

The Effect of Trade on Wage Inequality: The Hong Kong Case

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Abstract

The dramatic increase in the wage gap between skilled and unskilled workers observed in many developed countries has received much attention from economists in recent years. A similar rise of wage gap has now been observed for some newly developed economies, such as Hong Kong. However, few empirical studies have been carried out to explain the growing wage gap in these newly developed economies. This study uses the time series data to investigate the impact of increased outward processing trade with the Chinese Mainland on the wage inequality of Hong Kong. We found that there is a significant positive association between the volume of outward processing trade and the wage premium of university graduates over primary school graduates and university graduates over secondary school graduates. Moreover, our econometric analysis also shows that it is the increased outward processing trade that causes the widening of skill wage gap not vice versa. Furthermore, the increase of outward processing trade both increases the pay for well-educated people and at the same time decreases the pay for less well-educated people, thereby widening the wage gap in Hong Kong.

Keywords: wage inequality, outsourcing / outward processing trade, causality.

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I. Introduction

Since the 1970's, the rising wage gap between skilled and unskilled workers has become a common phenomenon in many developed countries. The issue has triggered a series of studies on what are the causes behind such a phenomenon. Amongst various theories proposed by economists, the theory of increased international trade and competition from developing countries on wage inequality in developed countries has received a lot of attention. So far, the empirical evidence on this theory has been quite mixed. While studies by Murphy and Welch (1991,1992), Borjas, Freeman and Katz (1992), Wood (1994), Borjas and Ramey (1994), Baldwin and Cain (2000) and Feliciano (2001) all found that increased trade and competition are responsible for at least some proportion of the rising wage inequality in the US and other countries, Bound and Johnson (1992), Lawrence and Slaughter (1993), Ghosh, Saunders and Biswas (2000) and Chakrabarti (2000) showed that trade only produced insignificant or even an opposite effect on wage inequality. The opponents of the trade and wage inequality theory argue that for trade to affect wage inequality there must be an increase in the relative prices of skill-intensive products over unskill-intensive products, assuming developed countries specialize in skill-intensive products and developing countries specialize in unskill-intensive products. Furthermore, the fact that the rising demand for skilled workers is mainly contributed by within-industry skill upgrading rather than demand shift between industries also seems to work against the theory of trade and wage inequality. The latter

evidence strongly supports skilled-biased technological progress as the cause for wage inequality.

Recently, a new wave of theoretical and empirical studies has emerged to suggest that, despite the absence of a rise in the relative price of the skill-intensive products, increased international trade could still be a major cause for rising wage inequality.¹ The key lies in the recognition that increased international trade today is often in the form of increased trade in intermediate rather than final products. This form of international trade is also called outsourcing or outward processing trade. So while one may observe small changes in the ratios of trade to GDP in many industrialized countries over the last century, there are substantial changes in the contents of trade for these countries, i.e. shifting towards more trade in intermediate goods or outward processing trade². Such a shift in the content of trade means that less unskill-intensive production processes are carried out in developed countries and hence the demand for unskilled workers declines even within the same industry. This declining in demand for unskilled labor in turn causes rising wage inequality. This theory is also consistent with the phenomenon that there may be no relative price increase of skill-intensive products, and that increases in demand for skilled workers appear to occur

¹ See Feenstra and Hanson (2001) for a detailed survey.

² Using input-output tables for 10 OECD countries and 4 emerging market countries, Hummels, Ishii and Yi (2001) found that 21% of these countries' exports are attributable to outsourcing, and the ratio grew by almost 30% between 1970 and 1990. Campa and Goldberg (1997) found that the share of imported inputs in total manufacturing inputs doubled in the US between 1975 and 1995, and is well over 20% for Canada and the UK.

mainly within rather than between industries. So far, evidence for a positive association between outward processing trade and wage inequality have been found for the US (Feenstra and Hanson, 1999), the UK (Anderton and Brenton, 1999), Japan (Head and Ries, 2000), Mexico (Feenstra and Hanson, 1997) and Hong Kong (Hsieh and Woo, 1999).

Hong Kong presents an interesting, telling case as like many developed countries, it has experienced rising wage inequality since the mid 1980's. Based on the Population Census data, the estimated Gini-coefficient reached 0.52 in Hong Kong in 2001, up from 0.47 in 1991 (estimated by the Census & Statistics Department of Hong Kong using household income). From 1990 to 2000, the wage premium for university graduates over primary school leavers and that over secondary school graduates increased by 50% and 30%, respectively (see Figure 1). So the issue of rising wage inequality in Hong Kong is an important one from both research and policy point of view.

The study of the relationship between trade and wage inequality in Hong Kong is also interesting as Hong Kong is a well-known international trade center. Since the opening up of the Chinese economy in the late 1979, the export-oriented Hong Kong manufacturers have gradually moved their production base to the Pearl River Delta region, leaving only their head offices or controlling centers in Hong Kong. Hong Kong has increasingly become a sourcing and controlling center for the manufacturing goods produced on the Mainland. From the period of 1980 to 2000, the share of Hong Kong's manufacturing output in its GDP

declined from about 40% to 12%. At the same time, Hong Kong's external trade volumes increased by fivefold (measured by the trade quantum index), making Hong Kong now the world's ninth largest trade partner. Furthermore, a bulk of this increased trade with the Mainland China is related to outward processing (see Figure 2). All these happened at the same time when income inequality increased significantly in Hong Kong. It is therefore interesting to see to what extent the widening wage inequality is associated with the increased outward processing trade between Hong Kong and the Mainland China.

Hsieh and Woo (1999) carried out a similar study on the relationship between outward processing trade and wage inequality for Hong Kong. Our study differs from theirs mainly in data and methodology. They used different years of population census data and ran cross-sectional regressions to show the linkage between outward processing trade and wage inequality, while we employed a quarterly time series data and applied the co-integration analysis. More specifically, our study employs the quarterly time series of experience-adjusted wage gaps between workers with different education qualifications over the period 1991 to 2000. This time series data enables us to carry out co-integration analysis and fit a vector error-correction model (VECM) to test if there is a causal relationship between the increasing outward processing trade and the increasing wage inequality in Hong Kong during the 1990's. We believe that the use of this dataset and methodology is more appropriate to study the association between outward processing trade and wage inequality

for Hong Kong.

The rest of the paper is divided into four sections. In the next Section, we calculate the experience-adjusted wage gaps between the well and less well-educated workers and show a general picture on how these wage gaps change over the sample period. Section 3 summarizes the major theories on the relationship between trade and wage inequality and establishes our testable hypothesis. Section 4 discusses our data and methodology. Section 5 presents our main empirical findings. Finally, Section 6 concludes our study.

II. The Trend of Wage Inequality in Hong Kong

The time series data for the earnings of workers with different educational attainment are obtained from the unpublished statistics collected by the Hong Kong Census and Statistics Department (C&S) through its Quarterly General Household Surveys. The original data provided by the C&S gave the median monthly earnings of employees by sex, educational levels and age groups from the first quarter of 1985 to the fourth quarter of 2000. We derive people's years of working experience using the information on age and schooling (by assumption, experience is equal to age minus years of schooling minus 6), and then estimate the following simple earnings equation:

$$\ln W_t = \alpha_t + \beta_t EDU_j + \varphi_t MALE + \theta_t EXP_i + \theta'_t EXP_i^2 + \mu_t \quad (1)$$

where $\ln W_t$ is the natural logarithm of median wage of employees in quarter t . EDU_j ($j =$ primary, secondary, tertiary-non-degree, and tertiary-degree) is a vector of dummy variables indicating people's highest educational attainment. EXP_i and EXP_i^2 are years of experience and its square term, respectively. $MALE$ is a dummy variable for male, and μ_t is an error term. The regressions were run separately for each quarter, for a total of 64 regressions, to form a time series of 64 observations.

Using the estimated coefficients of the earnings equation, we define our experience-adjusted earnings gaps between the well and less well-educated workers as $(\beta_u - \beta_p)$ and $(\beta_u - \beta_s)$, where subscript u , p and s denote the university graduates, primary school graduates and secondary school graduates, respectively.

Figure 1 shows the experience-adjusted wage differential series, $(\beta_u - \beta_p)$ and $(\beta_u - \beta_s)$, which are seasonally adjusted by the double exponential smoothing method. We can immediately see a sharp rise in wage gaps in the early 1990s. It indicates that workers with university education earn about 97 percent more than those with primary education in 1992. This premium increased to about 145 percent more in 2000, a close to 50 percent increase in earnings gap over this time period. The wage gap between the university graduates and the secondary school graduates also recorded 30 percent increase. Note that the share of the university graduates in the total labor force stood at about 5.9 percent in 1991 and increased to 12.7 percent in 2001, while the share of labor force with only primary school education

dropped from 25.2 to 20.5 percent during the same period (Population Census Summary Results, Hong Kong Census and Statistics 2001). Both groups represent a significant proportion of Hong Kong's total labor force.

III. Theories and Hypotheses

There is no doubt that increased international trade would improve the welfare of a society as a whole, however, empirical researches found that the gain from trade is not evenly distributed as some workers are made worse off when trade expands. The leading theory for analyzing the linkage between trade and wage is the Heckscher-Ohlin model. Suppose there are two countries (developed and developing countries) with identical production technology, two factors of production (skilled and unskilled labor) and two commodities (skilled-intensive and unskilled-intensive goods). Since developed country has a larger ratio of skilled to unskilled labor endowment than developing country, the Heckscher-Ohlin theory would predict that the developed country (relatively skilled labor abundant country) exports skilled-labor-intensive commodity and the developing country (relatively unskilled labor abundant country) exports unskilled-labor-intensive commodity. So, the unskilled-labor-intensive commodity industry in the developed countries will contract and the demand for them will decrease. Therefore, increased international trade will pull down the wage of unskilled workers in developed countries as they face import competition from

developing countries with abundant supply of unskilled workers, while skilled-labor-intensive commodity industry will expand and generate an increase in the demand for skilled workers and their wages. Hence, the shift in the demand away from unskilled workers to skilled workers will increase the wage differential across skill levels in developed countries.

The empirical tests of the above theory often use the so-called "factor-content-of-trade" approach. The method quantifies the amount of skilled and unskilled workers that is used in a country's exports, and the amount would have been needed to produce its imports domestically. The labor embodied in exports is interpreted as the increase in the demand for skilled and unskilled workers while labor embodied in imports interpreted as a subtraction from domestic labor demand. So, the effect of trade on the demand for skilled and unskilled workers can be calculated by country's factor content of its imports and exports. Murphy and Welch (1991) found that changes in international trade would shift the demand in favor of skilled workers (also see Murphy & Welch 1992; Berman, Bound & Griliches 1994; Wood 1994). Borjas, Freeman and Katz (1992) concluded that about 8-15 percent of the increase in the wage gap between college and high school graduates could be attributed to the trade-induced factor demand change in favor of skilled workers between 1980 and 1988. In fact, empirical researches based on this approach offer a consistent view that the changes in factor content of trade would shift the demand away from unskilled to skilled workers,

thereby widening the wage differential between them.

The factor-content-of-trade approach has been criticized by many trade economists (e.g. Bhagwati and Dehijia 1994; Learner 1994) who emphasize that trade affects factor price only through product price change but not necessarily through the change in trade volume. Their argument is strictly based on the Heckscher-Ohlin model, which implies that the linkage between trade and factor price works through the change in product price. For example, as trade occurs, the product price of unskilled-intensive commodities in the developed countries would fall as they are imported from developing countries at lower price. This will reduce the return to the factor (unskilled worker) that is used intensively in the production of those commodities. This result is known as the "Stolper-Samuelson theorem". The extension of this theorem is the "factor price equalization theorem" which states that since product price will converge after free trade, then workers who produce the same product should receive the same wage no matter where the product is produced as it is sold for the same world price. While this analysis is sound theoretically, empirical researches did not provide consistent evidence. Empirical finding showed that the US relative price of unskilled-intensive commodities to skilled-intensive commodities have risen during the 80s. That is just the opposite direction that the Heckscher-Ohlin model would predict (see Bhagwati & Dehijia 1994). So, they concluded that international trade could not push down

the relative wage of unskilled workers to the skilled workers. Sachs and Shatz (1994), however, provided evidence that the relative price of the product that used unskilled workers intensively in the production falls slightly, which is consistent with the Heckscher-Ohlin theory (also see Sachs & Shatz 1996).

An alternative view regarding international trade competition is the emergence of the practice of “outward processing” or “outsourcing”, i.e., many manufacturing firms relocate their less-skill intensive production operations to low-wage countries, leaving only their “upper-stream production task” such as financial, administrative and marketing activities domestically. This would increase the demand for more skilled workers as the “upper-stream production task” requires more skill. On the other hand, in industries that experienced such “outsourcing” activity, the demand for unskilled workers will be reduced. Such a shift in relative demand for skilled and unskilled workers takes place within the same industry and will result in an upward rising in wage gaps between these two groups.

More formally, let's assume that the number of skilled and unskilled workers in a country is fixed as H and L , respectively. The economy has two sectors, tradable vs. non-tradable sectors³. Both sectors use fixed ratio of skilled to unskilled workers for production (so technology is fixed): $s_t = H_t/L_t$ and $s_{nt} = H_{nt}/L_{nt}$ ($H = H_t + H_{nt}$, $L = L_t + L_{nt}$). The production process is such that skilled workers are engaging in the upper-stream production tasks, like

³ Following Freestra and Hanson (2001), we define tradable sector as the one that can trade both final and

designing, marketing and accounting tasks, and the unskilled workers are engaging down-stream tasks, like assembling line work. At the initial equilibrium, wages for skilled and unskilled workers should all equal to their values of marginal products, i.e. $W_{H0} = VMP_{H0}^t = VMP_{H0}^{nt}$ and $W_{L1} = VMP_{L1}^t = VMP_{L1}^{nt}$ (for simplicity, we assume that there are no sectoral wage differentials for both skilled and unskilled workers and workers are perfectly substitutable in both sectors). Now, suppose that the tradable sector finds that it can shift its down-stream tasks to a foreign country where the cost for unskilled workers is much cheaper. When it does so, unskilled workers previously working for the tradable sector in the home country will lose their jobs and have to go find jobs in the non-tradable sector, which causes a big increase in the supply of unskilled workers in this sector and hence push the wage for unskilled workers downwards to W_{L1} ($W_{L1} < W_{L0}$, see Panel A of Figure 3). At the same time, since the cost for unskilled workers abroad is much cheaper the tradable sector will not only shift out its down-stream production for outward processing but also increase its overall output level or operation scale. Given that there is a fixed ratio of skilled to unskilled workers in production, it will increase its demand for skilled workers at home (presumably the domestic country has a relative cost advantage in skilled workers), and thereby push the wage for skilled workers upwards to W_{H1} ($W_{H1} > W_{H0}$, see Panel B of Figure 3). This downward shift of unskilled wage and simultaneously upward shift of skilled wage will result in an

intermediate products. The intermediate products are those produced by the down-stream production process.

increased skill-wage gap⁴.

The Hong Kong case fits the latter theory well. As mentioned before, the large increase of Hong Kong's trade is related to trade with the Mainland China. The trade with the Mainland now takes 40% of Hong Kong's total trade. 50% of Hong Kong's imports are from the Mainland, and 30% of Hong Kong's domestic exports and 40% of Hong Kong's re-exports are destined for the Mainland. Among the trade with the Mainland, a large proportion involves outward processing (OP). It is estimated around 40% of Hong Kong's re-exports to China and 80% of Hong Kong's re-exports with the Mainland origin are OP related (see Fung, 1997). This large volume of OP trade is a result of a huge migration of Hong Kong's manufacturing firms⁵ (estimated about four-fifths) to the Pearl River Delta region, which is just across the border from Hong Kong. So in what follows, we want to test whether the empirical evidence in Hong Kong fits the prediction of this theory.

IV. Data and Methodology

The previous section shows how the increases in outward processing trade affect the wage inequality. Significant change with regard to this factor has taken place in Hong Kong during the last decade. So naturally, we would like to see whether this factor is behind the increasing

⁴ See Freenstra and Hanson (2001) for a more formal theoretical analysis.

⁵ Typically, they shift their whole production base to the Pearl Delta region and retain a controlling center in Hong Kong.

wage inequality in Hong Kong. Our basic approach is to test the causality between the changes of OP trade and the changes in wage gap in Hong Kong over the period of 1991 to 2000.

We use the proportion of re-exports of the mainland of China origin to other places involving outward processing in the mainland of China as our measure of OP trade. This is the published official figure estimated by the Hong Kong Census and Statistics Department (see Hong Kong Monthly Digest of Statistics). The official definition of re-exports of the mainland of China origin to other places involving outward processing in the mainland of China is goods re-exported through Hong Kong of which all or part of the raw materials or semi-manufactures have been exported from or through Hong Kong to the mainland of China for processing with a contractual arrangement for subsequent re-importation of the processed goods into Hong Kong. We believe that this measure of OP trade is a more accurate one than the other measures used, for example, by Hsieh and Woo (1999)⁶. Unfortunately, this measure of OP trade is only available from the 4th quarter of 1991. So our empirical analysis employs quarterly data from 1991Q4 to 2000Q4. The wage gap measures are those defined in Section II. The main descriptive statistics of the data are shown in Appendix Table 1.

Our estimation approach follows that of Borjas and Ramey (1994) and Ghosh, Saunders and Biswas (2000). Basically, we first check the stationarity of all the time series using the

⁶ The OP measures used by Hsieh and Woo (1999) are the ratio of imports from China in the sum of domestic

Augmented Dickey-Fuller (ADF) test. Next, the Johansen co-integration approach (1988) will be implemented to check whether the outward processing trade shares consistently the long-run trend with the wage gap. Finally, we will run the VECM model to establish the causality, if any, between them.

V. Results

We begin the analysis by examining the stationarity properties of the variables using Augmented Dickey-Fuller (ADF) Test (Dickey and Fuller, 1981). The following equations are estimated for each of the time series:

$$\Delta X_t = \alpha_0 + \alpha_1 t + \beta_1 X_{t-1} + \sum_{i=1}^k \delta_i \Delta X_{t-i} + \varepsilon_t \quad (2)$$

where Δ is the first difference operator, t is the time trend, k denotes the number of lags used and ε is the error term. The null hypothesis that series X is non-stationary can be rejected if β_1 is statistically significant with negative sign. The optimal lag period, k , is chosen carefully by Akaike Information Criterion (AIC). Table 1 shows that the test statistics for all the series in level form and in their first differences, respectively. The fact that the null hypothesis of unit root cannot be rejected when the series are in level but can be rejected when the series are in first differences indicates that all the series are integrated of order one.

Since the variables are integrated of the same order (I(1)), the next step is to carry out

shipments and imports from China, and the ratio of inputs imported from China in total intermediate inputs.

co-integration analyses of the variables. We first try to identify the long-run relationship between the OP trade and the wage differentials (GAPTP and GAPTS), and also their causal relationships by using the Johansen procedure (1988).

In order to ensure a correct lag specification for the Johansen test and avoid the possibility of obtaining misleading results, the lag length of the VAR for each case is determined by Akaike's Information Criterion (AIC) and Schwartz Bayesian Criterion (SBC). The results are presented in Panel A of Table 2.

The cointegration test results are presented in Panel A of Table 3. The number of co-integrating vectors r is determined by λ_{\max} and trace statistics. We start with the null hypothesis of $r=0$ and moving the value of r up step-by-step until the H_0 cannot be rejected.

The results show that the OP trade is found to be co-integrated with each of the wage differential measures.

Panel A of Table 4 reports the normalized cointegrating coefficients that are interpreted as long run equilibrium coefficients. These coefficients indicate that the OP trade has a positive and significant impact on the two measures of wage differentials. Hence, it can be said that the OP trade is one of the major determinants of the rising wage differentials in the long run.

It also confirms that the vector error correction model (VECM) is appropriate for examining their long run causal relationships. This is because in the presence of co-integration between two $I(1)$ series, the standard Granger causality test which requires all series are stationary $I(0)$

only picks up the short run interaction and is not appropriate for detecting long run relationships.

The VECM requires that we incorporate the error term obtained from the co-integration into the standard Granger causality tests. The corresponding regressions to run are:

$$\Delta Y_t = \mu + \sum_{i=1}^k \alpha_i \Delta Y_{t-i} + \sum_{i=1}^k \beta_i \Delta X_{t-i} + \delta \tau_{t-1} + \varepsilon_t \quad (3)$$

$$\Delta X_t = \mu + \sum_{i=1}^k \nu_i \Delta X_{t-i} + \sum_{i=1}^k \gamma_i \Delta Y_{t-i} + \phi \eta_{t-1} + \sigma_t \quad (4)$$

where Δ denotes first difference; ε and σ are the error term with the usual properties; τ and η are the error term taken from the bivariate co-integration test between X and Y. In equation (3), the lagged dynamic terms ΔX capture the short run effect of X on Y, while the lagged error correction term τ captures the adjustment toward the long run equilibrium. If δ is statistically significant with a negative sign, Y then is said to be Granger-caused by X in the long run. The same can be said for X if ϕ is negative and statistically significant.

The coefficients of the error correction terms (ECM) and their t-statistics are shown in Panel A of Table 5. The ECM coefficients enter significantly with negative sign only when the wage gaps are the dependent variables. The significant negative ECM coefficients, which represent the channel of causality in the long run, also confirm our earlier findings that co-integration exists between them. Based on these results, we can conclude that the direction of causality runs from outward processing trade to wage differentials.

The finding that the OP trade causes wage gaps to increase is consistent with our theory. The

theory also predicts that this causal relationship is based on the fact that the OP trade exerts a positive impact on the wage of skilled workers and a negative impact on the wage of unskilled workers. To show this is also true, we carry our analysis forward to examine the impact of the OP trade on the changes of returns to university, secondary school and primary school education individually. EDUT, EDUS and EDUP are the series of returns to university, secondary school and primary school education, respectively, which are estimated from equation (1). These three series are all I(1) series (see Table 1.).

Panel B of Table 3 shows that two of them (EDUT and EDUP) are co-integrated with LOP.

The estimated coefficients presented in Panel B of Table 4 further show that the OP trade generates a significant and negative impact on the return to primary education and a significant and positive impact on the return to university education. Finally, we also identify the causality runs only from the OP trade to EDUP and from the OP trade to EDUT, but not the other way round (see Panel B of Table 5). As for the return to secondary education, the results in Panel B of Table 3 and 4 reveal there is no clear evidence on co-integration between EDUS and LOP. So we can claim that the OP trade has no impact on the return to secondary school education. Overall, these results support the theory that the increased OP trade raises the wage for skilled workers and pull down the wage for unskilled workers thereby widening the wage gap between skilled and unskilled workers.

VI. Concluding remarks

The wage gaps between the university graduates and primary school leavers and between university graduates and secondary school graduates in Hong Kong have increased by nearly 50 percent and 30 percent, respectively, during the 1990s. This study aims to show whether this sharp increase in wage gaps is associated with the increased OP trade with the Mainland China. Using the quarterly time series data for the period of 1991 to 2000 and the co-integration analysis, we find that there is a long run causal relationship between the OP trade with the Mainland China and the wage inequality in Hong Kong. It is further confirmed that the OP trade not only raises the pay for the more skilled workers but also compresses the pay for the less skilled workers, and thereby raises wage gaps in Hong Kong. This finding is in line with those suggested by the theory of increasing outward processing trade on rising wage inequality. Our findings here are also consistent with those found in the United States, Canada, the United Kingdom and Japan. It also complements with the cross-sectional study done for Hong Kong by Hsieh and Woo (1999).

Our analysis covers the period just prior to China's accession to the WTO. It is expected that more Hong Kong firms will move their production bases or less skill-intensive operations to the Mainland to tap the cheap labor and land costs, and improved investment environment there. OP trade will then play an even more important role. Our finding hints that this may further deteriorate Hong Kong's wage inequality.

To ease this problem, the government has to act more swiftly to upgrade Hong Kong's labor force. The current share of public expenditure on education in GDP is still below 5% and the share of university graduates in the total labor force is still below 15% --- both of these two figures are well behind that of leading industrialized economies. These figures mean that the government must divert more resource to and improve the efficiency in manpower investment.

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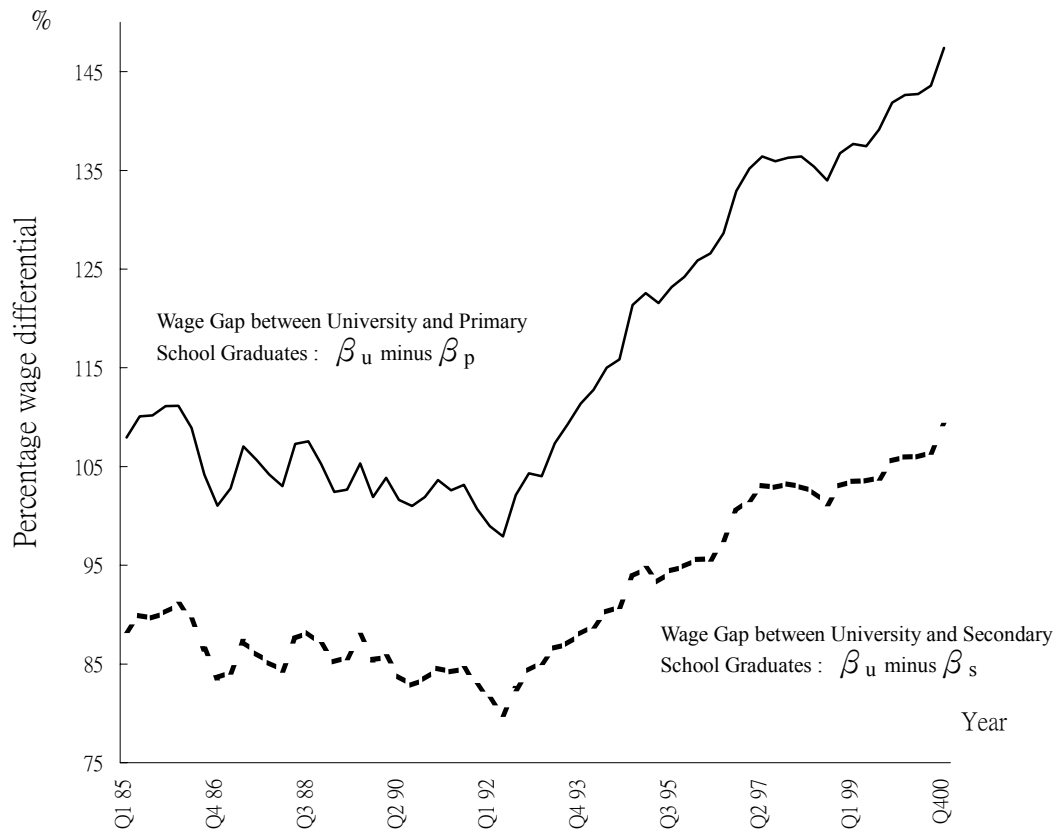
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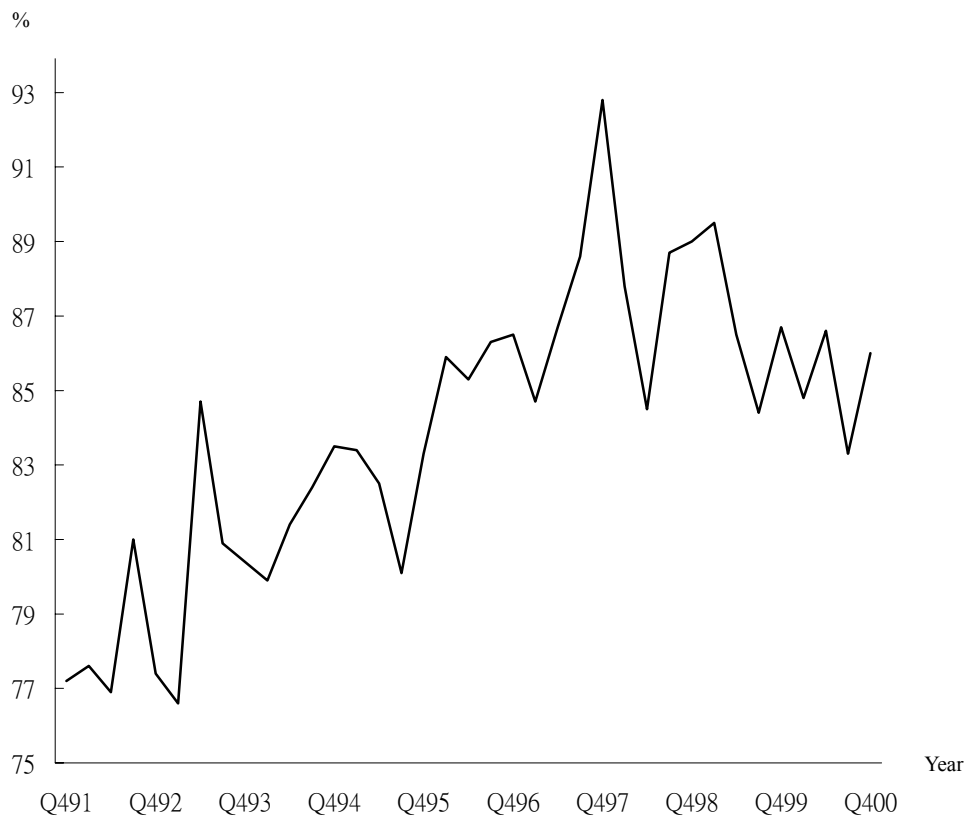
Wood, A., 1994. *North-south trade, employment and inequality : Changing fortunes in a skill driven world*. Clarendon Press, Oxford.

Figure 1. Experience-adjusted Wage Differentials 1985-2000



Source: Calculations are based on unpublished General Household Survey (GHS) data provided by the Census & Statistics Department, General Household Survey.

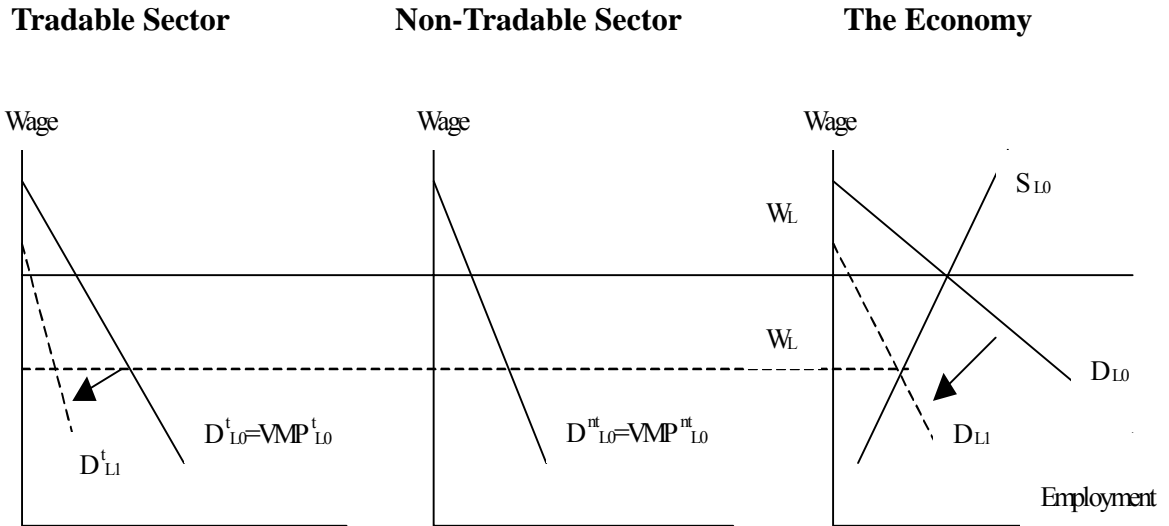
Figure 2. Share of OP Trade (%) in Hong Kong's Re-exports with the Mainland of China Origin



Source: Hong Kong Census and Statistics Department: Hong Kong Monthly Digest of Statistics, various issues.

Figure 3

Panel A. Unskilled Workers



Panel B. Skilled Workers

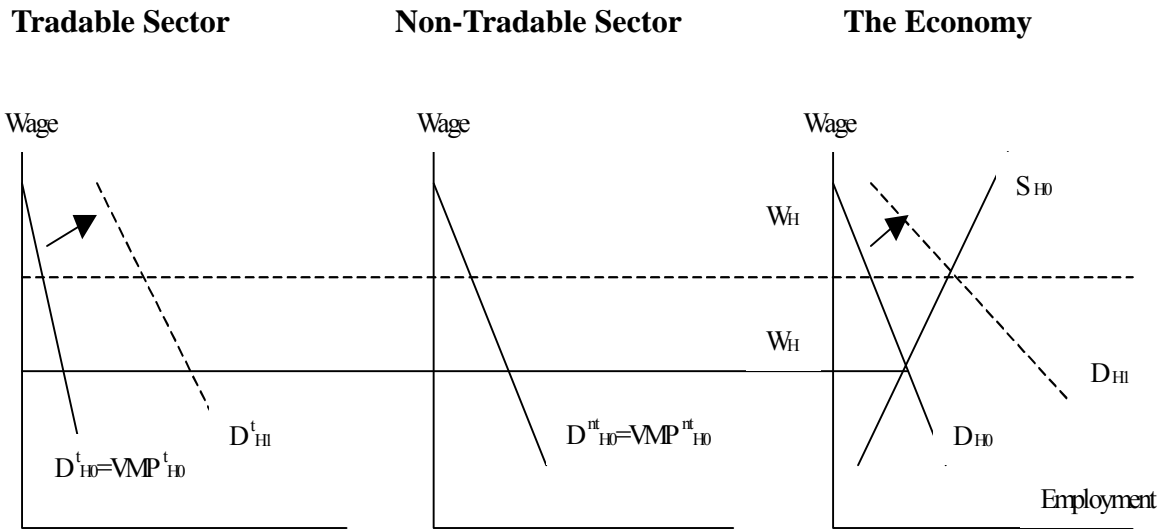


Table 1. Augmented Dickey-Fuller Test of Unit Root (Period: 1991Q4 to 2000Q4)

Variable name	Test on	No Trend	Trend	Conclusion
GAPTP	Level 1 st diff	-0.1810 -3.9743**	-2.3516 -3.9284**	I(1)
GAPTS	Level 1 st diff	-0.0863 -3.6555**	-2.9915 -3.6392**	I(1)
LOP	Level 1 st diff	-2.1757 -4.9405**	-2.2222 -6.1060**	I(1)
EDUP	Level 1 st diff	-1.1454 -7.5894**	-3.4873 -7.4678**	I(1)
EDUS	Level 1 st diff	-2.3417 -7.9923**	-2.2607 -8.0686**	I(1)
EDUT	Level 1 st diff	-2.0780 -5.0695**	-3.5213 -4.9865**	I(1)

** indicates 5% significance level.

Table 2. VAR Lag Order Selection

Lag	AIC	SBC
Panel A.		
GAPTP and LOP		
1	-9.6951*	-9.4230*
2	-9.6097	-9.1562
3	-9.4637	-8.8288
4	-9.2456	-8.4293
GAPTS and LOP		
1	-10.5643*	-10.2868*
2	-10.3291	-9.8665
3	-10.1197	-9.4721
4	-9.8867	-9.0541
Panel B.		
EDUP and LOP		
1	-7.0820*	-6.8044*
2	-6.8585	-6.3959
3	-6.8937	-6.2461
4	-6.7851	-5.9524
EDUS and LOP		
1	-7.7789*	-7.5041*
2	-7.5818	-7.1238
3	-7.5156	-6.8743
4	-7.6060	-6.7815
EDUT and LOP		
1	-7.3434*	-7.0659*
2	-7.1136	-6.6511
3	-6.9404	-6.2928
4	-6.8031	-5.9705

Notes: 1) *indicates lag order selected by the criterion
2) AIC: Akaike information criterion
SBC: Schwarz Bayesian criterion

Table 3. Testing Cointegration using the Johansen Procedure

Explanatory Variables	Null Hypothesis	Alternative Hypothesis	Test Statistics
Panel A.			
GATP = f (LOP)	Trace tests:		Trace Value
	$r = 0$	$r > 0$	13.5316**
	$r \leq 1$	$r > 1$	0.1333
	λ max tests:		λ max Value
	$r = 0$	$r = 1$	13.3982**
	$r = 1$	$r = 2$	0.1333
GAPTS = f (LOP)	Trace tests:		Trace Value
	$r = 0$	$r > 0$	10.4286*
	$r \leq 1$	$r > 1$	0.1175
	λ max tests:		λ max Value
	$r = 0$	$r = 1$	10.3112*
	$r = 1$	$r = 2$	0.1175
Panel B.			
EDUP = f (LOP)	Trace tests:		Trace Value
	$r = 0$	$r > 0$	20.880**
	$r \leq 1$	$r > 1$	4.2992
	λ max tests:		λ max Value
	$r = 0$	$r = 1$	16.5806**
	$r = 1$	$r = 2$	4.2992
EDUS = f (LOP)	Trace tests:		Trace Value
	$r = 0$	$r > 0$	22.5779*
	$r \leq 1$	$r > 1$	8.6007
	λ max tests:		λ max Value
	$r = 0$	$r = 1$	13.9773
	$r = 1$	$r = 2$	8.6007
EDUT = f (LOP)	Trace tests:		Trace Value
	$r = 0$	$r > 0$	21.2407**
	$r \leq 1$	$r > 1$	6.8436
	λ max tests:		λ max Value
	$r = 0$	$r = 1$	14.3971*
	$r = 1$	$r = 2$	6.8436

Notes: 1) ** and * denotes significance at 5% and 10% level, respectively.
 2) r indicates the number of cointegrating vectors.

Table 4. Normalized Cointegrating Coefficients (Bivariate Estimates) Using the Johansen Procedure

Cointegrating regressions	Coefficient	t-statistic
Panel A.		
GAPTP = f (LOP)	0.3939	13.1542***
GAPTS = f (LOP)	0.2756	14.8293***
Panel B.		
EDUP = f (LOP)	-1.4320	4.9824***
EDUS = f (LOP)	-0.0810	0.2245
EDUT = f (LOP)	1.0604	3.3549***

*** denotes significance at 1%

Table 5. Causality Tests Using the VECM Approach

Null Hypothesis	Coefficient for ECM(-1)	t-statistics for ECM(-1)
Panel A.		
LOP <i>does not cause</i> GAPTP	-0.0262	-3.8587***
GAPTP <i>does not cause</i> LOP	-0.0190	-1.4525
LOP <i>does not cause</i> GAPTS	-0.0271	-3.3091***
GAPTS <i>does not cause</i> LOP	-0.0023	-0.9901
Panel B.		
LOP <i>does not cause</i> EDUP	-0.7176	-3.7250***
EDUP <i>does not cause</i> LOP	-0.1497	-1.5432
LOP <i>does not cause</i> EDUT	-0.6278	-3.9594***
EDUT <i>does not cause</i> LOP	0.0905	0.9333

*** denotes significance at 1%.

Appendix Table 1: Key to Variables

Variables	Description	Data Sources
GAPTP	Seasonal adjusted Wage differential between university and primary school graduates (β_u minus β_p) : calculation from equation (1) (Mean : 1.2501 Std. Dev. : 0.1471)	Unpublished statistics from Hong Kong Census and Statistics Department, General Household Survey Section.
GAPTS	Seasonal adjusted Wage differential between university and secondary school graduate (β_u minus β_s) : calculation from equation (1) (Mean : 0.9603 Std. Dev. : 0.0844)	Unpublished statistics from Hong Kong Census and Statistics Department, General Household Survey Section.
LOP	Log proportion of outward processing trade involving in the re-exports of the mainland of China origin to other places (Mean : 4.4284 Std. Dev. : 0.0470)	Hong Kong Monthly Digest of Statistics, various issues, Hong Kong Census and statistics Department
EDUP	Wage returns to primary school graduates (β_p): estimated from (Equation 1) (Mean : -0.9981 Std. Dev. : 0.0818)	
EDUS	Wage returns to secondary school graduates (β_p): estimated from (Equation 1) (Mean : -0.7093 Std. Dev. : 0.0398)	
EDUT	Wage returns to university graduates (β_u) : estimated from (Equation 1) (Mean : 0.2674 Std. Dev. : 0.0859)	