Comparative advantage, endowment structure, and trade imbalances

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This research looks to theoretically demystify the evolutionary patterns of trade imbalances between developing countries and developed countries from a unique perspective of the comparative advantage in the factor endowment structure of developing countries. For this purpose, we construct a theoretical model to illustrate the inherent dynamics between the trade imbalance and the comparative advantage of the factor endowment structure under a two-country setting (Part I). The model results in three propositions: (1) as one country becomes more capital-intensive, its wage level increases and the cost of capital relative decreases. (2) The shift in the comparative advantage of the factor endowment structure from labor intensiveness to capital intensiveness in a developing country leads to a shrinkage in trade imbalance for the developed country. (3) An increase in the wage levels of developing countries eradicates the degree of the trade deficits of developed economies. To test those two conclusions, we employ panel GMM comprised of 157 developing countries over the period 1992–2017 (Part II). The empirical evidence is broadly consistent with the propositions demonstrated herein. Finally, we discuss the potential policy recommendations for policy makers according to our findings that the free international trade creates a win-win outcome and we propose further research directions (Part III).

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1. Introduction

The dynamics of trade imbalances between the United States (U.S.) and East Asian countries has attracted considerable attention in recent years. However, fully unlocking the intricacies within the dynamics of trade imbalances between developing and developed countries has been difficult for international trade researchers. Lin and Wang (2018) presented several notable stylized facts on U.S. trade imbalances. First, among all economies having a trade surplus with the U.S. over the last three decades, especially China. Second, for the remaining countries, their shares in the U.S. trade deficit has persistently declined since the 1990s. Third, among the sectors aligned with the comparative advantage of the labor-intensive factor endowment structure of China’s economy, U.S. trade imbalances with China have increased over time.

Naturally, one would furtherly ask whether we could proposed a theoretical foundation for studying the relationship between factor endowment structure and global imbalances. This is the main goal and contribution of this paper.

For this purpose, one possible explanation for those evolutions of trade imbalances between the U.S. and East Asian countries is a reallocation effect of the labor-intensive manufacturing and assembly sectors from East Asian countries to China or Southeast Asian.

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2 According to U.S. Census Bureau data (the same data source as the following two notes), 0.3% of the U.S. total trade deficit in 1985 was with China, but it hit 44% in 2016; whereas its trade imbalances with the other main trading partners (like Japan and South Korea) have been much more stable since 1985.

3 The total share of the trade surplus of East Asian economies within the U.S. total trade deficit declined from over 100% in early the 1990s, to 83.3% in 1995, and then to 63.1% in 2016.
4 The domestic value-added share of China’s exports to the U.S. in labor-intensive sectors rose from less than 45% in 1995 to more than 55% in 2009. However, for those sectors that are more capital-intensive such as high-tech industries, the U.S. trade imbalances with China actually declined after the latter’s accession to WTO in 2001, up until the proposition of the strategic plan “Made in China 2025” along with more recent shifts by China within its new normal growth strategy (i.e., the 13th Five-year Plan).
countries with low labor costs in the context of the global supply chain trade (Fu, 2018). This has decreased bilateral trade between East Asian countries and the U.S. and vice versa. The literature corroborates the reallocation of labor-intensive activities mainly by using the analogy of “flying-geese” (Kojima, 2000). The sequential economic development among “high performing Asian countries” ranges from the initial expansion of manufacturing industries within Japan’s economy to the rise of China’s own labor-intensive manufacturing industries. This reveals that a dynamic change in the comparative advantage of an economy’s endowment structure could largely affect the trade volume between East Asian countries and the U.S.

Inspired from those pioneering researches, this research looks to theoretically demystify the evolutionary patterns of trade imbalances between developing countries (Southern countries) and developed countries (Northern countries) from a unique perspective of the comparative advantage in the factor endowment structure of the former. Compared with the literature, our paper thus fills the gaps by constructing a theoretical model based on Crino and Epi- fani (2014) to demonstrate the importance of the inherent dynamics between the factor endowment structure of Southern countries and global trade imbalances.

The main contributions of this paper are: (1) We develop a general equilibrium framework that integrates a factor endowment structure paradigm of trade and global trade imbalances, allowing for their interplay. (2) We derive new results on how the global trade imbalance equilibrium responds to the dynamics of the comparative advantage in the factor endowment structure of Southern countries. (3) We incorporate the role of the factor endowment structure of Southern countries into our model to study the causes of global imbalances.

From this framework, our research has the following main propositions: (1) raising the wage ratio or labor cost of Southern countries could lead to a reduction in their trade surpluses, because manufacturing or assembly will reallocate from these countries to those with a comparative advantage of cheaper labor cost. (2) An increase in the factor-intensity ratio for Southern countries leads to a reduction in trade imbalances for Northern countries, because the higher level of capital intensiveness of the factor endowment structure in the South makes the relative prices of labor there more expensive, resulting in a reallocation of manufacturing or assembly from these Southern countries to countries with cheaper labor costs.

In addition, to examine our theory, we employ the panel generalized method of moments (GMM) comprised of 157 developing countries to detect the channels through which and how the wage ratio and factor intensity affect global trade imbalances.

The rest of the paper runs as follows. Section 2 presents the literature review of theories on the causes of trade imbalances. Section 3 sets up the model. Section 4 offers the empirical evidence. Section 5 gives the concluding remarks.

2. Literature review

There are several competing theories in the literature that might explain why global trade imbalances have emerged. The first strand of the literature is the work by Obstfeld and Rogoff (2000, 2005, 2007), who argued that the causes of global trade imbalances are due to economic distortion rather than an “equilibrium” phenomenon and proposed that such imbalances could only be resolved through policy adjustments, including changes in the exchange rate to reduce the imbalances. This paper differs from theirs as we argue that an exchange rate policy is actually endogenous to one country’s factor endowment structure. We believe the comparative advantage of endowment structure determines whether a country should promote export-oriented or imported-substitution policies, which require different types of exchange rate policies (Chen et al., 2018).

The second stream of the literature on the causes of global trade imbalances is mainly by Bernanke (2005), who stated that global trade imbalances are “equilibrium conditions” marked by the hypothesis of a global “savings glut.” Regarding this glut, different types of explanations have been found. For instance, Caballero et al. (2008) demonstrated in a theoretical model with heterogeneity across economies that different countries have their own abilities to supply safe assets. Mendoza et al. (2009) stressed the importance of different stages of financial development in determining heterogeneity in the demand for assets, and their model predicts that increased financial integration raises foreign demand for U.S. assets. Other works, such as Fogli and Perri (2015), have studied the impacts of time-varying macro-level risk on the degree of global imbalances. They suggested that volatility is an important determinant of the medium-/long-level evolution of external imbalances in developed countries. Another group of research studies have considered the emergence of external imbalances from the perspective of demographic heterogeneity. For example, Henriksen (2002) showed that the account deviations between Japan and the U.S. can be explained by differences in demographic dynamics. Cooper (2008) noted that the generally rising U.S. trade deficit over the last 10–15 years is a natural outcome of two important forces in the world economy: globalization of financial markets and demographic changes. Du and Wei (2010) proposed a theory of excess savings due to a steady increase in the surplus of men relative to women. They showed that greater competition in the marriage market can induce men to raise their savings rate, thus lifting aggregate savings and the current account surplus.

Our paper also agrees that global imbalances are an “equilibrium” condition. However, this equilibrium could be dynamic according to our theory. We further explore in the role in how the dynamic change of comparative advantage in the factor endowment structure may affect global trade imbalances, and therefore this equilibrium condition is dynamic in essence.

Other explanations for global trade imbalances have arisen, like the representative work of Engel and Rogers (2006). They argued that the current account is determined by the expected discounted present value of its future share of world GDP relative to its current share of world GDP. As a consequence, the anticipation of a future rise in the U.S. share of world output plays a critical role in explaining the large current account deficits of the U.S.

Other researchers have investigated the importance of trade channels. For instance, Ju et al. (2014) demonstrated that flexible factor markets reduce the need for the current account to adjust. Jin (2012) explained how capital flows driven by the “composition” effect of standard force and novel force could generate sizable current account imbalances between developing and developed countries. Cova et al. (2009) investigated the role of productivity growth in the non-traded sector as played by emerging Asia throughout the emergence and evolution of global trade imbalances. They found that productivity slowdown in the non-tradable sector of these economies in the second half of the 1990s had a limited spillover effect on the U.S. trade balance. Hausmann and Sturzenegger (2005) indicated that measurement errors are likely to continue to compensate for the measured trade deficit. Laibson and Mollerstrom (2010) showed that national asset bubbles in the late 1990s raised consumption, resulting in large trade deficits - that is, from a sample of 18 OECD countries plus China, the movements in home prices alone could explain half the variation in trade deficits.

The work by Lin and Wang (2018) is the one most closely associated with our argument proposed herein. However, their paper did not offer a theoretical model, and their empirical focus was
constrained within Sino–U.S. trade imbalances. Conversely, we use a dynamic panel data to test the generalization of our theory.

As another pioneering work, Crinó and Epifani (2014) proposed a Heckscher–Ohlin (H–O) model with a continuum of goods. They showed both theoretically and empirically that a Southern (Northern) trade surplus leads to an increase (decrease) in the average skill intensity of exports, in the relative demand for skills, and in the skill premium in both countries. However, they did not consider the effect from a dynamic change of comparative advantage. Instead, in our model we assume that the two countries differ in their factor endowment structure rather than labor skill intensity. Here comes the main research question: What are the consequences on relative factor price and trade imbalances when the factor endowment structure of a country changes?\(^5\) In summary, the essential innovation that our paper provides is a unique perspective on the effect of the dynamic change in comparative advantage upon global imbalances.

3. Model

3.1. Basic environment

The Fig. 1 presents the link and difference between literatures and our model. The main novelty of the model is integrating the trade imbalances and factor endowment structure in a Heckscher–Ohlin model. To do this, we adopt the following modeling strategy.

We assume the model comprises two countries, South (developing country) and North (developed country) (indexed by \(c = s\) or \(n\)); a continuum of traded goods (indexed by \(z \in [0,1]\)); and one non-traded good (denoted by the superscript \(nt\)). Hence, there are two primary factors, labor and capital, denoted by \(L\) and \(K\), respectively. South is more labor intensive - that is, \(h_c < h_n\), where \(h_c = \frac{K}{L}\) is country \(c\)'s factor-intensity ratio. We focus on a free trade equilibrium with factor price differences (FPD) - that is, an equilibrium with \(s_s > s_n\), where \(s_s = \frac{K_s}{L_s}\) is the relative factor price ratio for South and North. Here, \(s_s > s_n\) indicates that capital is more expensive in South, whereas it is cheaper in North.

We treat the trade imbalance as a transfer \(T\) from South to North.\(^6\) Additionally, a positive transfer \((T>0)\) implies the trade surplus for South, whereas a negative transfer \((T<0)\) indicates the trade surplus for North. The main purpose of this paper is to demonstrate that the trade imbalances are driven by the dynamics of comparative advantage of the factor endowment structure between South and North.

3.2. Preferences

We suppose that consumers share the same preferences across countries, which could be represented as the following Cobb–Douglas utility function:

\[
U = m \int_0^1 \ln(d(z))dz + (1 - m) \ln(d^nt),
\]

where, according to Eq. (1), \(d(z)\) is the consumption of the traded good \(z\), \(d^nt\) is the consumption of a non-traded good, and \(m\) is the expenditure share of traded goods, while \((1 - m)\) is the counterpart of non-traded goods.

3.3. Technology

All goods are produced under perfect competition and constant returns to scale. In greater detail, in country \(c\), good \(z\) is produced with the following Cobb–Douglas production technology:

\[
q_c(z) = \frac{1}{a_z} \left[ \frac{K_c(z)}{2} \right]^z \left[ \frac{L_c(z)}{1 - z} \right]^{1 - z},
\]

where \(q_c(z)\) is the output, \(\frac{1}{a_z}\) is productivity, and \(K_c(z)\) and \(L_c(z)\) are the units of capital and labor used in industry \(z\). Notably, this formulation implies that \(z\) also indexes the factor intensity of industry \(z\).

3.4. Borderline commodity

The unit cost function associated with Eq. (2) is:

\[
C_c(z) = a_z r^2 w^z L_z c^2 = a_z w_c c^2.
\]

\(^5\) The factor endowment structure in this paper refers to the relative intensity of different productive factors in a specific economy. We consider two factors: labor and capital. Thus, we distinguish between two structures: whether a country is labor intensive or capital intensive.

\(^6\) Trade imbalance is treated as a transfer; see for example, Lane et al. (2004), Corsetti et al. (2013), Picard and Worrall (2015), Trionfetti (2018), and Zhang et al. (2021).
The unit cost of good $z$ in South relative to North can be expressed as follows:

$$C_c(z) = \frac{C_s(z)}{C_n(z)} = \omega z^s,$$

(4)

where $\omega = \frac{m_n}{m_S}$ is the wage of Southern workers relative to Northern workers, $a = \frac{m_S}{m_n}$ is the reciprocal of South’s relative productivity, and $s = \frac{n}{m}$ is the South’s relative factor price level. One may recall that $s > 1$ in a free trade equilibrium with FPD. Thus, $\frac{\partial \ln C_c(z)}{\partial \ln z} = z > 0$ and $\frac{\partial \ln C_c(z)}{\partial z} = z > 0$, implying that $C(z)$ is upward sloping for the given level of factor prices.

The trade specialization pattern is illustrated by the borderline commodity $z_b$, which is equally priced in South and North. Thus, we normalize the cost condition for $z_b$, which is $C(z_b) = 1$. Hence, country $c$ exports all goods $z \in L_z(c)$, where:

$$l_c(z) = \begin{cases} 0, z_s \leq z, c = s \\ \{z \in L_z(c), \ c = n \} \end{cases}$$

(5)

Based on (5), the borderline commodity $z_b$ is produced in both countries.

3.5. Non-traded sector

We assume that the non-trade good $q^n$ is produced in each country by costlessly assembling locally-produced manufacturing goods with the following Cobb-Douglas features (expressed in logs):

$$\ln q^n_c = \frac{1}{z} \int_{z \in \mathcal{L}_z(c)} \ln(z, q_c(z)) dz,$$

(6)

where $z_c = z$ for $c = s$, and $z_c = 1 - z$ for $c = n$. The log unit cost associated with Eq. (6) is:

$$\ln C^n_c = \frac{1}{z} \int_{z \in \mathcal{L}_z(c)} \ln C_c(z) dz = \ln q_n, w_c + Z \ln s_c,$$

(7)

where $Z_c$ is the average factor intensity of goods produced and exported by country $c$:

$$Z_c = \frac{1}{z} \int_{z \in \mathcal{L}_z(c)} zdz = \begin{cases} \frac{1}{2} z_s, c = s \\ \frac{1}{2} (1 + z_s), c = n \end{cases}$$

(8)

3.6. Factor market equilibrium

Cobb-Douglas production functions and perfect competition imply that the costs of factors are equal to a constant share of industry revenue; $z$ and 1−$z$ are the cost shares of $K_c$ and $L_c$, respectively, in industry $z$, whereas $Z_c$ and 1−$Z_c$ are the cost shares of the non-traded sectors. Moreover, the Cobb-Douglas utility function in (1) and goods market equilibrium imply that revenue is equal to a constant share of total world expenditure $E_w = E_s + E_n$ in any traded industry as well as a share $(1 - m)$ of national expenditure $E_t$ in the non-traded sector. Thus, using Eq. (8), we write the market-clearing conditions for factors $K_c$ and $L_c$ in value terms as:

$$r_cK_c = m E_w \int_{z \in \mathcal{L}_z(c)} zdz + (1 - m)E_cZ_c = F_cZ_c,$$

(9)

$$w_cL_c = m E_w \int_{z \in \mathcal{L}_z(c)} (1 - z)dz + (1 - m)E_c(1 - Z_c) = F_c(1 - Z_c),$$

(10)

where $F_c = m E_w + (1 - m)E_c$. If we take the ratio of (9) and (10) and then solve for the relative factor price ratio $s_c$, we get:

$$s_c = \frac{1 + Z_c}{Z_c} \frac{r_c}{w_c} \begin{cases} 1, c = s \\ \frac{n}{m}, c = n \end{cases}$$

(11)

From Eq. (11), we take the first derivative of $s_c$ with respect to $h_c$ and $Z_c$ and obtain:

$$\frac{\partial s_c}{\partial h_c} = -\frac{1}{h_c} - \frac{Z_c}{1 - Z_c} < 0$$

and

$$\frac{\partial s_c}{\partial Z_c} = \frac{1}{(1 - Z_c) \frac{n}{m}} > 0.$$

(12)

From the results of Eq. (12), the following proposition is derived.

**Proposition 1.** In an $H-O$ world with a continuum of goods and FPD, the relative factor price ratio in country $c$ decreases as the factor endowment structure of country $c$ becomes more capital intensive. The relative factor price ratio in country $c$ decreases as the cost shares of labor used in the local assembly of manufactured goods increase.

**Proposition 1** implies that as one country, such as China or an East Asian economy, become more capital-intensive, the wage level of workers in these developing economies increases and the cost of capital relatively decreases. Additionally, if the labor cost share $(1 - z_s)$ of non-traded sectors, such as labor-intensive manufacturing, in a country increases, the relative factor price ratio of country $c$ decreases—that is, the wage level of workers in this country as a whole increases.

3.7. Trade imbalances

Trade imbalance also implies that expenditure does not equal income in country $c$, which is $R_c$. Hence, we have the following two identities: $E_c = R_c - T$ and $E_n = R_n + T$. The trade imbalance condition is expressed as follows:

$$T = \int E_s dz - \int E_n dz = z_s m (R_n + T) - (1 - z_s) m (R_s - T),$$

(13)

where the two terms of the RHS denote South’s exports and imports, respectively. Thus, rearranging, we have:

$$R_s = \frac{z_s}{1 - z_s} R_n - \frac{1 - m}{m} T.$$

(14)

Based on (11), income in country $c$ equals:

$$R_c = w_c L_c (s_c h_c + 1) = \begin{cases} 2w_n \frac{m}{1 - m}, c = s \\ \frac{m}{1 - m}, c = n \end{cases}.$$  

(15)

We plug (15) into (14) and set $w_n = 1$, which yields:

$$\omega = \frac{z_s (2 - z_s)}{(1 - z_s)^2 L} - \frac{2 - z_s}{1 - m} \frac{1}{2 (1 - z_s)} - \frac{1}{L_s},$$

(16)

where $L = \frac{1}{h_c}$.

Furthermore, from Eq. (16), we implement comparative statics to detect the channel through which the trade imbalances are affected by changes in the wages of South (emerging economies). To achieve this objective, we use the implicit function theorem to take the derivative of (16) with respect to $\omega$:

$$1 = -\frac{2 - z_s}{2 (1 - z_s)} - \frac{1 - m}{m} \frac{\delta T}{\delta \omega},$$

(17)

We rearrange (17) and compute $\frac{\delta T}{\delta \omega}$ as follows:

$$\frac{\delta T}{\delta \omega} = -\frac{2 (1 - z_s)}{-2 - z_s} \frac{m L_s}{1 - m} < 0.$$

(18)

From Eq. (18), we derive the second key proposition in this paper.

**Proposition 2.** Increases in Southern (developing economy) wage levels lead to a shrinkage in the trade surplus there.

**Proposition 2** indicates that once the wages of developing countries increase, the initial trade surplus for them will decrease, which could eradicate the degree of trade deficits for developed economies.
3.8. General equilibrium

The general equilibrium is characterized by finding the equilibrium values of \( z_t \), whose values are determined by the conditions \( C(z_t) = 1 \). To obtain \( z_t \), we denote a hypothetical value of \( z_t \) by using Eqs. (11) and (16) to eliminate \( s \) and \( \omega \) from \( C(z) \) and simplify it to obtain:

\[
C(z) = \frac{a}{hT} \left[ F(z) - \frac{1 - m}{m} T G(z) \right],
\]

where \( F(z) = \frac{\partial z}{\partial z} (1-z^{-1})^{t+1} - (1-z^{-1})^{t+1} \), \( F'(z) > 0 \), and:

\[
G(z) = \left( \frac{z}{1+z} \right) \left( \frac{2-z}{1-z} \right)^{t+1} - z^{-1}, \quad G'(z) < 0.
\]

From Eq. (19), we again compute comparative statics to detect the channel through which and how trade imbalances \( T \) are affected by factor-intensity ratio \( h \). We thus have our final proposition of the paper.

**Proposition 3.** Under the borderline commodity equilibrium, the trade imbalance for developed country shrinks when the South's factor endowment structure becomes more capital-intensive.

**Proof of Proposition 3.**

**Step 1.**
We again use the techniques of the implicit function theorem to proceed:

\[
0 = a(-z)h^{-z-1} \left[ F(z) - \frac{1 - m}{m} T G(z) \right] - \left[ -zh^{-z-1} \left( \frac{1 - m}{m} \right) \left( \frac{T}{L} \right) G(z) \right]
+ ah^{-z} \left( \frac{1 - m}{m} \right) \left( \frac{T}{L} \right) G(z)
\]

We further rearrange Eq. (21) as:

\[
a \left( \frac{1 - m}{m} \right) \left( \frac{T}{L} \right) G(z)
= a(-z)h^{-z-1} \left[ F(z) - \frac{1 - m}{m} T G(z) \right] + 2a \left( \frac{1 - m}{m} \right) T \frac{G(z)}{hT}.
\]

or in other words:

\[
\left( \frac{T}{h} \right) = \frac{a}{m \left( \frac{1 - m}{m} \right) \left( \frac{T}{L} \right) G(z)}{a(-z)h^{-z-1} \left[ F(z) - \frac{1 - m}{m} T G(z) \right] + z \left( \frac{1 - m}{m} \right) T \frac{G(z)}{hT}.
\]

We further express (23) as:

\[
\left( \frac{\partial T}{\partial h} \right) = \frac{Z \left[ F(z) - L^{-1} m F(z) \right] - \left[ G(z) (1 - m) - L^{-1} m F(z) \right] \left( \frac{1 - m}{m} \right) T}{hG(z)}
\]

Eq. (24) can be further converted into:

\[
\left( \frac{\partial T}{\partial h} \right) = \frac{Z \left[ F(z) - L^{-1} m F(z) \right]}{hG(z)}
\]

which we then have:

\[
\left( \frac{\partial T}{\partial h} \right) = \frac{Z \left[ F(z) - L^{-1} m F(z) \right]}{hG(z)}.
\]

Because \( h(1 - m)G(z) > 0 \), \( z > 0 \), the sign of \( \left( \frac{\partial T}{\partial h} \right) \) is thus dependent on \( T(1 - m)G(z) - L^{-1} m F(z) \). We thus judge the sign of \( \left( \frac{\partial T}{\partial h} \right) \) by using a proof by contradiction.

**Step 2.**
We suppose that \( \left( \frac{\partial T}{\partial h} \right) < 0 \). This then implies that \( T(1 - m)G(z) - L^{-1} m F(z) < 0 \).

Thus, we have:

\[
\frac{1 - m}{m} \ll \frac{L^{-1} m F(z)}{G(z)}.
\]

Because \( \frac{1 - m}{m} > 0 \), we assume that \( m \) cannot be equal to 1 here. By using the sandwich theorem, it must be the case that \( \frac{L^{-1} m F(z)}{G(z)} > 0 \). Because \( F(z) = \frac{\partial z}{\partial z} (1-z^{-1})^{t+1} \), \( G(z) = (1-z^{-1})^{t+1} \), and the condition \( \frac{L^{-1} m F(z)}{G(z)} > 0 \) must hold. We then finally verify that \( \frac{1 - m}{m} < 0 \).

**Proof Completed.**

**Proposition 3** has potential policy implications on the dynamics of trade imbalances for developing economies and developing economies. According to it, we argue that if there is one borderline commodity being produced by both South and North, then at this equilibrium an increase in the capital-intensiveness of South’s industries leads to a shrinkage in the trade imbalance of the developed country. In the context of East Asian–U.S. trade in the last several decades, when a common commodity is being produced by both East Asian countries and the U.S., there could be two channels through which the U.S. might reduce its trade deficit: (1) raise the capital-intensiveness of production of this borderline commodity in the U.S.; and (2) East Asian countries raise their capital-intensiveness of production. These two channels are consistent with the comparative advantage story that we present herein.

For the first channel, the comparative advantage of the U.S. in capital-intensiveness increases when labor-intensive manufacturing businesses relocate to low-wage countries such as Bangladesh. The relocation of such industries from China to other low-wage countries makes the comparative advantage of the factor endowment structure of China’s economy become more capital-intensive. Thus, the U.S. trade deficit is expected to shrink with China’s rising wages along with the relocation of labor-intensive manufacturing from China to low-wage labor-abundant economies.

4. Empirical evidence

This research employs a sample of 157 developing countries over the period 1992–2017 to estimate our models.\(^7\) This selection of variables is primarily dictated by data availability. The dependent variable we use is the log of annual trade balance (TB). The trade balance here is the current account balance as a percentage of a country’s GDP. We borrow all data from the World Development Indicators (WDI, 2018) published by the World Bank. Two main independent variables are of interest in our regression estimation: capital-labor ratio for country \( i \) at time period \( t \), \( KL_i \), which is a proxy for the factor endowment structure of a country, and the wage ratio for country \( i \) at time period \( t \), \( WAGE_i \), which is a proxy for the labor cost. To avoid omitted variable bias, we also include controlled variables, including economic growth rate (Growth), measured by GDP per capita growth (annual %); exchange rate (EX), measured by the official exchange rate (LCU per US$, period average); monetary base (MB), measured by broad money; and inflation (INF).\(^8\) Table 1 lists the summary statistics.

To ensure no multi-collinearity problem among the variables, we also present the correlation matrix table to determine whether any potential multi-collinearity is observed. Table 2 presents the correlation matrix.

Table 2 shows no multi-collinearity problem in our selected variables. Herein, we consider a dynamic panel GMM data equation (Lee et al., 2021; Jiang et al., 2021; Wang and Lee, 2022; Lee et al., 2022) with lagged dependent variables included in the regression to test how the trade balance is affected by the factor endowment

\(^7\) For the list of these 157 countries, please refer to Table A1 of Appendix 1.

\(^8\) Other possible omitted variables are customs tariffs and the presence of trade agreements. However, there could be over one million omitted variables. To consider the consequences of all possible omitted variables, we use the instrument variable in our panel regressions.
structure and the wage level. Our empirical model is given by:

\[
TB_{i,t} - TB_{i,t-1} = (\alpha - 1)TB_{i,t-1} + \beta KL_{i,t} + \mu WAGE_{i,t} + \gamma'X_{i,t} + \theta_i + v_t + \epsilon_{i,t}.
\]

(28)

Here, \(i = 1, ..., N\) refers to the country number; \(t = 1, ..., T\) is the time period; \(TB_{i,t}\) is the logarithm of trade balance; \(KL_{i,t}\) is a factor-intensity ratio; \(WAGE_{i,t}\) is the wage ratio (labor cost); \(X_{i,t}\) denotes country-level control variables, including economic growth rate, exchange rate, and inflation; \(v_t\) is a time-specific effect; \(\theta_i\) is an unobservable country-specific time-invariant effect, and \(\epsilon_{i,t}\) is the error term. Notably, Eq. (28) is equivalent to:

\[
TB_{i,t} = \alpha TB_{i,t-1} + \beta KL_{i,t} + \mu WAGE_{i,t} + \gamma'X_{i,t} + \theta_i + v_t + \epsilon_{i,t}.
\]

(29)

As is now standard in the literature, we first take the trade balance into first-difference form, proxied as the growth rate of trade balance. We take the first-difference transformation of Eq. (29), remove the unobserved country-specific effect \(\eta_i\), and use internal lagged level instruments to replace endogenous variables in the transformed equation. Therefore, \(\alpha\) is the estimated persistence coefficient. A significantly positive \(\alpha\) implies that the trade growth of a country shows persistence from the previous year to the current year, indicating the speed toward the long-run average (Lee and Wang, 2021). The unit root tests of panel data show that all the variables in the regression are stationary. Table 3 lists the regression results.

We employ the Hansen test here as well and define the null hypothesis as the instruments used that do not correlate with the residuals. AR(2) denotes the Arellano-Bond test for the second-order autocorrelation in first differences. If the null hypothesis of the Hansen test is not rejected, then the instrumental variables are valid.

In the regression of Table 3, the coefficient for the wage ratio is statistically significant and negative, indicating that an increase in wage levels in Southern countries leads to a reduction in their trade balance, and therefore the South’s trade imbalance increases, and vice versa for Northern countries and North. In addition, the coefficient for the factor-intensity ratio is also statistically significant and negative, implying that when the factor intensities of Southern countries become more capital-intensive, then the South’s trade balance declines. This also means that its trade imbalance increases and vice versa for North. Hence, the empirical results presented herein are consistent with the two proposed channels through which the trade balances of the Southern countries are affected by their factor endowment structure and wage level.

5. Discussion and conclusions

Based on the theoretical model and consistent empirical results, this study proposes several points of discussion on the current trade imbalances in developed countries and potential policy recommendations for the policy makers of both developed and developing countries.

5.1. Discussion

Several conclusions could be derived from the propositions and empirical results. First, the negative coefficient for the wage ratio confirms Proposition 2—that is, an increase in the wage levels of Southern countries leads to a reduction in their trade surpluses. This finding occurs, because the increasing labor cost weakens the competitiveness of Southern countries’ commodities and then decreases their current trade balance. Some other studies in the literature have confirmed our finding. For example, Adams et al. (2006) pointed out that extremely low labor costs is one important reason for China’s competitiveness in the world economy and relative to its East Asian rivals. Therefore, the U.S.–China trade deficit should improve over time, because China’s cost of labor is rapidly increasing. For example, Long and Herrera (2018) and Herrera and Long (2017) demonstrated the tendency for China’s industrial profit rate to decline over the past decades. This drop in the profit rate is mainly due to wage increases, particularly so after the 2008 global financial crisis. The forces pushing wages up are multiple. Ceglowski and Golub (2012) argued that much of the rise in China’s relative unit labor costs can be traced to a real appreciation of the yuan against the dollar. Li et al. (2012) discussed three potential reasons for this change: institutional reforms, the disappearing “demographic dividend,” and the slowdown of institutional reforms. The so-called “disappearing demo-
graphic dividend” refers to labor shortages. We basically agree with this and argue that the China government’s past draconian birth control plan, the One-Child Policy, might be a primary cause for its current increasing labor cost. Many authors such as Li and Zhang (2007) and Choukhmane et al. (2013) showed that this policy, together with other social and economic changes, has significantly impacted the fertility rate or other economic variables. The labor shortages thus raised wages.

Second, the negative coefficient for the factor-intensity ratio corroborates the views proposed by Proposition 3 - that is, the increasing level of capital-intensiveness in the endowment structure of Southern countries leads to a greater trade surplus for Northern countries (developed countries), meaning that once the factor endowment structure of Southern countries becomes more capital-intensive, they then incur a correspondingly lower level of trade surplus (balances).

5.2. Policy recommendations

The conclusions drawn from this paper have potential policy recommendations for the policy makers of both developed and developing countries as noted below. Firstly, the Northern countries still take an initiative position in industrial policy, while Southern countries are relatively passive and must build a strategic plan to hedge the reduction of trade surplus; to a certain degree, it might implies inequality (Herrera et al., 2021). For instance, according to our findings, when Southern countries experience an escalating level of labor costs, Northern countries could reduce their trade deficit by reallocating some of their manufacturing operations in the global supply chain to trade countries with even lower labor costs. Ginzburg and Simonazzi (2005) analyzed a typical study on the geographical change of electronics sector in East Asia, China and the USA alongside the evolution of comparative advantages. As long as China's labor forces become more expensive, industrial might transfer to other countries with comparative advantages. As a consequence, a selective policy such as the strategic plan “Made in China 2025” and more recent policies of China within the new normal growth strategy\(^1\) will play a critical role in China's transformation of its growth model. For instance, Savin et al. (2020) described the successful catch-up and smart diversification policies of Ireland, Israel, South Korea and Singapore and argue that the smart industrial policies are necessary to overcome the gravitation towards simple products and transform the economy towards focus on complex products. Ang (2018) pointed out that by replicating the aggressive investment promotion tactics of coastal cities, industrial transfer occurred domestically, rather than across nations that lightened the shock of international “flying geese”. Besides, Amable (2000) demonstrated that the comparative advantages could be diverse such as industry specialization and education, as consequence, industrial policy should also be multiple. For example, Andreoni et al. (2019) pointed out that the policy debates should be informed by historical studies revealing the context-specific dynamics of production transformation. And more generally, Andreoni and Chang (2019) provided a long-term analytical perspective of the industrial policy debate.

Secondly, it seems that the Northern countries do not need to worry too much about the current trade deficit, because with the convergent economic growth (such as classical literature of Barro and Sala-i-Martin, 1992; and more recently Barro, 2016), the capital-intensity and wage level of developing countries will rise. According to our findings, it means the gradual margin improvement of trade balance of Northern countries. A typical example is Germany. Aiginger (1998) shows that the trade balance is positive, nevertheless Germany is afraid to deindustrialize and to loose competitiveness due to high wages and high tax rates. On the other hand, even under a situation of uneven development pattern between north and south, Spinola (2020) argued that the industrialization and higher learning capabilities can change the adjustment to a catching-up scenario. The study of Long and Herrera (2018) shows that in the profit structure, the capital/wage ratio has an increasing tendency in China. Fig. A1 in Appendix 2 also shows similar evidence in China's exports of goods that the structure shifts from labor-intensive to capital- and/or technology-intensive. However, as indicated by our findings, this shift has not necessarily further damaged the U.S. trade imbalance. As China's factor endowment structure becomes more capital-intensive, the U.S. trade imbalance will shrink.

Lastly, all our conclusions are under the mechanism of a free global trade market to ensure the conditions of arbitrage and equilibrium. Cooperation of maintaining a free global market is the necessary condition to shrink the trade deficit. As indicated by Liu and Woo (2018), trade imbalance and technology spreading are major concerns that drove the U.S. into initiating the trade war against its competitors. For the latter, Lemoine and Onal-Kesenci (2004) already noted that outward-oriented and highly competitive industries that are based on imported technology and foreign affiliates seem to have had limited impacts on local production and on the diffusion of technology within China's domestic industry. For the former, the findings in this paper suggest that reallocating some manufacturing operations in the U.S. to China has helped reduce their trade imbalances. In long run cooperation and free international trade should create a win-win outcome, as the U.S. can see a reduced trade deficit and the workers in Southern countries can obtain higher wages.

\(^{1}\) The 13th Five-Year Plan and previous five-year plans.
5.3. Concluding remarks

This research builds a theory that relates global trade imbalances to the comparative advantage in the factor endowment structure of developing countries. We demonstrate in a theoretical model that: (1) a rise in the wage levels of Southern countries (developing) leads to a shrinkage of trade surpluses in these countries and decreases trade imbalances for developed countries; and (2) the trade imbalance for developed countries shrinks as the comparative advantage in the factor endowment structure of Southern countries (developing) shifts from labor-intensiveness to capital-intensiveness. We employ a sample of 157 developing countries over the period 1992–2017 to test our theory. By using a dynamic panel data equation with lagged dependent variables included in the regression, we test how the trade balance accounts of the Southern countries are affected by their wage ratio and their factor endowment structure. We find our empirical results are highly consistent with the theories proposed herein. And we proposed three potential policy recommendations for the policy makers of both developed and developing countries according to our findings that a free international trade market create a win-win outcome.

While this paper presents an exploratory example of a reduced model, many notable topics are not discussed so that there are some limitations. For instance, we only consider two productive factors (capital and labor), and so various questions remain. What is the situation of technical progress? What is the consequence for the U.S. trade imbalance if the factor endowment structure of developing countries like China become more technical-intensive? How does China's factor endowment structure change under specific selective policies? And unequal exchange might also influence the trade imbalance.12 These and other notable questions are worthwhile topics for further research.

CRediT author statement

The authors declare that we have no relevant or material financial interests that relate to the research described in this paper.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Appendix 1

12 See Long et al. (2020).
Table A1
List of 157 developing countries.

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Notes: International Monetary Fund’s World Economic Outlook Database, October 2018. Cuba and Korea, Dem. People’s Rep. are not listed by IMF.
Appendix 2

Fig. A1. Structure of China’s exports in 1980 and 2018.

Note: Data from China’s National Bureau of Statistics.
Declaration of Competing Interest

All authors declare that they have no conflict of interest.

Credit authorship contribution statement

Jim Huangnan Shen: Investigation, Writing – original draft. Zhiming Long: Investigation, Writing – original draft. Chien-Chiang Lee: Visualization, Conceptualization, Writing – review & editing. Jun Zhang: Supervision, Writing – review & editing.

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