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KALDORIAN DISAGGREGATION, TEMPORARY MIGRATION AND WELFARE: THEORY AND CALIBRATION

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Abstract. In this paper we examine a four-good, four-factor model of trade with two agents: domestic residents and temporary migrants. This modelling framework has three important features: first, there are two tradable and two non-tradable goods; second, there exists Kaldorian disaggregation in consumption; third, the structure incorporates a combination of price adjustment. The results emphasize the influence of factor accumulation at constant traded goods prices on the variable prices of non-traded goods. We also analyse the impact of temporary migration and other structural parameters on domestic welfare. To highlight our results, our model is calibrated on a typical small open economy, Hong Kong, and a wide array of situations are presented when temporary migration and Kaldorian disaggregation can reduce domestic welfare in response to exogenous shocks.

1. INTRODUCTION

It is well known that temporary migration is an important phenomenon in the international arena. In its *World Migration Report* for 2008, the International Organization for Migration reports that temporary migration in the OECD countries expanded by approximately 7% in 2003–2004, and Abella (2006) suggests that the growth rate was between 4 and 5% in 2004–2005. The OECD (2014) records a peak in temporary migrant flows into OECD countries in 2007, with a gradual decline in the post-financial crisis world; according to the Outlook, these flows in 2012 were 25% lower than in 2007.[1] Temporary migrant inflows are not limited to the OECD countries. The countries in the Gulf Cooperation Council (GCC) witnessed an extensive growth of such flows in the 1980s, and the foreign

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[1] Ruhs (2006) identifies a number of policy objectives that motivate the adoption of temporary migration programs by countries. Primarily, temporary migration programs are intended to alleviate labour shortages for both skilled and unskilled workers. Other motivations include the reduction of illegal immigration, and the promotion of political relationships and cultural ties. Moreover, Abella (2006) highlights the reasons why temporary migration may be preferred to permanent migration: the ability of a country to increase flexibility in the labour market without affecting long-term population trends; political expediency in terms of greater acceptance of temporary migration by electorates; and, the avoidance of the difficulties countries may experience with integrating permanently settled migrant communities.

population in the GCC outnumbers citizens (International Organization for Migration, 2008). More recently, Hong Kong, Singapore and Malaysia have served as popular destinations for temporary workers. In this paper, we focus on the impact of temporary migration on the Hong Kong economy.

Abella (2006, page 4) provides a definition of temporary migrants as 'those whose legal status is temporary, regardless of the amount of time they may actually have stayed in a country'. Hong Kong presents the case of a large class of temporary workers who conform to this definition of temporariness: foreign domestic helpers (FDH). In 2013, there were roughly 320 000 FDH in Hong Kong, constituting approximately 8% of the overall working population, and a significant proportion of all temporary migrants in Hong Kong.

There are a number of stylized features of FDH in Hong Kong that are important for our analysis. First, FDH perform a variety of roles, including household chores, cooking, taking care of the elderly and childcare. As such, they work in the non-tradable goods sectors of the economy. The model in Section 2 incorporates this feature by allowing the temporary migrants to work only in the non-tradable goods sectors of the economy. Second, FDH are hired under a standard employment contract, which stipulates that FDH are required to live with their employers, work 6 days of the week and receive a minimum allowance of HK $4110 per month.[2] Even allowing for a 40-h work week, this translates to roughly HK$25/h, which is below the minimum wage for other workers in Hong Kong, and suggests that FDH have limited consumption possibilities. Moreover, Coniglio (2004) notes that migrants often consume goods and services that are distinct from those consumed by domestic residents. These 'ethnic' goods may be tradable or non-tradable goods; Coniglio (2004) lists ingredients for ethnic meals, ethnic music and movies as examples of tradable ethnic goods, and religious services and alternative forms of medicine as examples of non-tradable ethnic goods. Consequently, domestic residents and migrants form distinct consumption groups. Our model accounts for these stylized facts by assuming that while domestic residents and temporary migrants share consumption of some (tradable) goods, there exists consumption disaggregation with the two groups consuming separate non-tradable goods. Third, FDH are required by law to return to their country of origin once their employment contract is completed or terminated, and are ineligible to gain permanent residency.[3] The legal status of FDH, therefore, aligns with the definition of temporary migrants provided by Abella (2006). Following standard trade theory, the welfare of temporary migrants is not included in national welfare; national welfare includes only the welfare of domestic citizens and permanent residents. Finally, Hong Kong is a typical small open economy; therefore, our model assumes that the price of tradable goods is exogenous.

Given the growing contribution of FDH in the Hong Kong economy, an investigation of the impact of temporary migrants on the domestic economy is essential, especially their influence on the welfare of domestic residents.

[2] See the Labor Department, Government of Hong Kong SAR website, http://www.labour.gov.hk.
[3] The ineligibility for permanent residency was recently upheld by the Court of Final Appeal in Hong Kong; see, for example, http://www.bbc.com/news/world-asia-china-21920811.

To investigate this issue, we first construct a theoretical model that encompasses the stylized features of the Hong Kong described above. The theoretical results derived here are valid not only for the Hong Kong economy, but for other economies as well that have similar characteristics in their migration programs, such as Singapore, Malaysia and countries in the GCC. Next, we calibrate our theoretical model with data from Hong Kong. Consequently, our paper lays the foundations for informed policy analysis on the role of temporary migrants in Hong Kong and other economies with temporary migrants.

In Section 2, we examine a four-good, four-factor model of trade with Kaldorian-type consumption disaggregation (Kaldor, 1955) and two agents: domestic residents and temporary migrants.[4] Temporary migrants supply labour, but no capital; all capital is owned by domestic residents. Of the four goods in the economy, two are tradable (the goods produced in Sectors 1 and 2) and two are non-tradable (the goods produced in Sectors 3 and 4).To allow for Kaldorian disaggregation in consumption, we assume that only domestic residents consume the good produced in Sector 3, while only migrants consume the good produced in Sector 4. For concreteness, Sector 3 can be thought of as the domestic help sector where FDH work, while Sector 4 represents non-traded ethnic goods, as described by Coniglio (2004) and summarized above.[5]

Our paper has the important feature that it incorporates elements of both fixed and flexible price models. Assuming a small open economy, the tradable good sectors exhibit standard responses to factor accumulation. However, the non-tradable good sectors display flexible price results. This represents an improvement over traditional analysis of the migration problem as the system has flexible prices that affect returns to factors and that are critical for both domestic workers and temporary migrants. With Kaldorian disaggregation, different consumption patterns among agents imply that these price effects have varied impacts on different groups in society.

In the second part of the paper we calibrate our model using data from Hong Kong. Our paper provides a framework to ascertain whether domestic residents in Hong Kong are affected positively or negatively by an increase in temporary migrant workers. Moreover, we calibrate the influence of changes in structural parameters of the Hong Kong economy in the presence of such migration. The calibration results indicate that the welfare of domestic residents may fall for a number of reasons. Given a particular level of temporary migration, a fall in domestic resident welfare may occur due to: (i) an increased share of expenditure on tradable goods by temporary migrants; (ii) an increase in the share of capital in Sector 3; (iii) an increase in the share of domestic labour in Sector 3; and (iv) increases in the elasticity of substitution of both domestic residents

[4] Temporary migrants can include illegal migrants as well. In what follows, 'migrants' refer to temporary migrants, while citizens and permanent migrants are described 'domestic residents'.

[5] For simplicity, we have assumed that only temporary migrants work in Sector 4; in the context of Hong Kong, the assumption is that temporary migrants other than FDH work in Sector 4, since FDH are permitted to work only in the domestic help sector.

and temporary migrants.[6] The changes to other key endogenous variables (welfare of migrants, price of non-tradable goods, return on capital in the non-tradable sectors and wage rate of migrants) are also summarized in the paper. To conclude the calibration exercise, we examine the robustness of the calibration results.

The paper is organized as follows. Section 2 outlines the theoretical model, while Section 3 derives the main results. Section 4 presents a geometric interpretation of the model to highlight the intuition and the structure of the model. Section 5 provides a benchmark calibration of the model with data from Hong Kong, as well as robustness checks. Section 6 concludes.

2. THE MODEL

Consider a small open economy that produces four goods (X_i, $i \in \{1, 2, 3, 4\}$); in what follows, we refer to industry X_i as Sector i). Two types of capital (K and T) and two types of labour (L and M) are used as inputs in the production of these goods. Here L denotes domestic labour and M represents temporary migrant labour. We assume that K and T are owned by domestic residents, while immigrants only supply labour. The production functions for this economy are described in equations 1 to 4 below:

$$X_1 = F_1(K_1, L_1) = L_1 f_1(k_1), \text{ where } k_1 = \frac{K_1}{L_1}; \tag{1}$$

$$X_2 = F_2(K_2, L_2) = L_2 f_2(k_2), \text{ where } k_2 = \frac{K_2}{L_2}; \tag{2}$$

$$X_3 = F_3(T_3, L_3, M_3) = M_3 f_3(t_3, l_3), \text{ where } t_3 = \frac{T_3}{M_3} \text{ and } l_3 = \frac{L_3}{M_3}; \tag{3}$$

$$X_4 = F_4(T_4, M_4) = M_4 f_4(t_4), \text{ where } t_4 = \frac{T_4}{M_4}. \tag{4}$$

Here, K_i, T_i, L_i and M_i represent the allocation of each factor across sectors.

We assume that: (i) X_1 and X_2 are tradable, with X_1 being an importable good and X_2 being an exportable good; and (ii) X_3 and X_4 are non-tradable.

The demand side of the model incorporates Kaldorian disaggregation. The aggregate utility functions for domestic residents and temporary migrants are assumed to be strictly concave, and are represented below:

[6] In a paper related to this one, Lai *et al.* (forthcoming) shows that under certain reasonable conditions the domestic residents may be immiserized as a result of temporary migration. This result also obtains in the more general model presented here. However, this paper provides many additional results as well as calibrations for many interesting propositions.

$$U = U[D_1, D_2, D_3] \tag{5}$$

$$U^M = U^M\left[D_1^M, D_2^M, D_4^M\right]. \tag{6}$$

Note that domestic residents do not consume good 4 and migrants do not consume good 3. The market equilibrium equations for the four commodities are:

$$D_1 + D_1^M = X_1 + I_1; \tag{7}$$

$$D_2 + D_2^M = X_2 - E_2; \tag{8}$$

$$D_3 = X_3; \tag{9}$$

$$D_4^M = X_4, \tag{10}$$

where, I_1 represents the imports of good 1 and E_2 represents the exports of good 2. As can be seen in equations 9 and 10, the markets for non-traded goods clear domestically.

Using a_{ij} to denote the unit input coefficients, the factor-utilization equations are:

$$a_{K1}X_1 + a_{K2}X_2 = \overline{K} \tag{11}$$

$$a_{L1}X_1 + a_{L2}X_2 + a_{L3}X_3 = \overline{L}; \tag{12}$$

$$a_{T3}X_3 + a_{T4}X_4 = \overline{T}; \tag{13}$$

$$a_{M3}X_3 + a_{M4}X_4 = \overline{M}, \tag{14}$$

where, $\overline{K}$ and $\overline{T}$ are the fixed supplies of the two types of capital, and $\overline{L}$ and $\overline{M}$ are given supplies of domestic labour and immigrants, respectively. While omitted from the analysis, the unit input coefficients are functions of factor prices.

The price equations of the system are given below, and follow standard analysis:

$$a_{L1}w + a_{K1}r = 1; \tag{15}$$

$$a_{L2}w + a_{K2}r = P; \tag{16}$$

$$a_{L3}w + a_{M3}w^M + a_{T3}R = P_3; \tag{17}$$

$$a_{M4}w^M + a_{T4}R = P_4, \tag{18}$$

where w and w^M denote the wage rates for domestic workers and immigrants, respectively, while r and R denote the rental on capital K and the rental on capital

T, respectively. Good X_1 serves as the numeraire. Given the small country assumption, P is exogenous. Consequently, there are six endogenous variables in the model: w, w^M, r, R, P_3 and P_4. Given the terms of trade, P, equations 15 and 16 provide the solutions for w and r. The remaining four variables, w^M, R, P_3 and P_4, are determined by equations 9, 10, 17 and 18.

To conclude this section, we specify the standard aggregate balance equations:

$$D_1 + PD_2 + P_3D_3 = X_1 + PX_2 + P_3X_3 + P_4X_4 - w^M M; \tag{19}$$

$$D_1^M + PD_2^M + P_4D_4^M = w^M M. \tag{20}$$

3. THEORETICAL RESULTS

Several trade theoretic results are derived from the model presented in Section 2. First, we obtain results related to factor endowment and output, as well as factor price–commodity price relationships. Second, we derive welfare results. Given that there are two agents in this model, domestic residents and temporary migrants, welfare results are obtained for each group as a consequence of parametric changes. Finally, all the results are given a unifying theme.

First, the impact of changes in factor endowments on output at constant prices is analysed. There are four factors of production in this model: two types of capital and two types of labour. Moreover, these factors are quasi-mobile; this feature distinguishes the model from many predecessors in the trade literature. To keep the analysis in this section tractable, we present results related to changes in only two factors: capital used in the traded goods sector (K) and temporary migrants employed in the production of non-traded goods (M). Results for the other two factors can be derived along similar lines, and are omitted here.

By differentiating equations 11 to 14 and using the standard '^' notation to represent proportional change, and λ_{ij} to denote the allocative share of factor i in Sector j, we obtain:

$$\lambda_{K1}\widehat{X}_1 + \lambda_{K2}\widehat{X}_2 = \widehat{K}; \tag{21}$$

$$\lambda_{L1}\widehat{X}_1 + \lambda_{L2}\widehat{X}_2 + \lambda_{L3}\widehat{X}_3 = 0; \tag{22}$$

$$\lambda_{T3}\widehat{X}_3 + \lambda_{T4}\widehat{X}_4 = -\lambda_{T3}\widehat{a}_{T3} - \lambda_{T4}\widehat{a}_{T4}; \tag{23}$$

$$\lambda_{M3}\widehat{X}_3 + \lambda_{M4}\widehat{X}_4 = \widehat{M} - \lambda_{M3}\widehat{a}_{M3} - \lambda_{M4}\widehat{a}_{M4}. \tag{24}$$

We note that in this model, the relative prices of non-traded goods are not constant and, consequently, the input coefficients in the non-traded goods sectors cannot remain constant.

The determinant of the coefficients of output in the left-hand sides of equations 21–24 is:

$$\Delta = \lambda_{L1}\lambda_{L2}\lambda_{M3}\lambda_{M4}(k_1 - k_2)(t_3 - t_4).$$

It is evident that:

$\Delta > 0$ if : (a) $(k_1 - k_2) > 0$ and $(t_3 - t_4) > 0$, or (b) $(k_1 - k_2) < 0$ and $(t_3 - t_4) < 0$;

$\Delta < 0$ if : (a) $(k_1 - k_2) < 0$ and $(t_3 - t_4) > 0$, or (b) $(k_1 - k_2) > 0$ and $(t_3 - t_4) < 0$.

In the Heckscher–Ohlin model, the only intensity differential that matters is $(k_1 - k_2)$. Here, we have four capital intensities (k_1, k_2, t_3 and t_4) resulting from the presence of two types of capital and four goods. The intensity differential $(t_3 - t_4)$ may be positive or negative, and this feature gives rise to non-standard results in our paper.

Solving equations 21 to 24, we obtain:

$$\widehat{X}_1 = \frac{\widehat{K}}{\lambda_{L1}\lambda_{L2}(k_1 - k_2)}; \tag{25}$$

$$\widehat{X}_2 = -\frac{\widehat{K}}{\lambda_{L1}\lambda_{L2}(k_1 - k_2)}. \tag{26}$$

The changes $\widehat{X}_1$ and $\widehat{X}_2$ are in accordance with the predictions of the Rybczynski theorem, and the traded sectors, therefore, behave in the same manner as in the Heckscher–Ohlin framework.

Consider, now, the changes in P_3, P_4, Y and Y^M due to changes in capital used in Sectors 1 and 2, where Y and Y^M refer to the income of domestic residents and migrants, respectively:

$$\widehat{P}_3 = \frac{\widehat{K}}{|\nabla|}\varphi_K \eta^L \left[-N_4 + \eta^M \varepsilon_{4M} - \eta^M \frac{S_4}{\kappa}\theta_{T3}\right]; \tag{27}$$

$$\widehat{P}_4 = \frac{\widehat{K}}{|\nabla|}\varphi_K \eta^L \eta^M \left(-\frac{S_4}{\kappa}\theta_{T4}\right); \tag{28}$$

$$\widehat{Y} = \frac{\widehat{K}}{|\nabla|}N_3\varphi_K \left[N_4 - \eta^M \varepsilon_{4M} + \eta^M \frac{S_4}{\kappa}\theta_{T3}\right]; \tag{29}$$

$$\widehat{Y}^M = \frac{\widehat{K}}{|\nabla|}\varphi_K \eta^L \left[-\frac{S_4}{\kappa}\theta_{T4}\right], \tag{30}$$

where:

$|\nabla| = N_3N_4 + N_3\eta^M\left[\varepsilon_4 - \frac{S_4}{\kappa}\theta_{T3} - \varepsilon_{4M} + \frac{\theta_{T3}}{\kappa}\right] + \eta^L N_4 \frac{S_4}{\kappa}\theta_{T4} + \eta^L\eta^M\left[\varepsilon_4 \frac{\theta_{T4}}{\kappa} - \frac{S_4}{\kappa}\theta_{T4}\varepsilon_{4M}\right]$; $\varphi_K = \frac{K \cdot r}{Y}$; $\eta^M = \frac{\partial D_4}{\partial Y^M}\frac{Y^M}{D_4}$ is the income elasticity of good 4 consumption for immigrants; $\eta^L = \frac{\partial D_3}{\partial Y}\frac{Y}{D_3}$ is the income elasticity of good 3 consumption for domestic residents; $N_i = \frac{\partial D_i}{\partial P_i}\frac{P_i}{D_i} - \frac{\partial X_i}{\partial P_i}\frac{P_i}{X_i}$ is the difference between price elasticity of demand for good i and its price elasticity of supply; $\varepsilon_{4M} = \frac{P_4 X_4}{Y^M}$ is the share of the expenditure on good 4 of the income of temporary migrants; $\theta_{Ti} = \frac{R \cdot T_i}{P_i X_i}$ is the share of capital payoff to total revenue from selling good i; $S_4 = \frac{w^M \cdot M}{Y}$ the ratio of the income of temporary migrants to the income of domestic residents; and $\kappa = \theta_{M3}\theta_{M4}(t_3 - t_4)\frac{R}{w^M}$ where θ_{Mj} represents the distributive share of migrant labour in sector j.

The sign of $|\nabla|$ is negative, from Walrasian stability of the system. If K increases, the price of good 4 will also increase. Changes to the price of good 3 are ambiguous. However, if the substitution effect $-N_4$ outweighs the income effect $\eta^M\varepsilon_{4M}$ for good 4, the price of good 3 will increase.

Consider, now, the changes in X_3 and X_4:

$$\widehat{X}_3 = H_1 \cdot \left(G_1 \cdot \widehat{P}_4 - G_2 \cdot \widehat{P}_3\right);$$

$$\widehat{X}_4 = H_2 \cdot \left(G_1 \cdot \widehat{P}_4 - G_2 \cdot \widehat{P}_3\right), \tag{31}$$

where

$$H_1 = \frac{-(\lambda_{T3}\theta_{L3}\sigma_3\lambda_{M4} + \lambda_{T4}\theta_{L4}\sigma_4\lambda_{M4} + \lambda_{T4}\theta_{T3}\sigma_3\lambda_{M3} + \lambda_{T4}\theta_{T4}\sigma_4\lambda_{M4})}{(\lambda_{T3}\lambda_{M4} - \lambda_{T4}\lambda_{M3})(\theta_{M3}\theta_{M4})(t_3 - t_4)}$$

$$H_2 = \frac{-(\lambda_{T3}\theta_{L3}\sigma_3\lambda_{M3} + \lambda_{T4}\theta_{L4}\sigma_4\lambda_{M3} + \lambda_{T3}\theta_{T3}\sigma_3\lambda_{M3} + \lambda_{T3}\theta_{T4}\sigma_4\lambda_{M4})}{(\lambda_{T3}\lambda_{M4} - \lambda_{T4}\lambda_{M3})(\theta_{M3}\theta_{M4})(t_3 - t_4)}.$$

$$G_1 = \theta_{T3} + \theta_{M3}, G_2 = \theta_{T4} + \theta_{M4}$$

A change in $\overline{K}$ causes changes in P_3 and P_4, which leads to changes in X_3 and X_4.

Consider, next, the impact of an increase in temporary migrants on the changes in X_3 and X_4. The changes in these outputs incorporate changes in the level of migration and, more importantly, in relative prices. The formal expressions for $\widehat{X}_3$ and $\widehat{X}_4$ are as follows:

$$\widehat{X}_3 = \frac{\lambda_{T4}\widehat{M}}{|\lambda|} + \frac{(A+B)}{|\lambda||\theta|}\left(\widehat{P}_3 - \widehat{P}_4\right); \tag{32}$$

$$\widehat{X}_4 = -\frac{\lambda_{T3}\widehat{M}}{|\lambda|} + \frac{(C+E)}{|\lambda||\theta|}\left(\widehat{P}_4 - \widehat{P}_3\right); \tag{33}$$

$$\widehat{X}_3 - \widehat{X}_4 = Z{\cdot}\widehat{M} + Z'\left(\widehat{P}_3 - \widehat{P}_4\right), \tag{34}$$

where:
λ_{ij} represents the allocative share of factor i in Sector j;
θ_{ij} represents the distributive share of factor i in Sector j;

$$|\lambda| = \lambda_{M3}\lambda_{M4}(t_3 - t_4);$$

$$|\theta| = \theta_{M3}\theta_{M4}(t_3 - t_4);$$

$$A = \lambda_{T4}[\lambda_{M3}\theta_{T3}\sigma_3 + \lambda_{M4}\theta_{T4}\sigma_4] > 0;$$

$$B = \lambda_{M4}[\lambda_{T3}\theta_{M3}\sigma_3 + \lambda_{T4}\theta_{M4}\sigma_4] > 0;$$

$$C = \lambda_{T3}[\lambda_{M3}\theta_{T3}\sigma_3 + \lambda_{M4}\theta_{T4}\sigma_4] > 0;$$

$$E = \lambda_{M3}[\lambda_{T3}\theta_{M3}\sigma_3 + \lambda_{T4}\theta_{M4}\sigma_4] > 0;$$

$$Z = \frac{(\lambda_{T4} + \lambda_{T3})}{|\lambda|}, Z' = \frac{(A+B+C+E)}{|\lambda||\theta|},$$

where σ_j is the elasticity of substitution between M and T in Sector j.

The response of output, $\widehat{X}_3$ and $\widehat{X}_4$, depends on $\widehat{M}$, $\widehat{P}_3$ and $\widehat{P}_4$. The coefficients of the $\widehat{M}$ term provide the Rybczynski effects; hence, $\widehat{X}_3 < 0\ (>0)$ and $\widehat{X}_4 > 0\ (<0)$ as $(t_3 - t_4) > 0\ (<0)$. As expected, $\widehat{X}_3$ is rising in $\widehat{P}_3$ and falling in $\widehat{P}_4$, while $\widehat{X}_4$ is falling in $\widehat{P}_3$ and rising in $\widehat{P}_4$. Our model thus displays elements of fixed-price and flexible-price responses to factor accumulation.

To investigate the impact of factor accumulation on the relative prices of X_3 and X_4, we differentiate equations 9, 10, 19 and 20 to obtain:

$$\widehat{P}_3 = \frac{\widehat{M}}{|\nabla|}\left[Z_3 N_4 + \eta^M\left(\varepsilon_4 - \frac{S_4}{\kappa}\theta_{T3}\right)(1 + \eta^L - Z_4) - \eta^M\left(\varepsilon_{4M} - \frac{\theta_{T3}}{\kappa}\right)\right]; \tag{35}$$

$$\widehat{P}_4 = \frac{\widehat{M}}{|\nabla|}\left[Z_3\eta^M\frac{\theta_{T4}}{\kappa} + \left(\eta^L\frac{S_4}{\kappa}\theta_{T4} - N_3\right)\left(Z_4 - \eta^M\right)\right], \tag{36}$$

where:
$Z_i = \frac{\partial X_i}{\partial M}\frac{M}{X_i}$ is the Rybczynski elasticity for X_i;
$\eta^M = \frac{\partial D_4}{\partial Y^M}\frac{Y^M}{D_4}$, is the income elasticity of good 4 consumption for immigrants;
$\eta^L = \frac{\partial D_3}{\partial Y}\frac{Y}{D_3}$ is the income elasticity of good 3 consumption for domestic residents;
$N_i = \frac{\partial D_i}{\partial P_i}\frac{P_i}{D_i} - \frac{\partial X_i}{\partial P_i}\frac{P_i}{X_i}$ is the difference between price elasticity of demand for good i and its price elasticity of supply;
$\varepsilon_4 = \frac{P_4X_4}{Y}$ is the ratio of expenditure on good 4 to the income of domestic residents;
$\theta_{Ti} = \frac{R\cdot T_i}{P_iX_i}$ is the share of capital payoff to total revenue from selling good i;
$S_4 = \frac{w^M\cdot M}{Y}$ is the ratio of the income of temporary migrants to the income of domestic residents;
$\varepsilon_{4M} = \frac{P_4X_4}{Y^M}$ is the share of the expenditure on good 4 of the income of temporary migrants;
$\kappa = \theta_{M3}\theta_{M4}(t_3 - t_4)\frac{R}{w^M}$;
and $|\nabla| = N_3N_4 + N_3\eta^M\left[\varepsilon_4 - \frac{S_4}{\kappa}\theta_{T3} - \varepsilon_{4M} + \frac{\theta_{T3}}{\kappa}\right] + \eta^LN_4\frac{S_4}{\kappa}\theta_{T4} + \eta^L\eta^M\left[\varepsilon_4\frac{\theta_{T4}}{\kappa} - \frac{S_4}{\kappa}\theta_{T4}\varepsilon_{4M}\right]$.

In the presence of income effects the signs of $\widehat{P}_3$ and $\widehat{P}_4$ are ambiguous. The sign of $|\nabla|$ was negative, as we have Walrasian stability in this system. Similarly, $Z_3 < 0$ ($Z_4 > 0$) for $(t_3 - t_4) > 0$ and $Z_3 > 0$ ($Z_4 < 0$) for $(t_3 - t_4) < 0$; these follow from the Rybczynski theorem. From the stability conditions, we know that N_3 and N_4 are negative. Hence, it follows that:

$$Z_3N_4 > 0 \text{ and } Z_4N_3 < 0 \text{ for } (t_3 - t_4) > 0;$$

$$Z_3N_4 < 0 \text{ and } Z_4N_3 > 0 \text{ for } (t_3 - t_4) < 0.$$

In the absence of income effects, the signs of $\widehat{P}_3$ and $\widehat{P}_4$ can, therefore, be determined unambiguously. Assuming that $(t_3 - t_4) > 0$ holds, for example, it follows that $\widehat{P}_3 < 0$ and $\widehat{P}_4 > 0$.

It is worth emphasizing that in the model relative prices of both non-traded goods change in response to factor accumulation. Because consumption is disaggregated and different groups consume different goods, these changes have different welfare effects on different groups. Our model, consequently, establishes why it is important to depart from the representative agent models that are widely used in economics. When temporary migrants form a distinct group in an economy, the welfare of groups may be affected in different ways that cannot be captured in a representative agent framework. We examine the factor reward and welfare implications next.

Differentiating the factor price equations and solving, we obtain:

$$\widehat{R} = \frac{\left(\theta_{M4}\widehat{P}_3 - \theta_{M3}\widehat{P}_4\right)}{\theta_{M3}\theta_{M4}(t_3 - t_4)R/w^M}; \tag{37}$$

$$\widehat{w}^M = \frac{-\theta_{T4}\widehat{P}_3 + \theta_{T3}\widehat{P}_4}{\theta_{M3}\theta_{M4}(t_3 - t_4)R/w^M}. \tag{38}$$

Equations 37 and 38 indicate that for $(t_3 - t_4) > 0$, $\widehat{R}$ is rising in $\widehat{P}_3$ and falling in $\widehat{P}_4$, while the reverse is true for $\hat{w}^M$. These results are in line with the Stolper–Samuelson theorem. However, they indicate a changed nature in the conflict between capitalists and workers. The conflict is now between foreign workers and domestic capitalists; these two groups receive rewards that move in opposite directions. While the status quo is maintained when $\widehat{P}_3 = \widehat{P}_4$, the changes in factor rewards depend on the magnitude of price movements when $\widehat{P}_3 \neq \widehat{P}_4$. This clearly presents a problem from a policy-making perspective, because it provides ambiguous theoretical directions for imposing taxes and subsidies.

To conclude our theoretical investigation, we consider the welfare changes for domestic residents and migrants:

$$\widehat{Y} = \left(\varepsilon_4 - \frac{s_4}{\kappa}\theta_{T3}\right)\widehat{P}_4 + \frac{s_4}{\kappa}\theta_{T4}\widehat{P}_3; \tag{39}$$

$$\widehat{Y}^M = s_4^{'}\widehat{M} + \left(\frac{s_4^{'}}{\kappa}\theta_{T3} - \varepsilon_4\right)\widehat{P}_4 - \frac{s_4^{'}}{\kappa}\theta_{T4}\widehat{P}_3, \tag{40}$$

where:

$$\varepsilon_4 = \frac{X_4 P_4}{Y^M};$$

$$s_4 = \frac{w^M M}{Y};$$

$$s_4^{'} = \frac{w^M M}{Y^M} = 1;$$

$$\kappa = \theta_{T3}\theta_{M4} - \theta_{M3}\theta_{T4}.$$

Substituting equations 35 and 36 into equation 39 and simplifying, we obtain:

$$\widehat{Y} = \frac{\widehat{M}}{|\nabla|}\left[\left(Z_4 N_3 - \eta^M\right)\left(\varepsilon_4 - \frac{S_4}{\kappa}\theta_{T3}\right) + Z_3 N_4 \frac{S_4}{\kappa}\theta_{T4} + Z_3 \eta^M\left(\eta_4 - \frac{\theta_{T4}}{\kappa} - \frac{S_4}{\kappa}\theta_{T4}\varepsilon_{4M}\right)\right]. \tag{41}$$

Walrasian stability implies that $|\nabla| < 0$. It can be shown that $\left(\varepsilon_4 - \frac{s_4}{\kappa}\theta_{T3}\right) < 0$ and $Z_3 N_4 \frac{s_4}{\kappa}\theta_{T3} > 0$. When there is a growth in the number of migrants and $\widehat{M} > 0$,

it is ambiguous whether the welfare of domestic residents rises or falls. As such, we perform a calibration of the model in Section 5 to show numerically the impact of exogenous shocks on endogenous variables, especially the welfare of domestic residents. Before doing so, however, we outline the intuition and geometry of the methodology and results in this paper.

4. A GEOMETRIC ANALYSIS

There are two 'blocks' in this model: the traded and the non-traded. For clarity, these blocks are represented below in Figure 1.

In Figure 1, L is mobile between the two blocks and forms an extremely important resource link between the traded and non-traded sectors. The other significant link is via the income effect between the two blocks.

We begin with the demand and supply equations in the non-traded sector (eqns 9 and 10): $D_3 = X_3$ and $D_4^M = X_4$. Figure 2 below depicts the demand and supply curves for both these goods. Given our assumptions, these are well behaved. They intersect at points e_3 and e_4 and solve for the following variables: $P_3^*, P_4^*, X_3^*, X_4^*, D_3^*$ and D_4^{M*}. The markets for goods X_3 and X_4 are equilibriated by the process of Walrasian tatonnement.

There exist two production possibility curves: one for X_1 and X_2 based on the traded block, and one for X_3 and X_4 based on the non-traded block. The two production possibility curves are linked via the resources link; that is, L_3. The production possibility curve for goods X_3 and X_4 is shown in Figure 3. The production possibility curve is concave to the origin and, given the price ratio $P_4/$

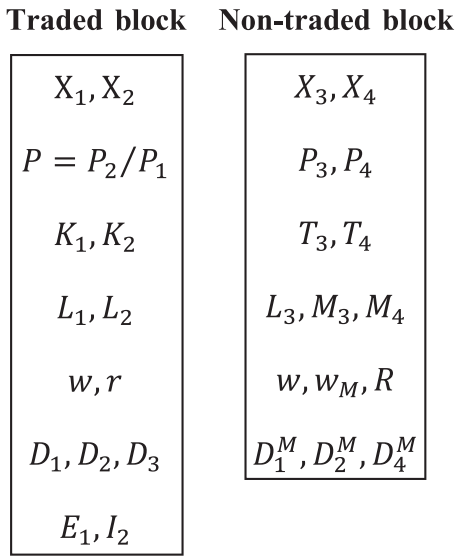

Figure 1. The traded and non-traded blocks

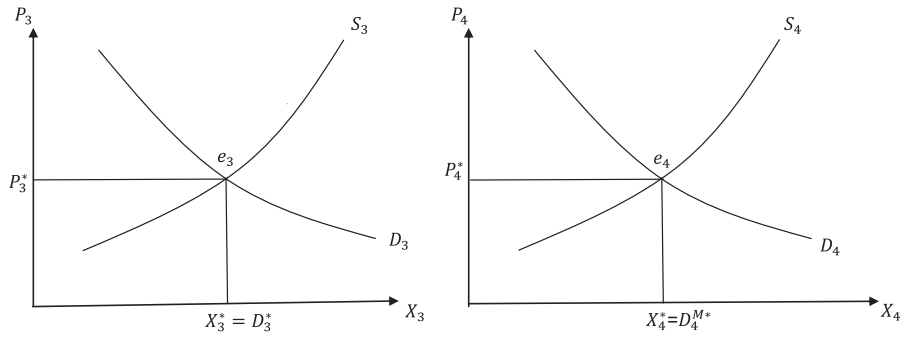

Figure 2. The market for the two non-traded goods

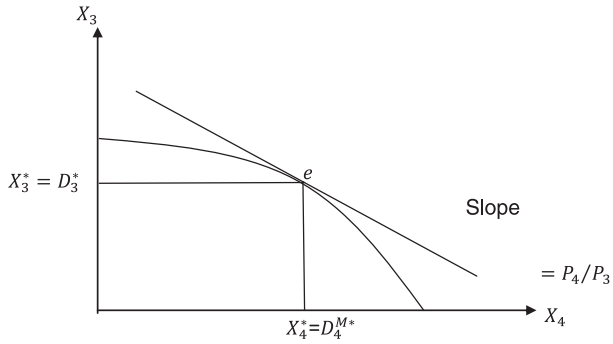

Figure 3. The production possibility curve for the two non-traded goods

P_3, there is a unique solution at point e. The equilibrium outputs in this space are shown by the tangency condition at point e.

As there exists an Edgeworth–Bowley box behind the production possibility curve, we examine that next. In Figure 3 we have determined the output level of X_3 and X_4 and the relative price ratio P_4/P_3. Because the level of X_3 is known we can solve for L_3, the domestic labour allocation for the non-traded block. Given that L_3 is fixed in this manner, we can draw a box diagram that shows the endowment of $\overline{T}$ and $\overline{M}$, as depicted in Figure 4.

Because the relative price P_4/P_3 is now given, it follows from the marginal productivity conditions that w^M and R are also determined. Moreover, as t_4 and t_3 are functions of the wage rental ratio, these are also determined as shown by the slope of O_4e and O_3e in Figure 4. So, from the box diagram we can determine the following: t_4, t_3, and the allocation of M_3 and M_4 ($O_3\tilde{M}'$ and $O_4\tilde{M}$); although not shown explicitly in the graph, the allocation of T_4 and T_3 can also be determined along the vertical axes of the box. Consequently, we now have a solution for the following variables: P_4/P_3, X_3, X_4, w^M, R, T_3, T_4, M_3, M_4, L_3, as well as the consumption levels $D_3 = X_3$ and $D_4^M = X_4$. This implies that we have solved for all the variables in the non-traded block using Figures 2 to 4.

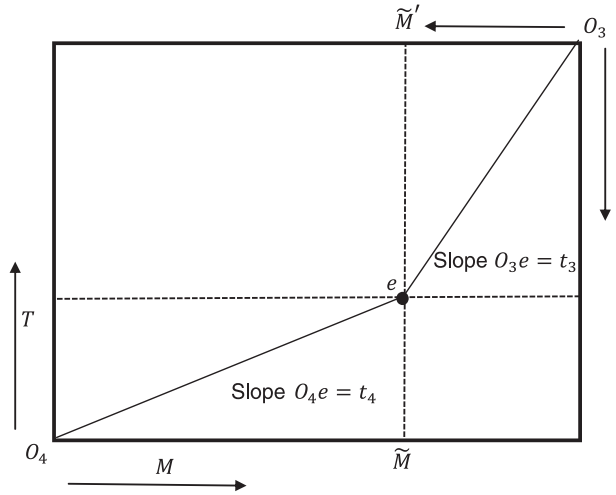

Figure 4. The Edgeworth-Bowley box for the non-traded goods

We now proceed to solve for the equilibrium levels of variables in the traded block. A distinguishing feature of this model is that the system is solved from the non-traded goods sector rather than the traded goods sector, as is the case in the analysis presented in Komiya (1967). The quantities in the traded sector cannot be derived without a solution to the relative price of non-traded goods and their quantities.

A solution has been obtained for L_3, which is the supply of domestic labour used in the non-traded goods sector. The labour market endowment constraint implies that $L_1 + L_2 + L_3 = \overline{L}$.

We have a solution for L_3 and, therefore, we know the supply of labour to the traded goods sectors. Let L_3^* denote the equilibrium supply of labour to the non-

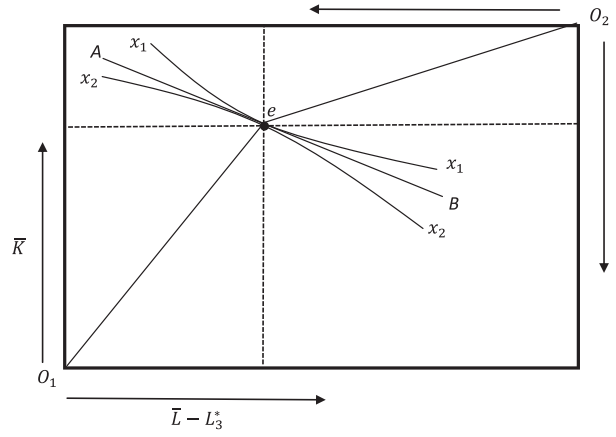

Figure 5. The Edgeworth-Bowley box for the traded goods

traded goods sector. The labour endowment constraint implies that $L_1 + L_2 = \overline{L} - L_3^*$.

This determines the supply of labour to the traded goods sectors. We also know that $K_1 + K_2 = \overline{K}$.

Therefore, the traded goods box diagram can be drawn as shown in Figure 5.

The terms of trade P is given exogenously. Figure 5 solves for: w, r, k_1, k_2, X_1, X_2, L_1, L_2, K_1 and K_2. This is the standard two-sector general equilibrium model. Because we now know k_1 and k_2, we can depict the equilibrium positions in Figure 5, where it is assumed that $k_1 > k_2$. Equilibrium occurs at point e. The slopes of O_1e and O_2e show the equilibrium values of k_1 and k_2, respectively. The isoquants x_1x_1 and x_2x_2 determine the levels of output X_1 and X_2, respectively. The slope of the tangent AB depicts the wage–rental ratio, w/r, in Sectors 1 and 2.

In Figure 6 below, we have drawn the production possibility curve for the traded goods sectors, given endowments $\overline{K}$ and $\overline{L} - L_3^*$. The curve is concave to the origin and, given P, the equilibrium occurs at point E, with equilibrium output levels X_1^* and X_2^*.

Given that we have two agents in the economy with different preferences, we cannot draw a social indifference curve map, as their preferences are not identical. However, we can represent the trade equilibrium in this diagram. This is shown by the point E' where the economy exports EO' of X_2 and imports $O'E'$ of X_1.

We now depict the comparative static exercise of changing M. Let us suppose that M increases and Sector 4 is M intensive. The fact that Sector 4 is M intensive implies that the production possibility curve shifts from SS to $S'S'$, as shown in Figure 7.

At constant prices, the output X_4 increases and X_3 falls. Because these are non-traded goods, there will be some adjustment in the relative price of X_4. Figure 7 depicts the outcome after these price adjustments, with a movement from X_3^* to X_3^{**} for X_3 and from X_4^* to X_4^{**} for X_4. In this diagram, we have shown that as a result of an increase in temporary migration, the following things occur in the non-traded sector: (i) the output of X_4 increases and the

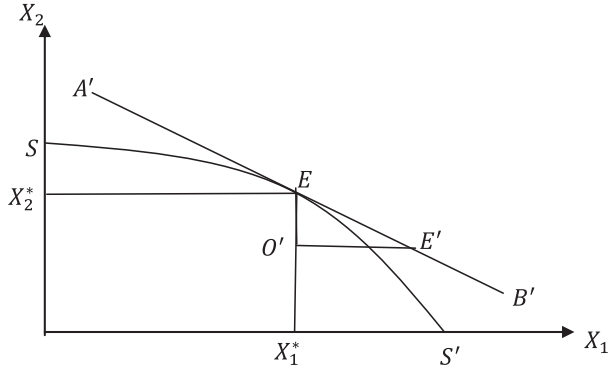

Figure 6. The production possibility curve for the traded goods

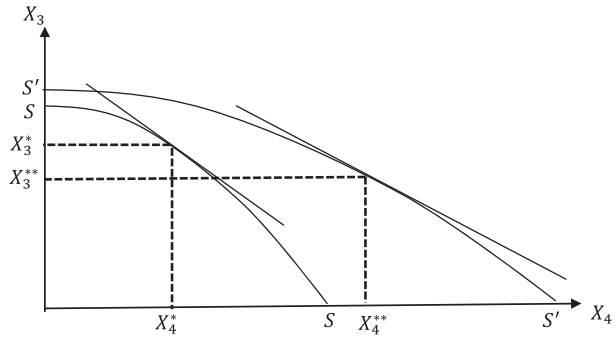

Figure 7. The impact of an increase in M on the non-traded goods

output of X_3 decreases; and (ii) the relative price of X_4 falls. Because we know the movement in the relative price of X_4, the impacts on the wages of migrants and on the rental of type T capital simply follow from the Stolper–Samuelson theorem.

The most interesting effects of the increase in temporary migrants are on the welfare of domestic residents and migrants. In Figure 7, it is clear that the consumption of good 3 falls for domestic residents. We know that $D_3 = X_3$ and, therefore, when X_3 falls, so must D_3; this represents a loss for the welfare of domestic residents. In a similar manner, the increase in the output of X_4 (which equals D_4^M) represents a gain for temporary migrants. However, this is not the complete story as far as welfare is concerned. This needs to be analysed by examining the changes to the traded goods sector.

We know that a decrease in the output of X_3 results in the release of labour L_3 from the non-traded sector. Thus, the amount of domestic labour available to the traded goods sector increases at constant prices. So the traded goods sector has a Rybczynski effect, as shown in Figure 8. This effect shifts the traded

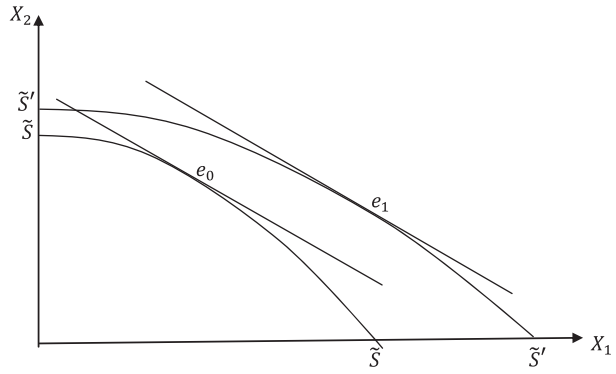

Figure 8. The impact of an increase in M on the traded goods

goods production possibility curve from $\widetilde{S}\widetilde{S}$ to $\widetilde{S}'\widetilde{S}'$ and equilibrium output from e_0 to e_1. The domestic residents have a gain in welfare in the traded goods sector. The total welfare of the domestic residents, therefore, consists of two effects: (i) a loss in welfare from the decline in consumption of the non-traded good D_3; and (ii) an increase in welfare from consumption in traded goods arising from the Rybczynski effect on the traded goods sector. If the magnitude of (i) is greater than (ii), then the welfare of domestic residents decreases as a result of an increase in temporary migration; otherwise, domestic welfare increases.

5. CALIBRATION

5.1. *The calibration model*

In this section, we calibrate our model on a set of parameters based on the Hong Kong economy. We assume that both domestic residents and temporary migrants have constant elasticity of substitution utility functions. The utility function of domestic residents is:

$$U = [\gamma C^{\rho} + (1-\gamma){D_3}^{\rho}]^{\frac{1}{\rho}}, \tag{42}$$

where $C = D_1^{\alpha} D_2^{1-\alpha}$ is the tradables that domestic residents consume. The elasticity of substitution between tradables and non-tradable good in Sector 3 is $\frac{1}{1-\rho}$. Temporary migrants have a utility function of the following form:

$$U_M = \left[\gamma_M (C_M)^{\rho_M} + (1-\gamma_M)\left(D_4^M\right)^{\rho_M}\right]^{\frac{1}{\rho_M}}, \tag{43}$$

where $C_M = \left(D_1^M\right)^{\alpha_M}\left(D_2^M\right)^{1-\alpha_M}$ is the tradables that migrants consume, and $\frac{1}{1-\rho_M}$ is the elasticity of substitution between the tradables and the non-tradable good in Sector 4 for migrants. From equations 42 and 43 we obtain the expenditure functions of domestic residents and migrants:

$$e = [\gamma^{\varphi} + (1-\gamma){P_3}^{\varphi}]^{\frac{1}{\varphi}} U, \tag{44}$$

$$e_M = [{\gamma_M}^{\varphi_M} + (1-\gamma_M){P_4}^{\varphi_M}]^{\frac{1}{\varphi_M}} U_M, \tag{45}$$

where $\varphi = \frac{\rho-1}{\rho}$ and $\varphi_M = \frac{\rho_M - 1}{\rho_M}$; P_3 and P_4 are relative prices of non-tradables.

On the production side, we employ Cobb–Douglas production functions for the four sectors:

$$X_1 = F_1(K_1, L_1) = {K_1}^{\alpha_1}{L_1}^{1-\alpha_1}; \tag{46}$$

$$X_2 = F_2(K_2, L_2) = {K_2}^{\alpha_2}{L_2}^{1-\alpha_2}; \tag{47}$$

$$X_3 = F_3(T_3,\ L_3, M_3) = {T_3}^{\alpha_3} {L_3}^{\beta_3} {M_3}^{1-\alpha_3-\beta_3}; \tag{48}$$

$$X_4 = F_4(T_4,\ M_4) = {T_4}^{\alpha_4} {M_4}^{1-\alpha_4}. \tag{49}$$

We also impose the conditions that the resource constraints and market clearing equations are satisfied.

The key endogenous variables that we are interested in are U, U_M, P_3, P_4, R and w^M. In these models, welfare can be evaluated by utility or by real income; as such, we use real income to measure welfare. Other endogenous variables in our model include $w,\ r,\ K_1,\ L_1,\ K_2,\ L_2,\ T_3,\ L_3,\ M_3,\ T_4$ and M_4. We are mainly interested in the following two questions in our sensitivity analysis:

1. How would an increase in the number of temporary migrants affect the welfare of domestic residents?
2. How would changes to structural parameters in the economy affect the welfare of domestic residents in the presence of migrants?

Along with these questions that focus on the impact on domestic welfare, we also calibrate the effect of these changes on the relative prices of non-tradable goods, return to capital in non-tradable good sectors, and on the wage rate of temporary migrants.

5.2. *Data sources*

Population and capital data are taken from Hong Kong Census and Statistics Department reports from 2011 and 2012; specifically, we incorporate labour participation data from the fourth quarter of 2011 and capital stock data from the second quarter of 2012. We normalize labour supply to 100 for domestic residents (permanent residents). For simplicity, we divide capital supply equally between tradable sectors and non-tradable sectors.

Reliable data for Hong Kong for the exponents of the production functions ($\alpha_1, \alpha_2, \alpha_3, \alpha_4$ and β_3), as well as for elasticities of substitution, are scarce. We approach this complication in two steps. First, we use plausible parametric estimates from studies conducted based on Hong Kong and the US to construct a benchmark case; second, we test the robustness of the results by considering other parametric values.

While calibrating a DSGE model of the Hong Kong economy with a single sector, Garaigorta and Iza (2011) employ a capital share of 0.4. Young (1995) provides an estimate of the capital share for the tradable sector in the US as 0.37. Similarly, Stockman and Tesar (1995) estimate the capital share in the non-tradable sector in the USA as 0.44. Valentinyi and Herrendorf (2008) provide estimates of the capital shares in the tradable and non-tradable sectors in the USA as 0.35 and 0.32, respectively. While these studies vary across countries, time and sectors, the estimates for capital shares vary in a relatively narrow

Table 1. Parameter calibration for the benchmark model

Parameters:	
Elasticity of substitution	
φ	0.2181
φ_M	−0.3158
Share parameter	
γ	0.60
γ_M	0.40
Capital share in the tradable Sector 1	
α_1	0.30
Capital share in the tradable Sector 2	
α_2	0.35
Capital share in the non-tradable Sector 3	
α_3	0.45
Capital share in the non-tradable Sector 4	
α_4	0.35
Domestic labour share in the non-tradable Sector 3	
β_3	0.40
Population composition	
Total	3 804 200
Domestic permanent work force	64% out of total
Temporary migrants	36% out of total
Labour employment	100
Total Capital	1 126 060 (million HKD)
Capital in the tradable sector	50% out of total
Capital in the non-tradable sector	50% out of total

range between 0.3 and 0.45. Therefore, we construct different scenarios based on capital shares that vary across this range as well.

5.3. *The benchmark calibration*

Table 1 presents the parameter calibration for the benchmark model.

The parameters for the elasticity of substitution are taken from Li (2009).[7] For the benchmark calibration, capital shares in Sectors 1, 2, 3 and 4 are set at 0.30, 0.35, 0.45 and 0.35, respectively. The domestic labour share in Sector 3 is set at 0.4. Subsequently, we will test the robustness of the benchmark calibration results to changes in these parameter values.

Figure 9 presents the first group of results. In all the six graphs in the figure, the horizontal axis shows the number of temporary migrants (normalized). In Figure 9a the vertical axis measures the welfare of domestic residents. We observe that when the number of migrants increases, the welfare of domestic residents increases monotonically. The other graphs in the figure indicate that the relative prices of non-tradable goods in Sectors 3 and 4 decrease (Figure 9c,d), the welfare of temporary migrants increases (Figure 9b), return to capital

[7] Li (2009), based on Agarwal *et al.* (2010), estimates $\varphi = 0.2181$ for the rich class and $\varphi_M = -0.3158$ for the poor class in an economy. We borrow these numbers for domestic residents and temporary migrants in our model, respectively.

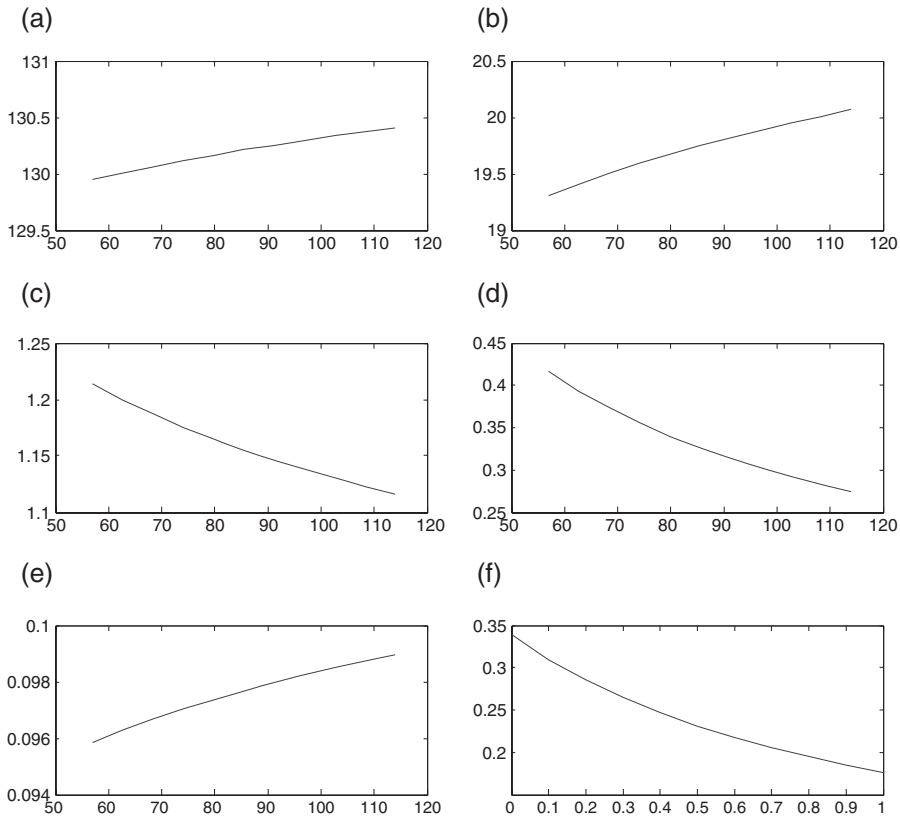

Figure 9. Change of temporary migrants versus changes of key endogenous variables: (a) temporary migrants versus welfare of domestic residents; (b) temporary migrants versus welfare of temporary migrants; (c) temporary migrants versus price of non-tradable good 3; (d) temporary migrants versus price of non-tradable good 4; (e) temporary migrants versus return to capital of non-tradables; and (f) temporary migrants versus wage rate of temporary migrants

employed in non-tradable sectors increases (Figure 9e), and the wage rate of temporary migrants declines (Figure 9f).

Next, we change the expenditure share on tradable goods for temporary migrants and analyse the impact on key endogenous variables. The results are summarized in Figure 10. The horizontal axis measures γ_M, which we increase from the benchmark level of 0.4 up to 0.6, the latter also being the share of expenditure for domestic residents in the benchmark case.

Figure 10a shows that when γ_M increases, the welfare of domestic residents decreases monotonically. At the same time, Figure 10c and d suggest that the relative prices of non-tradable goods also decline, as demand by migrant workers shifts to tradable goods. The wage rate of temporary migrants (Figure 10f), the return to capital in non-tradable sectors (Figure 10e) and the welfare of temporary migrants (Figure 10b) decrease as well.

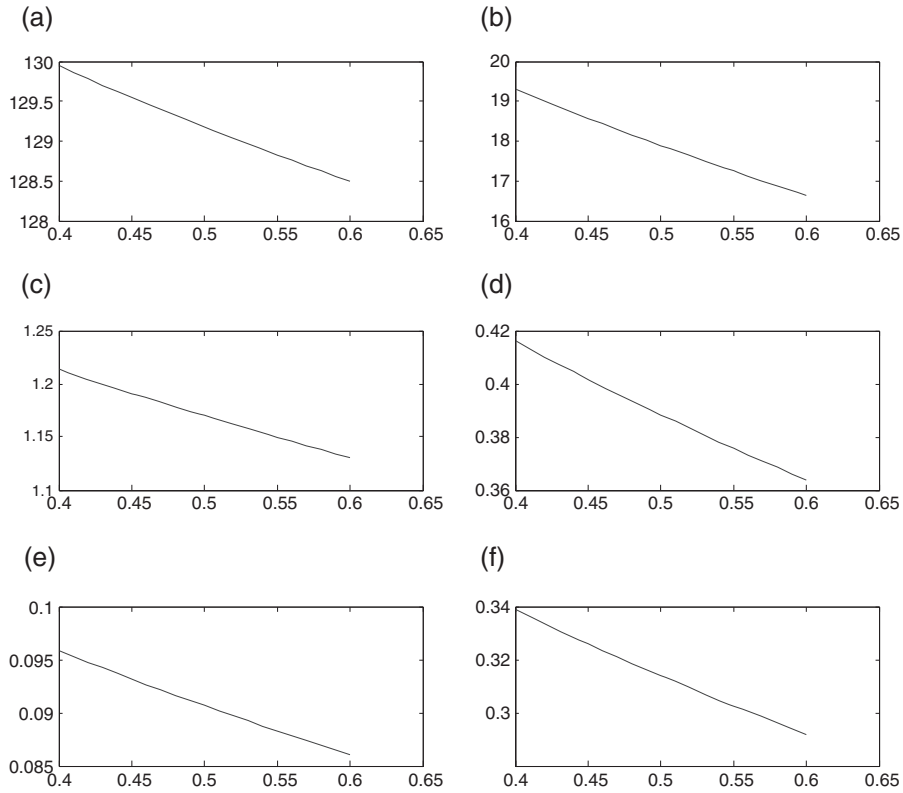

Figure 10. Change of expenditure share of tradable goods by temporary migrants versus changes of key endogenous variables: (a) share of expenditure on tradables versus welfare of domestic residents; (b) share of expenditure on tradables versus welfare of temporary migrants; (c) share of expenditure on tradables versus price of non-tradable good 3; (d) share of expenditure on tradables versus price of non-tradable good 4; (e) share of expenditure on tradables versus return to capital on non-tradables; and (f) share of expenditure on tradables versus wage rate of temporary migrants

Figure 11 presents our results on altering the share of capital in Sector 3, which is captured by the parameter α_3. Figure 11a shows the effect of this change on domestic welfare: domestic welfare decreases as α_3 increases. This monotonic response is also displayed by the return to capital in non-tradable sectors (Figure 11e). The welfare of temporary migrants (Figure 11b), their wage rate (Figure 11f) and the price of the non-tradable good in Sector 3 and 4 (Figure 11c and d) also decrease in the range we consider.

Finally, we turn to another interesting scenario in which we raise the share of domestic labour in Sector 3, that is, we allow β_3 to rise. Figure 12 shows the results, where changes to β_3 are measured on the horizontal axis. Figure 12a presents a stark and important feature: the negative relationship

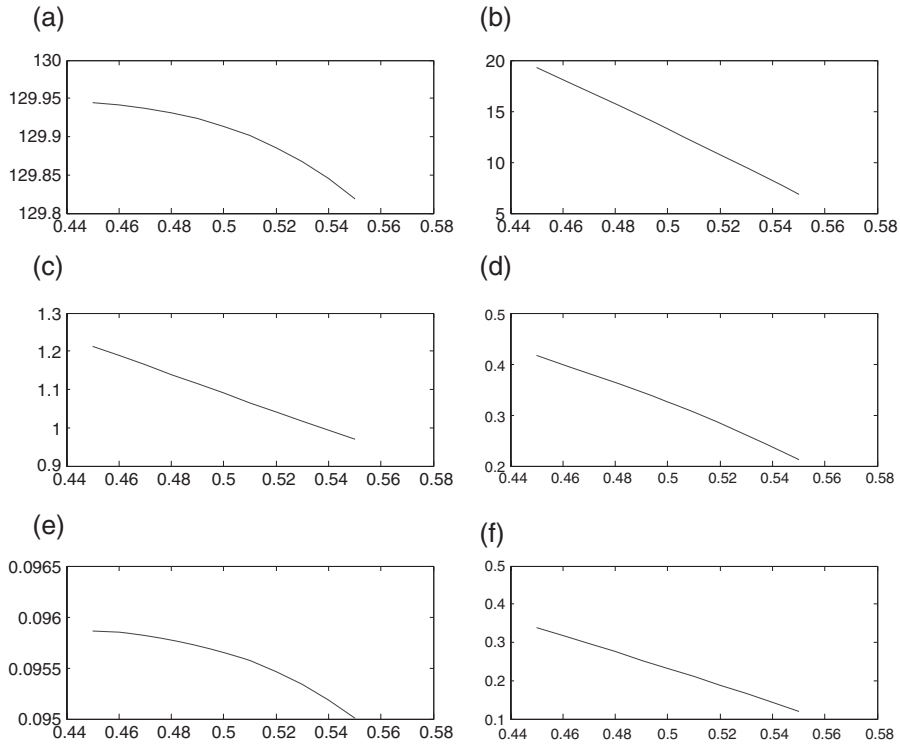

Figure 11. Change of capital share in Sector 3 versus changes of key endogenous variables: (a) capital share in Sector 3 versus welfare of domestic residents; (b) capital share in Sector 3 versus welfare of temporary migrants; (c) capital share in Sector 3 versus price of non-tradable good 3; (d) capital share in Sector 3 versus price of non-tradable good 4; (e) capital share in Sector 3 versus return to capital in non-tradables; and (f) capital share in Sector 3 versus wage rate of temporary migrants

between domestic welfare and β_3. Our analysis suggests, therefore, that even at existing levels of migration, domestic residents can be immiserized when domestic labour is diverted to non-tradable sectors. The remaining graphs in Figure 12 indicate that other endogenous variables decrease in response to an increase in β_3.

5.4. *Robustness to changes in capital shares*

We now consider the impact of changing the benchmark parameter values. The benchmark case was performed with capital shares of the tradable sectors being equal to or lower than capital shares in the non-tradable sectors, which is consistent with Young (1995) and Stockman and Tesar

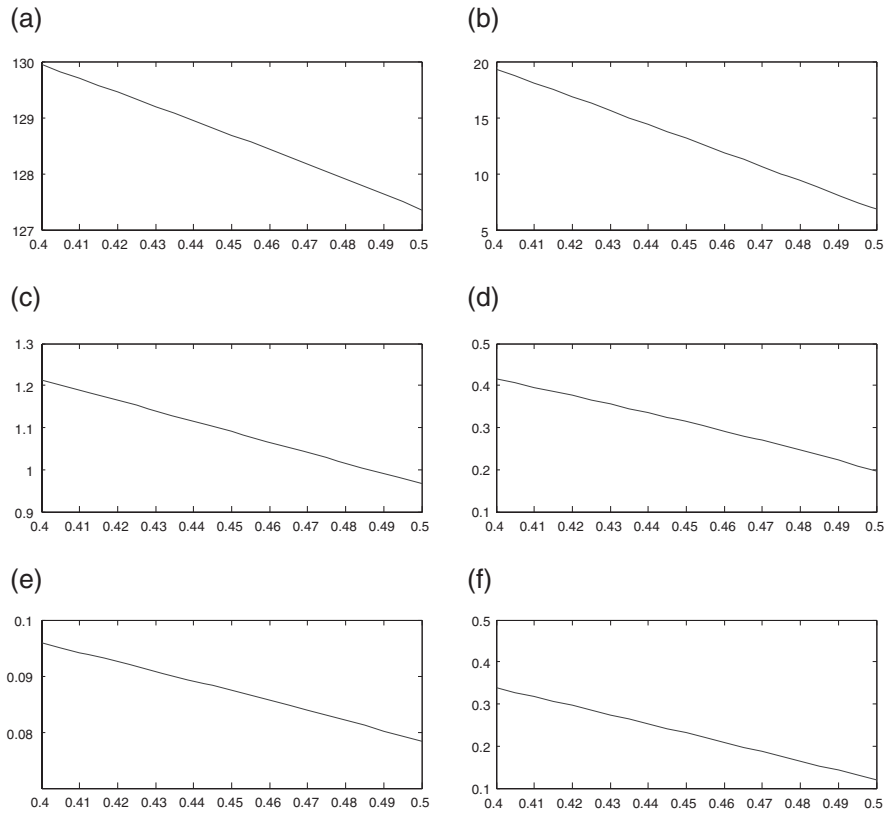

Figure 12. Change of domestic labour share in Sector 3 versus changes of key endogenous variables: (a) domestic labour share in Sector 3 versus welfare of domestic residents; (b) domestic labour share in Sector 3 versus welfare of temporary migrants; (c) domestic labour share in Sector 3 versus price of non-tradable good 3; (d) domestic labour share in Sector 3 versus price of non-tradable good 4; (e) domestic labour share in Sector 3 versus return to capital in non-tradables; and (f) domestic labour share in Sector 3 versus wage rate of temporary migrants

(1995). On the other hand, Obstfeld and Rogoff (1996) and Valentinyi and Herrendorf (2008) argue the reverse: that the capital shares of the tradable sectors tend to be larger than those in the non-tradable sectors. To further explore these alternative viewpoints, we construct two additional scenarios:

Table 2. Capital shares for Scenarios 1 and 2

Capital shares	Benchmark case	Scenario 1	Scenario 2
Sector 1 (tradable): α_1	0.30	0.30	0.35
Sector 2 (tradable): α_2	0.35	0.35	0.37
Sector 3 (non-tradable): α_3	0.45	0.45	0.3
Sector 4 (non-tradable): α_4	0.35	0.40	0.32

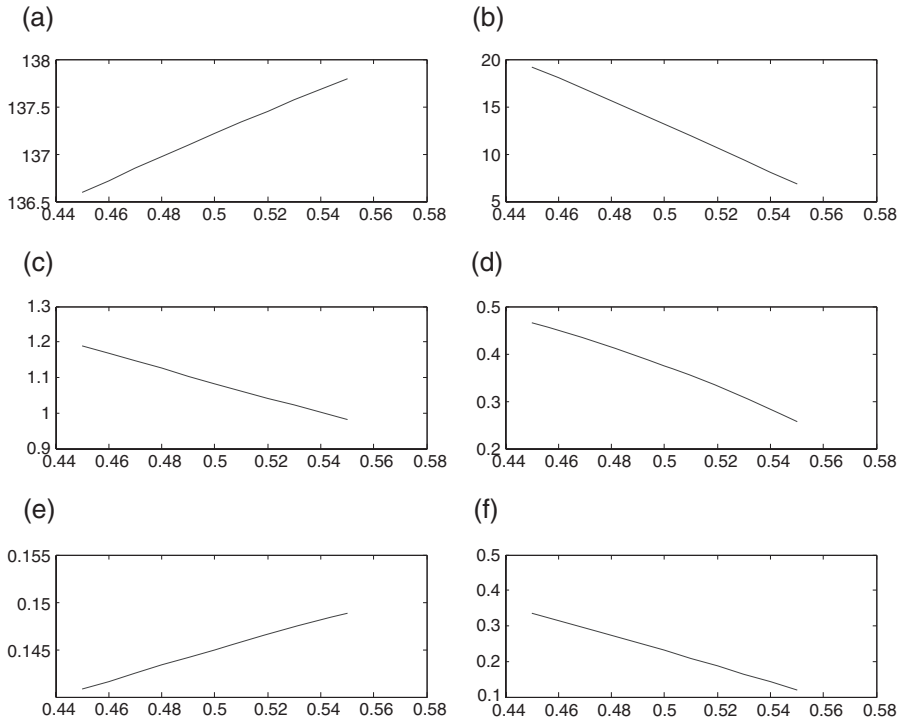

Figure 13. Change of capital share in Sector 3 versus changes of key endogenous variables for Scenario 1: (a) capital share in Sector 3 versus welfare of domestic residents; (b) capital share in Sector 3 versus welfare of temporary migrants; (c) capital share in Sector 3 versus price on non-tradable good 3; (d) capital share in Sector 3 versus price on non-tradable good 4; (e) capital share in Sector 3 versus return to capital in non-tradables; and (f) capital share in Sector 3 versus wage rate of temporary migrants

Scenario 1: Capital shares in the tradable sectors are lower than in the non-tradable sectors, as in the benchmark case; however, this scenario allows the divergence between the shares to be wider than the benchmark case by eliminating the situation where $\alpha_2 = \alpha_4$.

Scenario 2: Capital shares in the tradable sectors are, in contrast with the benchmark case, significantly higher than the non-tradable sectors.

In both these scenarios, we maintain capital shares between the range of 0.3 and 0.45. The capital shares of the two scenarios, along with the benchmark shares as a reference, are summarized in Table 2:

Our results indicate that the impact of changes in the number of temporary migrants and the expenditure share of tradable goods by temporary migrants were qualitatively identical to the benchmark case; in other words, the results described in Figures 9 and 10 were replicated in both Scenarios 1

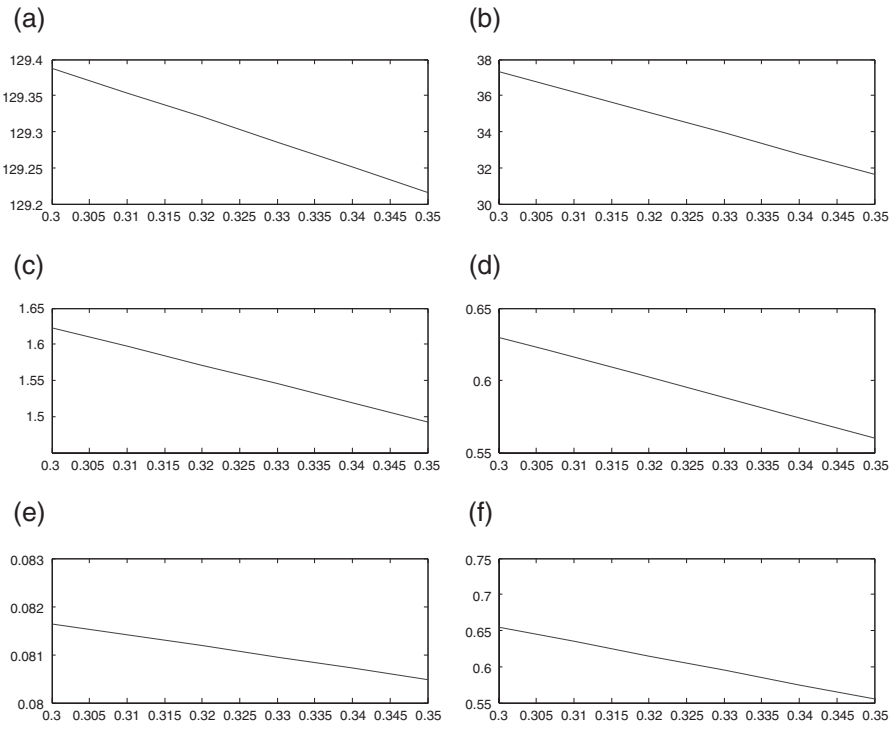

Figure 14. Change of capital share in Sector 3 versus changes of key endogenous variables for Scenario 2: (a) capital share in Sector 3 versus welfare of domestic residents; (b) capital share in Sector 3 versus welfare of temporary migrants; (c) capital share in Sector 3 versus price on non-tradable good 3; (d) capital share in Sector 3 versus price on non-tradable good 4; (e) capital share in Sector 3 versus return to capital in non-tradables; and (f) capital share in Sector 3 versus wage rate of temporary migrants

and 2. Consequently, to keep the analysis tractable, we elaborate here only those results that were not robust to changes in the capital share parameter values.[8]

The most striking results were produced when the capital share of Sector 3 was allowed to change, while keeping other parameters the same in the various scenarios. In the benchmark case, described by Figure 11, the welfare of domestic residents falls as α_3 increases. In contrast, for Scenario 1 we observe that the welfare of domestic residents rises monotonically in the range considered with an increase in α_3, while in Scenario 2 the reverse is true and the welfare of domestic residents falls with an increase in α_3, which is consistent with the result in Figure 11. The results parallel to Figure 11 for Scenarios 1 and 2 are summarized in Figures 13 and 14, respectively.

8 All the results from the calibration exercises are available from the authors on request.

Comparing Figures 11, 13 and 14, it is evident that the changes in welfare of domestic residents, the price of non-tradable good 3 and return to capital in the non-tradable sectors to changes in α_3 are sensitive to the parametric assumptions. Overall, Figures 11 and 14 indicate in a stark manner the possibility of a decrease in the welfare of domestic residents as the non-tradable good consumed by domestic residents becomes more capital intensive, while Figure 13 shows that, in some circumstances, domestic welfare may decrease as the non-tradable good becomes less capital intensive.

In terms of Figure 12, all the graphs were qualitatively similar for Scenarios 1 and 2 relative to the benchmark case. Importantly, the immiserization of domestic residents is reflected in Scenarios 1 and 2 as well.

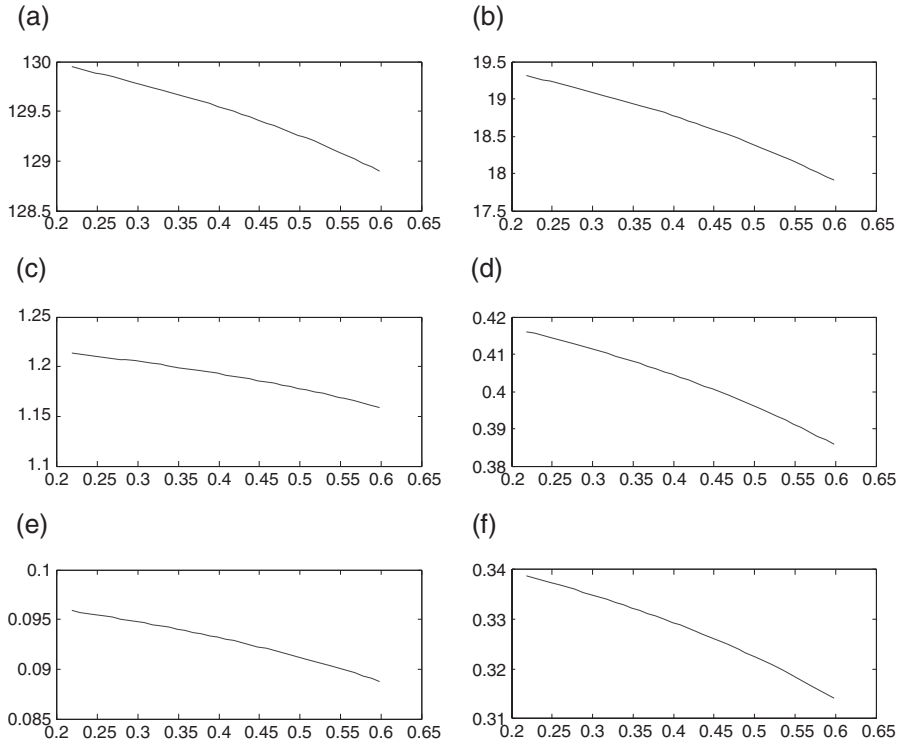

Figure 15. φ versus changes of key endogenous variables (benchmark case): (a) ESTNT of domestic residents versus welfare of domestic residents; (b) ESTNT of domestic residents versus welfare of temporary migrants; (c) ESTNT of domestic residents versus price of non-tradable good 3; (d) ESTNT of domestic residents versus price of non-tradable good 4; (e) ESTNT of domestic residents versus return to capital in nontradables; and (f) ESTNT of domestic residents versus wage rate of temporary migrants

5.5. *Robustness to changes in the elasticity of substitution*

To conclude our calibration exercise, we examine the impact of changes in the elasticities of substitution, while keeping the values of the other parameters at the benchmark case levels. Specifically, we allow φ to vary between 0.2181 and 0.6, and φ_M to vary between -0.3158 and -0.1. Figures 15 and 16 summarize the results, where the elasticities of substitution have been abbreviated to ESTNT.

The above figures indicate that an increase in φ or φ_M results in a decrease in all the endogenous variables considered, including the welfare of domestic residents. Importantly, all the graphs in Figures 15 and 16 were qualitatively similar to the graphs obtained when we changed the parameters to conform to Scenarios 1 and 2, affirming the robustness of these results.

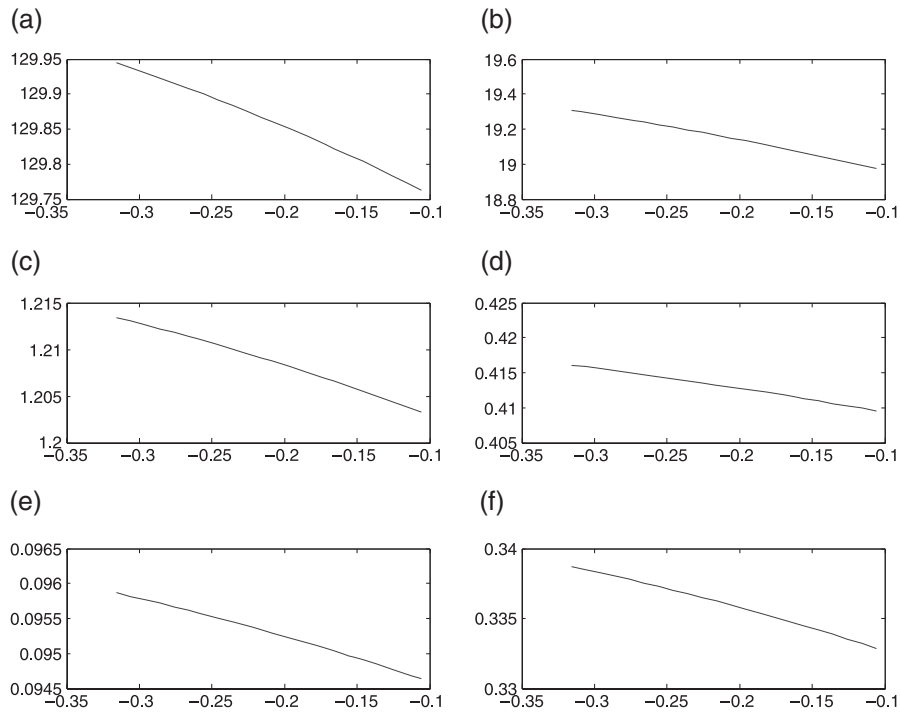

Figure 16. φ_M versus changes of key endogenous variables (benchmark case): (a) ESTNT of domestic residents versus welfare of domestic residents; (b) ESTNT of domestic residents versus welfare of temporary migrants; (c) ESTNT of domestic residents versus price of non-tradable good 3; (d) ESTNT of domestic residents versus price of non-tradable good 4; (e) ESTNT of domestic residents versus return to capital in nontradables; and (f) ESTNT of domestic residents versus wage rate of temporary migrants

5. CONCLUSION

In this paper, we set up a trade model with four goods and four factors to study the impact of temporary migration and Kaldorian consumption disaggregration on a small open economy. Our framework allowed the existence of tradable and non-tradable goods, and displayed characteristics of fixed-price as well as flexible-price models. Our theoretical results highlighted the differing impacts that factor accumulation has on tradable goods sectors relative to non-tradable goods sectors. Because prices are flexible in some sectors and consumption is characterized by Kaldorian disaggregation, price changes resulting from factor accumulation produce differing effects on the welfare of different groups. Specifically, our model emphasizes the nature of conflict that develops in this scenario: that between domestic capitalists and foreign workers.

We calibrate the implications of our theory using data from Hong Kong. The calibration results indicate that the welfare of domestic residents may fall for a number of reasons in the presence of temporary migration and Kaldorian disaggregation. At existing levels of temporary migrants, the fall in domestic welfare may occur due to an increased share of expenditure on tradable goods by temporary migrants, an increase in the share of capital in Sector 3, an increase in the share of domestic labour in Sector 3, or as a result of increases in the elasticities of substitution of both domestic residents and migrants.

Our theoretical and calibration results have important implications for migration policy in small open economies like Hong Kong. The possibility that domestic welfare may decrease due to structural changes in an economy even at existing levels of temporary migration, as well as the possibility that growth in temporary migration can produce similar welfare reducing effects, is worth noting. This immiserization effect linked to temporary migration has not been well analysed in the trade literature, and our paper provides a much needed framework to systematically gauge the welfare changes of domestic residents due to structural changes in an economy where temporary migration is important.

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