment while u is unemployment rate. For e, I use effective exchange rate deflated by CPI. m is M2 money supply of Hong Kong dollars and m^f is the counterpart of foreign currency. p_f is import value index. I take natural log of all series except the unemployment rate. Table 4.1 reports the ADF unit root test. The critical value indicates that all the data are *I(1)* series.

Further check of Johansen test finds co-integrated relationship among the relevant variables. P value of the trace statistics are reported in the last row of Table 4.2. The second column regression with n being the dependent variable shows that when real exchange rate rises by one per cent, total employment will increase 0.121 per cent. If the employment population is 3 million, approximately as the data set reports, then 3,630 more workers will be employed. I regress unemployment on the same set of independent variables and the results are given in the third column. The exchange rate coefficient is statistically significant and negative. Thus the results are consistent with what I predict from the model.

Chapter 6 Conclusion

This paper has demonstrated the mechanism of unemployment. Intuitively, this transmission effect is natural. If the currency base country has higher unemployment, the inflation rate would decline on the premise of inflation-unemployment tradeoff, which comes from Phillips curve that I use as a building block. This affects the inflation rate of the currency linked economy like Hong Kong. Indeed, the linked exchange rate system helps to narrow the gap between the interest rates in Hong Kong and those of the United States. This is one of the goals among gaining fiscal discipline and financial stability. The interest rate of currency linked country thus moves in the same direction with the base country and its unemployment would go up. By using Hong Kong data, I find that one percent increase in the U.S. unemployment rate transmits 0.53 percent increase in Hong Kong. The results consistently suggest a robust and strong transmission effect.

Similar patterns show up in the Europe. After the launch of euro, I find that for one percent increase in the Germany unemployment, there is about 0.224% increase in the France unemployment. The transmission effects are significant, which partially explain the severity of this long-lasting problem.

Under the floating system, I analyze this problem in France and Germany before 1999 when euro was first introduced. The magnitude of the transmitted unemployment from Germany to France is 0.091%, smaller than the 0.224% figure after 1999. This may signify that the transmission effect is intensified because of euro.

I'm well aware that this model relies heavily on the PPP theory and the Phillips curve. The discussion may go further and deeper in either of these two theories. However, I hope to offer a new angle to consider the unemployment problem in a global context.

To discuss more thoroughly, I take the second endeavor by constructing a three sector model. I find that the exchange rate effect on total employment is unconditionally positive and negative on unemployment. These results take roots in the assumption that labor demand is more affected by exchange rate movements than labor supply is. A second issue is that after import competition is introduced to the model, those effects are more significant in the sense that a depreciation of home currency helps employment and cures unemployment even more than it did when there are no foreign competitors in domestic product market. The empirical analysis on Hong Kong confirms those effects do exist. I intend to test the theory on more countries in future studies.

Appendix

Part A

Table 1: Reports of the ADF unit root tests (Hong Kong and the United State)

		code	level	critical value	1st diff	critical value
Unemployment[1]	U_{US}	USUN%TOTQ	-1.033	-3.425	-3.931	-2.871
	U_{HK}	HKUN%TOTQ	-2.477	-3.424	-7.146	-2.871
US-CPI	P_{US}	USOCP009E	-2.401	-3.424	-11.723	-2.871
	π_{US}		-11.638	-3.424		
HK-Hang Seng CPI	P_{HK}	HKCONPRHF	-2.296	-3.424	-1.579	-2.871
	π_{HK}		-1.695	-3.425	-10.194	-2.871
	$d\pi_1^e$		-1.811	-3.425	-10.723	-2.871
	$d\pi_2^e$		-10.714	-3.425		
	$d\pi_3^e$		-19.271	-3.424		
HK-CPI-M	P_{HK}	HKCONPRCF	-1.357	-3.425	-2.713	-2.871
	π_{HK}		-2.850	-3.425	-13.254	-2.871
	$d\pi_1^e$		-15.386	-3.424		
	$d\pi_2^e$		-11.154	-3.425		
	$d\pi_3^e$		-17.430	-3.424		
HK-CPI-IFS	P_{HK}	HKI64...F	-1.381	-3.425	-2.680	-2.871
	π_{HK}		-2.783	-3.425	-13.448	-2.871
	$d\pi_1^e$		-1.806	-3.425	-11.417	-2.871
	$d\pi_2^e$		-11.418	-3.425		
	$d\pi_3^e$		-17.391	-3.424		

Notes:

1. According to Hong Kong Monthly Digest of Statistics publish by Census and Statistic Department:

   Statistics on labor force, unemployment and underemployment are compiled based on data obtained from the General Household Survey.

   The labor force refers to the land-based non-institutional population aged 15 and over who satisfy the criteria for inclusion in the employed population or the unemployed population. The labor force participation rate refers to the proportion of labor force in the land-based non-institutional population aged 15 and over.

   The employed population consists of persons aged 15 and over who have been at work for pay or profit during the 7 days before enumeration or who have had formal job attachment.

   The unemployed population comprises all those persons aged 15 and over who fulfill the following conditions:

   (a) have not had a job and have not performed any work for pay or profit during the 7 days before enumeration; and
   (b) have been available for work during the 7 days before enumeration; and
   (c) have sought work during the 30 days before enumeration.

   However, if a person aged 15 or over fulfils the conditions (a) and (b) above but has not sought work during the 30 days before enumeration because he/she believed that work was not available, he/she is still classified as unemployed, being regarded as a so-called "discouraged worker".

   Notwithstanding the above, the following types of persons are also classified as unemployed:

   (a) persons without a job, have sought work but have not been available for work because of temporary sickness; and
   (b) persons without a job, have been available for work but have not sought work because they:
      (i) have made arrangements to take up a new job or to start business at a subsequent date; or
      (ii) were expecting to return to their original jobs.

   The unemployment rate refers to the proportion of unemployed persons in the labor force.

Table 2: Reports of the results from Error Correction Model with Hong Kong unemployment as the dependent variable (t-value) and [p-value]

$$\Delta U_{At} = \beta_0 + \beta_1 \Delta U_{Bt} + \beta_2 \Delta(\pi^e_{At} - \pi^e_{Bt}) + \beta_3 \hat{e}_{t-1} + \varepsilon_t$$

A=Hong Kong, B=the United States

	β_0	β_1	β_2	β_3	Johansen	Elas β_1	notes
$\pi^e_t = \pi_t$	0.001	0.245	-0.011	-0.006	4.190**	0.5281	1
	(0.126)	**(4.029)**	(-0.827)	(-0.984)	[0.0406]		2
	0.001	0.245	-0.003	-0.004	2.015		3
	(0.126)	**(4.029)**	(-0.286)	(-0.753)	[0.1557]		
	0.001	0.244	-0.005	-0.004	2.013		4
	(0.152)	**(3.991)**	(-0.402)	(-0.700)	[0.1559]		
$\pi^e_t = \pi_t - \pi_{t-1}$	0.001	0.244	-0.002	-0.004	2.829*	0.5269	5
	(0.149)	**(4.000)**	(-0.189)	(-0.841)	[0.0926]		
	0.001	0.247	0.002	-0.004	2.804*	0.5334	6
	(0.126)	**(4.059)**	(0.364)	(-0.878)	[0.094]		
	0.001	0.246	0.002	-0.004	2.750*	0.5305	7
	(0.149)	**(4.026)**	(0.256)	(-0.845)	[0.0973]		
$\pi^e_t = (\pi_t - \pi_{t-1})/\pi_t$	0.001	0.246	0.001	-0.004	2.406		8
	(0.125)	**(4.050)**	(0.353)	(-0.783)	[0.1208]		
	0.001	0.245	-0.0003	-0.004	2.734*	0.5292	9
	(0.125)	**(4.032)**	(-0.217)	(-0.780)	[0.0982]		
	0.001	0.244	-0.0004	-0.004	2.662		10
	(0.151)	**(4.007)**	(-0.283)	(-0.739)	[0.1028]		

Notes:

1. This is the regression using Hong Kong Hang Seng CPI and treating the expected inflation as the actual inflation.
2. The elasticity 0.5281 is the average of all elasticities calculated by taking the estimated coefficient β_1 to multiply the actual data points of the U.S. unemployment and divided by the actual data points of the Hong Kong

unemployment. This rule applies to all subsequent computations for other elasticities reported in different rows.

3. This is the regression using Hong Kong CPI M and treating the expected inflation as the actual inflation.
4. This is the regression using Hong Kong CPI (IFS) and treating the expected inflation as the actual inflation.
5. This is the regression using Hong Kong Hang Seng CPI and treating expected inflation as the difference in actual inflation between time t and t-1.
6. This is the regression using Hong Kong CPI M and treating expected inflation as the difference in actual inflation between time t and t-1.
7. This is the regression using Hong Kong CPI (IFS) and treating expected inflation as the difference in actual inflation between time t and t-1.
8. This is the regression using Hong Kong Hang Seng CPI and treating expected inflation as the percentage changes in actual inflation.
9. This is the regression using Hong Kong CPI M and treating expected inflation as the percentage changes in actual inflation.
10. This is the regression using Hong Kong CPI (IFS) and treating expected inflation as the percentage changes in actual inflation.

Part B

Table 1a: Reports of the ADF unit root tests after euro (1999M3-2009M12)

		code	level	critical value	1st diff	critical value
Unemployment	U_{BD}	BDUN%TOTQ	-1.352	-3.446	-4.532	-2.884
	U_{FR}	FROUN014Q	-3.684	-3.447		
Germany CPI	P_{BD}	BDOCP009F	-2.262	-3.445	-15.744	-2.884
	π_{BD}		-15.8	-3.445		
France CPI	P_{FR}	FRI64…F	-2.747	-3.445	-10.334	-2.884
	π_{FR}		-10.340	-3.445		
	$d\pi^e_{1,FR\_BD}$		-2.174	-3.449	-8.3092	-2.886
	$d\pi^e_{2,FR\_BD}$		-8.255	-3.448		
	$d\pi^e_{3,FR\_BD}$		-10.913	-3.445		

Table 1b: Reports of the ADF unit root tests before euro (1978M03-1998M12)

		code	level	critical value	1st diff	critical value
Unemployment	U_{BD}	BDUN%TOTQ	-1.641	-3.428	-6.254	-2.873
	U_{FR}	FROUN014Q	-2.192	-3.428	-4.373	-2.873
Germany CPI	P_{BD}	BDOCP009F	-1.192	-3.428	-11.338	-2.873
	π_{BD}		-11.124	-3.428		
France CPI	P_{FR}	FRI64…F	-0.708	-3.428	-1.951	-2.873
	π_{FR}		-2.861	-3.428	-14.484	-2.873
	$d\pi^e_{1,FR\_BD}$		-12.310	-3.428		
	$d\pi^e_{2,FR\_BD}$		-10.695	-3.429		
	$d\pi^e_{3,FR\_BD}$		-18.099	-3.428		
Exchange rate	S_{FR_UK}	UKEFFR..	-2.479	-3.428	-14.173	-2.873
	S_{BD_UK}	UKEDMK..	-2.077	-3.428	-15.167	-2.873
	S_{FR_BD}		-0.483	-3.428	-15.195	-2.873
	$\dot{S}_{FR\_BD}$		-15.826	-3.428		
	S_{BD_FR}		-0.756	-3.428	-14.987	-2.873
	$\dot{S}_{BD\_FR}$		-15.856	-3.428		

Table 2a: Reports of the results from Error Correction Model with France unemployment as the dependent variable after 1999

$\Delta U_{At} = \alpha_0 + \alpha_1 \Delta U_{Bt} + \alpha_2 \Delta(\pi_{At}^e - \pi_{Bt}^e) + \alpha_3 \hat{e}_{t-1} + \varepsilon_t$

A=France, B=Germany

(t-value) and [p-value] are reported.

	α_0	α_1	α_2	α_3	Johansen	Elas α_1	notes
$\pi_t^e = \pi_t$	-0.002	0.206	-0.002	-0.015	4.137**	0.2248	(1)
	(-0.300)	**(3.394)**	(-0.135)	(-1.001)	[0.0419]		
$\pi_t^e = \pi_t - \pi_{t-1}$	-0.002	0.205	-0.0001	-0.015	4.254**	0.2244	
	(-0.300)	**(3.388)**	(-0.014)	(-1.018)	[0.0391]		
$\pi_t^e = (\pi_t - \pi_{t-1})/\pi_t$	-0.002	0.205	-0.00009	-0.016	4.224**	0.2243	
	(-0.298)	**(3.395)**	(-0.375)	(-1.063)	[0.0398]		

Notes:

1. The elasticity 0.2248 is the average of all elasticities calculated as in Part A, by taking the estimated coefficient α_1 to multiply the actual data points of the Germany unemployment and divided by the actual data points of the France unemployment.

Table 2b: Reports of the results from Error Correction Model with Germany unemployment as the dependent variable after 1999

$\Delta U_{Bt} = \beta_0 + \beta_1 \Delta U_{At} + \beta_2 \Delta(\pi^e_{Bt} - \pi^e_{At}) + \beta_3 \hat{e}_{t-1} + \varepsilon_t$

A=France, B=Germany

(t-value) and [p-value] are reported.

	β_0	β_1	β_2	β_3	Johansen	Elas β_1
$\pi^e_t = \pi_t$	-0.017	0.421	-0.014	0.007	1.429	
	(-1.498)	**(3.426)**	(-0.643)	(0.599)	[0.2319]	
$\pi^e_t = \pi_t - \pi_{t-1}$	-0.017	0.419	-0.008	0.007	1.484	
	(-0.150)	**(3.416)**	(-0.647)	(0.584)	[0.2231]	
$\pi^e_t = (\pi_t - \pi_{t-1})/\pi_t$	-0.017	0.423	-0.001	0.008	1.268	
	(-1.512)	**(3.445)**	(-0.402)	(0.658)	[0.2602]	

Hausman Specification Test

In the two country model, we have the following equations:

$$U_A = \alpha_0 + \alpha_1 U_B + \alpha_2(\pi_A^e - \pi_B^e) + \alpha_3 \dot{S}_{AB} + \alpha_4 \dot{S}_{AB} U_B + \alpha_5 \pi_B^e \dot{S}_{AB} + \varepsilon_1$$

$$U_B = \beta_0 + \beta_1 U_A + \beta_2(\pi_B^e - \pi_A^e) + \beta_3 \dot{S}_{BA} + \beta_4 \dot{S}_{BA} U_A + \beta_5 \pi_A^e \dot{S}_{BA} + \varepsilon_2$$

Define $U_A = Y_1$, $U_B = Y_2$, $\pi_A^e - \pi_B^e = X_1$, $\dot{S}_{AB} = X_2$, $\dot{S}_{AB} U_B = X_3$, $\pi_B^e \dot{S}_{AB} = X_4$, $\dot{S}_{BA} = X_5$, $\dot{S}_{BA} U_A = X_6$, $\pi_A^e \dot{S}_{BA} = X_7$. The Ys are endogenous and the Xs are exogenous.

The system is then written as

$Y_1 = \alpha_0 + \alpha_1 Y_2 + \alpha_2 X_1 + \alpha_3 X_2 + \alpha_4 X_3 + \alpha_5 X_4 + \varepsilon_1$ (1)

$Y_2 = \beta_0 + \beta_1 Y_1 + \beta_2 X_1 + \beta_3 X_5 + \beta_4 X_6 + \beta_5 X_7 + \varepsilon_2$ (2)

Note that we don't distinguish $\pi_A^e - \pi_B^e$ from $\pi_B^e - \pi_A^e$.

Solve the model and we obtain the reduced-form equations.

$Y_1 = \Pi_0 + \Pi_1 X_1 + \Pi_2 X_2 + \Pi_3 X_3 + \Pi_4 X_4 + \Pi_5 X_5 + \Pi_6 X_6 + \Pi_7 X_7 + \upsilon$ (3)

$Y_2 = \Pi_8 + \Pi_9 X_1 + \Pi_{10} X_2 + \Pi_{11} X_3 + \Pi_{12} X_4 + \Pi_{13} X_5 + \Pi_{14} X_6 + \Pi_{15} X_7 + \omega$ (4)

Estimating (3) by OLS, we obtain

$\hat{Y}_1 = \hat{\Pi}_0 + \hat{\Pi}_1 X_1 + \hat{\Pi}_2 X_2 + \hat{\Pi}_3 X_3 + \hat{\Pi}_4 X_4 + \hat{\Pi}_5 X_5 + \hat{\Pi}_6 X_6 + \hat{\Pi}_7 X_7$ (5)

Therefore,

$Y_1 = \hat{Y}_1 + \hat{\upsilon}$ (6)

$\hat{Y}_1$ is the fitted value of Y_1 and $\hat{\upsilon}$ is estimated residual. Substituting (6) into (2), we get

$Y_2 = \beta_0 + \beta_1 \hat{Y}_1 + \beta_1 \hat{\upsilon} + \beta_2 X_1 + \beta_3 X_5 + \beta_4 X_6 + \beta_5 X_7 + \varepsilon_2$ (7)

It there is no simultaneity, the correlation between $\hat{\upsilon}$ and ε_2 should be zero. Thus we run OLS on (7) to see if the coefficient of $\hat{\varepsilon}_1$ is statistically significant from zero.

Pindyck and Rubinfeld suggest using Y_1 instead of $\hat{Y}_1$.

$Y_2 = \delta_0 + \delta_1 Y_1 + \delta_2 \hat{\upsilon} + \delta_3 X_1 + \delta_4 X_5 + \delta_5 X_6 + \delta_6 X_7 + \varepsilon_2$ (8)

Table 3 Hausman test for France and Germany before 1999

Y_1	Y_2	π^e	$\hat{\delta}_2$	simultaneity
U_FR	U_BD	$\pi_t^e = \pi_t$	0.036647 (0.185596)	No
		$\pi_t^e = \pi_t - \pi_{t-1}$	0.188556 (1.143017)	No
		$\pi_t^e = \frac{\pi_t - \pi_{t-1}}{\pi_{t-1}}$	0.259341 (1.513234)	No

Table 4a: Reports of the results from Error Correction Model with France unemployment as the dependent variable before 1999

$$\Delta U_A = \alpha_0 + \alpha_1 \Delta U_B + \alpha_2 \Delta(\pi_A^e - \pi_B^e) + \alpha_3 \Delta \dot{S}_{AB} + \alpha_4 \Delta(\dot{S}_{AB} U_B) + \alpha_5 \Delta(\pi_B^e \dot{S}_{AB}) + \alpha_6 \hat{e}_{-1} + \varepsilon_1$$

A=France, B=Germany

(t-value) and [p-value] are reported.

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	Johansen	Elas α_1	notes
$\pi_t^e = \pi_t$	0.023***	0.112***	-0.005	0.017	-0.003	-0.004	-0.012	8.452***	0.091	(1)
	(3.600)	**(2.868)**	(-0.290)	(0.848)	(-0.977)	(-0.368)	(-1.190)	[0.0036]		
$\pi_t^e = \pi_t - \pi_{t-1}$	0.023***	0.111***	0.003	0.012	-0.002	-0.002	-0.008	2.153		
	(3.613)	**(2.848)**	(0.374)	(0.674)	(-0.731)	(-0.731)	(-0.903)	[0.1468]		
$\pi_t^e = (\pi_t - \pi_{t-1})/\pi_t$	0.022***	0.117***	0.005*	0.014	-0.003	-0.003	-0.008	2.1572		
	(3.680)	**(3.003)**	**(1.737)**	(0.814)	(-1.010)	(-0.608)	(-0.949)	[0.1419]		

(1) The elasticity is the average of all elasticities calculated by taking the estimated coefficient α_1 to multiply the actual data points of the Germany unemployment and divided by the actual data points of the France unemployment. This rule applies to all subsequent computations for other elasticities reported in different rows.

Table 4b: Reports of the results from Error Correction Model with Germany unemployment as the dependent before 1999

$$\Delta U_B = \beta_0 + \beta_1 \Delta U_A + \beta_2 \Delta(\pi_B^e - \pi_A^e) + \beta_3 \Delta \dot{S}_{BA} + \beta_4 \Delta(\dot{S}_{BA} U_A) + \beta_5 \Delta(\pi_A^e \dot{S}_{BA}) + \beta_6 \hat{e}_{-1} + \varepsilon_2$$

A=France, B=Germany

(t-value) and [p-value] are reported.

	β_0	β_1	β_2	β_3	β_4	β_5	β_6	Johansen	Elas β_1	notes
$\pi_t^e = \pi_t$	0.021**	0.268***	0.020	0.001	-0.001	0.006	-0.029**	8.4520***	0.3374	
	(2.014)	**(2.623)**	(0.790)	(0.019)	(-0.128)	(0.232)	**(-2.479)**	[0.0036]		
$\pi_t^e = \pi_t - \pi_{t-1}$	0.021**	0.265**	0.007	0.008	-0.001	0.004	-0.027**	7.9830***	0.3329	
	(2.019)	**(2.581)**	(0.496)	(0.220)	(-0.272)	(0.166)	**(-2.331)**	[0.0047]		
$\pi_t^e = (\pi_t - \pi_{t-1})/\pi_t$	0.020**	0.284***	-0.008*	0.018	-0.002	0.029	-0.026**	7.1862***	0.3577	
	(1.990)	**(2.785)**	**(-1.799)**	(0.483)	(-0.557)	(0.161)	**(-2.298)**	[0.0073]		

Table 5 Hausman Test for United Kingdom

(t-value) are reported.

Y_1	Y_2	π^e	$\hat{\delta}_2$	simultaneity
U_BD	U_UK	$\pi_t^e = \pi_t$	0.808581 (1.581762)	No
		$\pi_t^e = \pi_t - \pi_{t-1}$	0.634162 (1.257208)	No
		$\pi_t^e = \frac{\pi_t - \pi_{t-1}}{\pi_{t-1}}$	0.530991 (0.721957)	No
U_FR	U_UK	$\pi_t^e = \pi_t$	1.075783* (1.799655)	Yes
		$\pi_t^e = \pi_t - \pi_{t-1}$	-0.279694 (-0.221170)	No
		$\pi_t^e = \frac{\pi_t - \pi_{t-1}}{\pi_{t-1}}$	-0.488643 (-0.289478)	No

Table 6: Reports of the results from Error Correction Model with UK unemployment as the dependent variable (t-value) and [p-value]

$$\Delta U_B = \beta_0 + \beta_1 \Delta U_A + \beta_2 \Delta(\pi_B^e - \pi_A^e) + \beta_3 \Delta \dot{S}_{BA} + \beta_4 \Delta(\dot{S}_{BA} U_A) + \beta_5 \Delta(\pi_A^e \dot{S}_{BA}) + \beta_6 \hat{e}_{-1} + \varepsilon_2$$

A=Germany, B=UK

	β_0	β_1	β_2	β_3	β_4	β_5	β_6	Johansen	Elas β_1	notes
$\pi_t^e = \pi_t$	0.004	0.139***	0.002	0.002	-0.0002	-0.002	-0.007**	4.0864**	0.1715	(1)
	(0.581)	**(3.255)**	(0.229)	(0.223)	(-0.215)	(-0.320)	**(-2.320)**	[0.0432]		
$\pi_t^e = \pi_t - \pi_{t-1}$	0.004	0.138***	0.003	0.002	-0.0003	-0.003	-0.007**	3.7260*	0.1702	
	(0.584)	**(3.229)**	(0.516)	(0.334)	(-0.420)	(-0.827)	**(-2.216)**	[0.0536]		
$\pi_t^e = (\pi_t - \pi_{t-1})/\pi_t$	0.004	0.140***	-0.0009	0.0003	-0.00003	-0.0001	-0.007**	3.7058*	0.1727	
	(0.578)	**(3.275)**	(-0.514)	(0.043)	(-0.048)	(-0.144)	**(-2.244)**	[0.0542]		

Table 7: Reports of the results from Error Correction Model with UK unemployment as the dependent variable (t-value) and [p-value]

$$\Delta U_B = \beta_0 + \beta_1 \Delta U_A + \beta_2 \Delta(\pi_B^e - \pi_A^e) + \beta_3 \Delta \dot{S}_{BA} + \beta_4 \Delta(\dot{S}_{BA} U_A) + \beta_5 \Delta(\pi_A^e \dot{S}_{BA}) + \beta_6 \hat{e}_{-1} + \varepsilon_2$$

A=France, B=UK

	β_0	β_1	β_2	β_3	β_4	β_5	β_6	Johansen	notes
$\pi_t^e = \pi_t$	-0.0003 (-0.053)	0.396*** **(5.867)**	0.002 (0.156)	0.001 (0.065)	-0.0001 (-0.093)	-0.002 (-0.422)	-0.002 (-0.539)	0.4973 [0.4807]	
$\pi_t^e = \pi_t - \pi_{t-1}$	-0.0004 (-0.061)	0.388*** **(5.824)**	0.0001 (0.141)	-0.001 (-0.144)	0.00004 (0.041)	-0.002 (-0.566)	-0.001 (-0.449)	0.2446 [0.6209]	
$\pi_t^e = (\pi_t - \pi_{t-1})/\pi_t$	-0.0004 (-0.062)	0.388*** **(5.845)**	-0.001 (-0.720)	-0.002 (-0.224)	0.0001 (0.123)	-0.0002 (-0.276)	-0.001 (-0.433)	0.1982 [0.6562]	

Part C

Solution

Section 2.4

$$dy = \frac{\beta\delta+\sigma(\tau-\gamma)}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}de + \frac{\sigma(1-\tau)}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dm + \frac{-\sigma\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dp_f + \frac{\sigma\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dm^f$$

$$dr = \frac{\alpha\delta+\lambda(1-\tau)\delta+\gamma-\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}de + \frac{\tau-1}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dm + \frac{\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dp_f - \frac{\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dm^f$$

$$dn = \frac{\gamma b_1\theta}{b_1+\theta}de$$

$$dw = \left(\frac{\lambda[\beta\delta+\sigma(\tau-\gamma)]}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda} + \frac{\theta\gamma}{b_1+\theta}\right)de + \frac{\lambda\sigma(1-\tau)}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dm - \frac{\lambda\sigma\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dp_f + \frac{\lambda\sigma\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dm^f$$

Section 2.5

$$dy = \frac{\beta\delta+\sigma(\tau-\gamma)}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}de + \frac{\sigma(1-\tau)}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dm + \frac{-\sigma\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dp_f + \frac{\sigma\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dm^f$$

$$dr = \frac{\alpha\delta+\lambda(1-\tau)\delta+\gamma-\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}de + \frac{\tau-1}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dm + \frac{\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dp_f - \frac{\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dm^f$$

$$dn = -\frac{\theta\gamma}{c_1(b_1+\theta)+1}de$$

$$dw = \left(\frac{\lambda[\beta\delta+\sigma(\tau-\gamma)]}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda} + \frac{\theta\gamma}{c_1(b_1+\theta)+1}\right)de + \frac{\lambda\sigma(1-\tau)}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dm - \frac{\lambda\sigma\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dp_f + \frac{\lambda\sigma\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dm^f$$

Section 3.2

$$dy = \frac{\beta\delta+\sigma(\tau-\gamma)}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}de + \frac{\sigma(1-\tau)}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dm + \frac{-\sigma\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dp_f + \frac{\sigma\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda}dm^f$$

$$dr = \frac{\alpha\delta+\lambda(1-\tau)\delta+\gamma-\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda} de + \frac{\tau-1}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda} dm + \frac{\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda} dp_f - \frac{\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda} dm^f$$

$$dn = \left(\frac{b_1\theta_1\lambda[\beta\delta+\sigma(\tau-\gamma)]}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda](b_1+\theta_2)} + \frac{b_1(\theta_1+\theta_2\gamma)}{b_1+\theta_2}\right) de + \frac{b_1\theta_1\lambda\sigma(1-\tau)}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda](b_1+\theta_2)} dm - \frac{b_1\theta_1\lambda\sigma\tau}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda](b_1+\theta_2)} dp_f + \frac{b_1\theta_1\lambda\sigma\tau}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda](b_1+\theta_2)} dm^f$$

$$dw = \left(\frac{(b_1+\theta_1+\theta_2)\lambda[\beta\delta+\sigma(\tau-\gamma)]}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda](b_1+\theta_2)} + \frac{\theta_1+\theta_2\gamma}{b_1+\theta_2}\right) de + \frac{\lambda\sigma(1-\tau)(b_1+\theta_2)}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda](b_1+\theta_2)} dm - \frac{\lambda\sigma\tau(b_1+\theta_2)}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda](b_1+\theta_2)} dp_f + \frac{\lambda\sigma\tau(b_1+\theta_2)}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda](b_1+\theta_2)} dm^f$$

Section 3.3

$$dy = \frac{\beta\delta+\sigma(\tau-\gamma)}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda} de + \frac{\sigma(1-\tau)}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda} dm + \frac{-\sigma\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda} dp_f + \frac{\sigma\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda} dm^f$$

$$dr = \frac{\alpha\delta+\lambda(1-\tau)\delta+\gamma-\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda} de + \frac{\tau-1}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda} dm + \frac{\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda} dp_f - \frac{\tau}{\beta+\sigma\alpha+\sigma(1-\tau)\lambda} dm^f$$

$$du = \left(\frac{\theta_1\lambda[\beta\delta+\sigma(\tau-\gamma)]}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda][c_1(b_1+\theta_2)+1]} + \frac{\theta_1+\theta_2\gamma}{c_1(b_1+\theta_2)+1}\right) de + \frac{\theta_1\lambda\sigma(1-\tau)}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda](b_1+\theta_2)} dm - \frac{\theta_1\lambda\sigma\tau}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda](b_1+\theta_2)} dp_f + \frac{\theta_1\lambda\sigma\tau}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda](b_1+\theta_2)} dm^f$$

$$dw = \left(\frac{(b_1+\theta_1+\theta_2)\lambda[\beta\delta+\sigma(\tau-\gamma)]}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda][c_1(b_1+\theta_2)+1]} + \frac{c_1(\theta_1+\theta_2\gamma)}{c_1(b_1+\theta_2)+1}\right) de + \frac{\lambda\sigma(1-\tau)[c_1(b_1+\theta_2)+1]}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda][c_1(b_1+\theta_2)+1]} dm - \frac{\lambda\sigma\tau[c_1(b_1+\theta_2)+1]}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda][c_1(b_1+\theta_2)+1]} dp_f + \frac{\lambda\sigma\tau[c_1(b_1+\theta_2)+1]}{[\beta+\sigma\alpha+\sigma(1-\tau)\lambda][c_1(b_1+\theta_2)+1]} dm^f$$

Table 4.1: Reports of the ADF unit root tests

		code	level	critical value	1st diff	critical value
employment	n	HKEMPLOYP	-2.527	-3.440	-7.478	-2.881
Unemployment rate	u	HKUN%TOTR	-2.645	-3.441	-8.5187	-2.881
Real exchange rate	e	HKESRC41F	-3.157	-3.440	-10.180	-2.881
Home money	m	HKM2MONHA	-1.301	-3.440	-11.510	-2.881
Import price	p_f	HKIMPVAIE	-2.422	-3.440	-18.262	-2.881
Foreign money	m^f	HKM2MONFA	-1.191	-3.440	-11.641	-2.880

Table 4.2: Reports of OLS estimation

	Dependent variable	
	n	u
constant	5.283***	87.988***
e	0.121***	-9.314***
m	0.034**	-2.161***
p_f	0.094***	-4.341***
m^f	0.093***	0.575
Johansen test (p-value)	0	0.0005

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