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**Abstract**

Trade openness and the share of the working-age population vary in different geographic regions of the world, especially, they tend to be high in Europe. Under the hypothesis that the share of the working-age population has a positive effect on trade openness, we clarify the difference of trade openness by region caused by age structure using the panel data for the following four regions in the world: Europe, Asia, America, and Africa. We estimate equations including trade openness as the dependent variable and the share of the working-age population as one of the independent variables based on fixed-effects models and conduct the Blinder-Oaxaca decomposition by region. Our empirical results show that the share of the working-age population has significantly positive effects on trade openness in three regions except Africa. Moreover, high trade openness in Europe compared with Asia or America can be explained by endowment effect of age structure and that compared with Africa can be explained by both endowment and coefficient effects of age structure. Therefore, trade openness is greatly influenced by age structure in Europe, but hardly in Africa.

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## 1. Introduction

Many demographers have found that age structure greatly influences macroeconomy through labor force and saving. Studies such as Bloom and Williamson (1998) , Bloom et al. (2000), and Kelly and Schmidt (2005) and Bloom et al. (2017) insist that age structure affect economic growth because population in different age have different contribution to economy through different labor force participation by age. Many studies based on life cycle hypothesis conclude age structure is an important determinant of national saving and consumption because of different saving behavior in different generation (Modigliani and Brumberg, 1954; Fry and Mason,1982; Mason,1987, 1988; Fair and Dominguez, 1991; Kinugasa and Mason, 2007; Mason and Kinugasa, 2008; Dramani and Oga, 2017). Extending their research to open economy macroeconomics, the relationship between age structure and current account balance or capital flow is investigated (Taylor and Williamson, 1994; Taylor,1995; Higgins and Williamson, 1997; Higgins,1998; Hassan et al., 2011).

The main interest of this research is trade openness, which is defined as the ratio of trade to GDP here, has been historically high at the global level and has attracted attention of international economists.[1] Trade openness is one of the key determinants of economic growth and it is important to research what influences trade openness.[2] As for demographic effect on

[1] See Feenstra and Taylor 2014, Chapter 1; Krugman et al. 2014, Chapter 1.

[2] For details, see Barro and Sala-i-Martin (1995), Frankel and Romer (1999) and Yanikkaya (2003). We also need to note that growing trade openness under the unbalanced situation of the

trade openness, Alesina and Wacziarg (1998) indicate that an increase in country size induced by an increase in population can decrease trade openness because welfare of a country with small population increases by exporting limited goods and importing many kinds of goods from other countries, but they do not analyze the effect of age structure. The point of Braude (2000) has important implication for the effect of age structure on international trade. Braude (2000) states that a change in age structure can influence consumption structure, although the object of empirical analysis is real exchange rate. Education, nursing care, and medical services are mostly non-tradable and the share of consumption for non-tradable goods is likely to be high in dependent age. Fukumoto and Kinugasa (2017) is the first study that analyze the effect of age structure on trade openness. The authors apply the aforementioned work of Braude (2000) and point that higher share of working-age population in total population leads higher trade openness. This is because working-age individuals have higher share of tradable goods in total demand than dependent individuals.

This research focuses attention on difference of age structure and trade openness by region. Glancing over the world, age structure is quite different among geographic regions. Wilson (2011; pp. 384–385) contends that the geographic regions differ in regard to the timing and tempo of the fertility transition.[3] In Europe, the share of working-age population in total

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export and the import has caused serious trade friction and has been regarded as political and economic problems.

[3] For details of demographic transition, see Kirk (1996), van de Kaa (2002) and Lee (2015). As Reher (2011, p. 14) discusses, the changes in fertility affect the base of the population pyramid.

population is high and the share of young dependent population is high in Africa. Trade openness also differs substantiall by region. Regionalism could be one important reason. Mansfield and Milner (1999; p. 589) insist that much of the existing research on regionalism centers on international trade. Regionalism promotes intra-regional trade integration, and will influence trade openness in each region. According to the data on the share of intra-regional trade, nearby countries are the main trade partners.[4] Engel and Rogers (1998), Frankel et al. (1998) and Fukumoto (2011) conclude that goods markets have been regionalized.[5] In contrast, nobody has pointed that difference of trade openness among region is influenced by age structure. In fact, trade openness and the share of working-age population in Europe are higher than any other region.

This research hypothesize that the difference of age structure causes difference of trade openness by region. Moreover, we suspect that the effect of age structure will be different by region. We investigate formally using statistical method whether the estimated coefficient for age structure varies by region. In our empirical analysis, the world is divided into the following four regions: Europe, Asia, America, and Africa. First, we estimate trade-openness equations in

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[4] The World Trade Organization (WTO, hereafter) reports the intra- and inter-regional merchandise trade, 2014 (Table I.4) in *International Trade Statistics 2015* (https://www.wto.org/english/res_e/statis_e/its2015_e/its15_world_trade_dev_e.htm).

[5] Anderson and Norheim (1993) discuss the regionalization of world trade from 1830 to 1990 in Europe, and from 1928 to 1990 in America, Asia, Africa, and the Middle East. See also Norheim et al. (1993).

which the dependent variable is trade openness and the independent variables include the share of the working-age population, based on fixed-effects models by region, and analyze the coefficients of the share of the working-age population. Next, we use the Blinder-Oaxaca decomposition for the trade-openness equations of two regions to identify endowment and coefficient effects of age structure. The endowment effect of age structure is based on the differences of the share of the working-age population between two regions. If the share of the working-age population is greatly different by region, the endowment effect will have an important contribution on the difference of trade openness by region. The coefficient effect of age structure is based on the difference of the coefficients of the share of the working-age population in trade-openness equations between two regions. Therefore, the coefficient effect might play an important role in the difference of trade openness by region even if the shares of the working-age population of two regions are equal.

The remainder of this paper is organized as follows. In Section 2, we discuss factors that influence trade openness and introduce variables used in the empirical analysis. In Section 3, we describe the empirical results of fixed-effects models by region. In Section 4, we describe the empirical results of the Blinder-Oaxaca decomposition. Finally, in Section 5, we draw conclusions.

## 2. Model and Data

Our study is based on that the share of tradable goods in aggregate demand is higher for the working-age individuals than for the dependent individuals. Braude (2000; Section 3.1) initiated this line of research, focusing attention on the tendency of dependent individuals to

consume more non-tradable goods, such as childcare, education, nursing care, and medical services, than the working-age individuals. Braude (2000), Andersson and Österholm (2005, 2006), Rose et al. (2009) and Hassan et al. (2015) suggest that age structure affects the real exchange rate. We hypothesize that an increase in the share of the working-age population would increase trade openness under intergenerational differences in demand for tradable and non-tradable goods, following Fukumoto and Kinugasa (2017). A higher share of tradable goods in aggregate demand will lead to a higher share of tradable goods in aggregate supply. If the share of tradable goods has a positive impact on trade openness, as suggested by Aizenman (1985), increases in the share of tradable goods in aggregate demand and supply caused by an increase in the share of the working-age population will increase trade openness.[6]

We discuss the effect of age structure on difference of trade openness by region, distinguishing the following two kinds of effects: endowment and coefficient effects. The endowment effect refers to the effect of the difference of age structure by region on trade

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[6] Hill (1989) and Herbertsson and Zoega (1999) point out that an increase in the share of the working-age population increases net export. Therefore, an increase in the share of the working-age population can increase GDP, because net export is a part of GDP. However, this contribution to GDP will be limited, because an increase in the share of the working-age population increases both import and export. That is to say, a higher share of the working-age population will increase trade volume more than GDP. As a result, a higher share of the working-age population would have a positive effect on not only trade volume, but also trade openness.

openness. This is clear from the findings of previous studies that an increase in the share of the working-age population would increase trade openness. That is, trade openness would tend to be high in the region with high share of the working-age population even if factors other than age structure were equal in each region. The coefficient effect is based on the fact that the effects of 1% point increase of the share of the working-age population on trade openness are different among regions. The share of demand of tradable goods of different generation might greatly different in each region. In fact, even if dependent individuals consume more non-tradable goods than the working-age individuals, their weights will not necessarily be equal by regions. In addition, the share of trade of tradable goods will not necessarily be equal among all regions. Previous studies did not conduct empirical analysis by region, so they did not consider coefficient effect.[7]

We investigate whether age structure influences trade openness with consideration to several factors suggested by previous studies to influence trade openness. We estimate trade-openness equations based on fixed-effects models by region, and then conduct the Blinder-Oaxaca decomposition for two regions. The following variables are considered in our above-mentioned analyses. The dependent variable is *Trade openness*, which is defined as the ratio of

[7] It has already been observed that coefficients representing the effect of age structure on other macroeconomic fundamentals are sensitive to regional diversity. For example, see Doshi (1994) about relationship between age structure and the saving rate.

the sum of exports and imports to GDP. The independent variables are *Age structure*, *Government size*, *Country size*, *Economic development*, and *Period dummies*.[8]

We use the share of the working-age population as age-structure variable. It is defined as the ratio of the working-age population (aged 15–64) to the total population. The share of the working-age population would have a positive effect on trade openness. Tian et al. (2011) and Fukumoto and Kinugasa (2017) determined the positive effect of share of the working-age population on international trade, but they did not examine the effect in individual regions.[9] The government consumption share of GDP is defined as the variable of government size. Benarroch and Pandey (2008; Table 2) found that there is a negative causality from government size to trade openness.[10] Population is considered to be representative of the country size. Alesina and Wacziarg (1998; Tables 2 and 6) found that larger country size had a negative effect on trade openness. Real GDP per capita is used as the variable representing economic development. Feenstra (1998; p. 33) contends that increases in demand for luxury non-tradable goods due to economic development would reduce trade openness. Ram (2009; Tables 2, 5 and 6) used real GDP per capita as a control variable to test the negative effect of

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[8] Due to the limitation of data with respect to the sample period and sample countries, it is difficult to include other variables such as tariff rates.

[9] Tian et al. (2011) found a positive effect for the share of working-age population on trade volume in terms of the labor supply and labor income.

[10] The relationship between trade openness and government size is a topic that has attracted the attention of international economists. See, for example, Alesina and Wacziarg (1998).

country size on trade openness. We use period dummies as proxy variables for the trade barriers and foreign outsourcing. Declining trade barriers and increasing foreign outsourcing could be important reasons for the upward trend of trade openness over the last several decades. Intra-regional trade integration also comprises a part of the period dummy variables. These would influence trade openness for many countries in the same region during the same period. Thus, it is possible that the effects of period dummies on trade openness differ greatly by region.

Our data sources are as follows. The data for variables other than age structure are obtained from *Penn World Table 8.1*. Trade openness is calculated as the sum of the absolute values of the shares of merchandise exports and imports in GDP (Indicator Codes: csh_x and csh_m, respectively). Government size is represented as the share of government consumption in GDP (Indicator Code: csh_g). We obtain real GDP per capita by dividing real GDP (Indicator Code: rgdpo) by population (Indicator Code: pop). The variables for age structure are obtained from *World Population Prospects: The 2015 Revision* by the United Nations, Department of Economic and Social Affairs, Population Division.[11]

We include the data for 92 countries from 1951 to 2010. We choose countries whose data are available from both *Penn World Table 8.1* and *World Population Prospects: The 2015 Revision*. We excluded countries in which the population is extremely low, trade openness is extremely large or small, and oil industries have a substantial share of GDP, as well as those

[11] File POP/15-1: Annual total population (both sexes combined) by five-year age group, major area, region and country, 1950–2100 (thousands).

classified as Least Developed Countries (LDCs, hereafter). Doing so reduces the probability that the estimated coefficients of independent variables obtained from statistical inferences will be dominated by large outliers. The 92 countries are categorized into the following four regions: 33 European countries; 28 Asian countries; 18 American countries; and 13 African countries.[12] We calculate the five-year average data from 1951 to 2010, and create panel data for 12 periods: 1951–1955, 1956–1960, 1961–1965, 1966–1970, 1971–1975, 1976–1980, 1981–1985, 1986–1990, 1991–1995, 1996–2000, 2001–2005, and 2006–2010.[13]

Here, we discuss whether trade openness and age structure are related, based on data for the four geographic regions. Figure 1 presents line graphs depicting trade openness and the share of the working-age population, and shows that both have upward trends. Glancing through the sample period, we can see that trade openness was higher in the following order: Europe > Asia > Africa > America. In the same way, the share of the working-age population was higher in the following order: Europe > Asia > America > Africa. The orders for trade openness and the share of the working-age population are consistent for Europe and Asia.

< Insert Figure 1 >

[12] The countries in the sample are listed in Appendix Table.

[13] If there is a missing value in any period, we do not include that period in the sample. For example, if data is available after 1958 for a country, we include that country for the period of 1961–1965 and afterwards.

Figure 2 presents scatter plots of trade openness and the share of the working-age population. The distributions in Asia and America indicate that these two variables are positively correlated. Figure 3 presents scatter plots of logged trade openness and the share of the working-age population. Trade openness is natural-logged because trade openness in many countries is less than 1 but not a few countries in Europe and Asia have trade openness much higher than 1. In addition, Figure 2 suggests that trade openness increases along with an increase in the share of the working-age population more rapidly than a linear relationship. According to Figure 3, the relationship is closer to linear in Europe and Asia. In Figures 2 and 3, the distributions in Europe and Africa are dense, and they do not seem to be correlated strongly. However, this might be because Europe and Africa have stronger intra-regional ties than the other two geographic regions. That is, trade openness may be similar within Europe and Africa because the share of the working-age population is similar within each region.[14]

< Insert Figures 2 and 3 >

Table 1 presents descriptive statistics of the variables used in our empirical analysis. Whether trade openness should be logged or not is not necessarily based on economic theory and neither possibility can be denied according to Figure 2 and 3. Therefore, we conduct

[14] There seems to be several outliers in the bottom of Figure 3 (a), and these are Albania and Romania. In the empirical analyses in Section 3, these two countries are included, but our conclusion does not change even if we conduct empirical analyses excluding these countries.

empirical analyses for both cases of non-logged and logged trade openness. Share of the working-age population and government consumption share of GDP are not logged and population and GDP per capita are natural-logged.

< Insert Table 1 >

**3. Empirical Results of Fixed-Effects Models**

We estimate the trade-openness equations that include the country dummies based on the fixed-effects models. The country dummies represent country-specific characteristics such as tradition, language, culture, and natural enviroment.[15] We consider the following equations by geographic region:

$$\begin{aligned} Openness^R_{it} = {} & \alpha^R_i + \beta^R_1 \, Working^R_{it} + \beta^R_2 \, Gov^R_{it} + \beta^R_3 \, Pop^R_{it} + \beta^R_4 \, GDP/Pop^{\,R}_{it} \\ & + \beta^R_5 \, D(1956\text{–}1960)_t + \beta^R_6 \, D(1961\text{–}1965)_t + \beta^R_7 \, D(1966\text{–}1970)_t \\ & + \beta^R_8 \, D(1971\text{–}1975)_t + \beta^R_9 \, D(1976\text{–}1980)_t + \beta^R_{10} D(1981\text{–}1985)_t \\ & + \beta^R_{11} \, D(1986\text{–}1990)_t + \beta^R_{12} \, D(1991\text{–}1995)_t + \beta^R_{13} D(1996\text{–}2000)_t \\ & + \beta^R_{14} \, D(2001\text{–}2005)_t + \beta^R_{15} \, D(2006\text{–}2010)_t + \varepsilon^R_{it} \end{aligned} \qquad (1)$$

[15] The random-effects models assume that unobserved country fixed-effects do not correlate with the independent variables. Such an assumption would not be sound for the information considered in our analysis.

The superscripts $R$ denote region ( $R$ = *Europe*, *Asia*, *America*, *Africa*), and the subscripts $i$ and $t$ denote country and period, respectively. The dependent variable $Openness^R_{it}$ represents trade openness. $\alpha^R_i$ is a country dummy variable. Let $Working^R_{it}$ be the share of the working-age population. $Gov^R_{it}$ denotes the government consumption share of GDP. $Pop_{it}$ denotes population, and $GDP/Pop^R_{it}$ is the real GDP per capita. $D(1956–1960)_t$, $D(1961–1965)_t$, $D(1966–1970)_t$, $D(1971–1975)_t$, $D(1976–1980)_t$, $D(1981–1985)_t$, $D(1986–1990)_t$, $D(1991–1995)_t$, $D(1996–2000)_t$, $D(2001–2005)_t$, and $D(2006–2010)_t$ are period dummies for 1956–1960, 1961–1965, 1966–1970, 1971–1975, 1976–1980, 1981–1985, 1986–1990, 1991–1995, 1996–2000, 2001–2005, and 2006–2010, respectively. $\varepsilon^R_{it}$ denotes the disturbance term. Equation (1) is almost the same as Equation (3) in Table 5 in Ram (2009) except an age-structure variable.

Tables 2 and 3 present empirical results with non-logged and logged dependent variables, respectively. Standard error is calculated based on Cameron and Miller (2015). The signs of the estimated coefficient of the share of the working-age population are positive in Tables 2 and 3. In addition, these coefficients are statistically significant, except Africa in Tables 2 and 3, and except America in Table 3. The estimated coefficients of the share of government consumption in GDP are negative, except Europe in Tables 2 and 3, and all of the coefficients are insignificant. Thus, the hypothesis of Benarroch and Pandey (2008) does not seem to be supported. The signs of the estimated coefficient of population are negative, except Asia in Table 2, and most coefficients are significantly negative in Tables 2 and 3. Overall, the hypothesis of Alesina and Wacziarg (1998) seems to be supported. The signs of the estimated coefficient of GDP per capita are negative, except Asia in Table 2, and the coefficients are

significantly negative in America and Africa. The empirical results are consistent with the hypothesis of Feenstra (1998) in some regions. In Tables 2 and 3, most period dummies are significantly positive, and the coefficients for later periods are larger than those for earlier periods, except Asia in Table 2. This indicates that the degree of development of intra-regional trade integration differs among regions.[16] As observed above, the results of Tables 2 and 3 are different in terms of significance for some variables. Nevertheless, the signs of the coefficients are not significantly opposite from the hypothesis discussed in Section 2 in any estimations.

< Insert Tables 2 and 3 >

Based on the results in Tables 2 and 3, the effects of age structure on trade openness by region can be discussed as follows. In Table 2, the coefficients of age structure are higher in the following order: Europe > Asia > America > Africa. In Table 3, the coefficients of age structure are higher in the following order: Asia > Europe > America > Africa. In Europe, the similarity of age structure may influence the similarity of trade openness, because the dispersion of trade openness and the share of the working-age population are small in Figure 3. In case of Asia, the relationship between trade openness and age structure is stronger when trade openness is logged. Meanwhile, significant relationship between these variables is not observed for

[16] Since the 1990s, many Regional Trade Agreements have been concluded. Detailed information is available from the website of the WTO (https://www.wto.org/ english/ tratop_e/region_e/region_e.htm).

America when trade openness is logged. Therefore, the results might be different depending on model specification.

The effects of age structure on trade openness in America and Africa seem to be smaller than those in Europe and Asia. Trade openness might be less sensitive to age structure in America because trade policies based on the infant industry argument were predominant in South American countries, compared to Asian countries (Krugman et al. 2014; Chapter 11). Manufacturing protection under import-substituting industrialization could decrease the share of international trade of tradable goods. It is possible that even countries not classified as LDCs do not prepare goods and labor markets in Africa, compared to the other three regions.[17] In such circumstances, the supply of non-tradable goods that require time-consuming skills and training, especially education and medical services, will be insufficient for any generation. The consumption structure of tradable and non-tradable goods could then be less different among generations, so that the age structure might not influence trade openness.

## 4. Empirical Results of the Blinder-Oaxaca Decomposition

In examining the influence of age structure on difference in trade openness by region, we focus attention on which is more important, endowment effect or coefficient effect. In case the endowment effect works, even if the shares of tradeable goods and non-tradable goods in total demand for the working-age individuals are not different by region, trade openness could be

[17] Bloom et al. (1998; p. 211) state that Africa's economic performance is further impeded by its extraordinarily disadvantageous geography and demographic circumstances.

different because of the difference of the share of working age population by region. In case the coefficient effect works, even if the share of the working-age population is not different by region, trade openness could be different because of the difference of the share of the demand of tradable goods and non-tradable goods for the working-age individuals by region. In Europe, the share of the working-age population is higher than any other region (Figure 1 and Table 1), so endowment effect would definitely be important. Moreover, the coefficient of the share of working-age population is higher than the other regions except one case (Tables 2 and 3), thus it is possible that coefficient effect is important.

The Blinder-Oaxaca decomposition would be effective in distinguishing the two kinds of effects of age structure on difference of trade openness in Europe and other regions.[18] Based on Equation (1), the difference of the average trade openness between Europe and other region is expressed in Equation (2). Superscripts $R$ denote regions other than Europe ( $R$ = *Asia*, *America*, *Africa*).

$$\overline{Openness^{Europe}} - \overline{Openness^{R}} = \beta^{Europe}_{1} \left( \overline{Working^{Europe}} - \overline{Working^{R}} \right)$$

[18] The Blinder-Oaxaca decomposition was suggested by Blinder (1973) and Oaxaca (1973) as the method to decompose the effects of sex and race on wage gap mainly in the field of labor economics. For example, the method is used in order to distinguish whether wage gap between men and women exists due to different education level or due to different evaluation for men and women even under the same education level. See also Weichselbaumer and Winter-Ebmer (2005) and Carson (2017).

$$+(\beta^{Europe}{}_1 - \beta^{R}{}_1)\,\overline{Working^{R}} + \Omega \qquad (2)$$

where the bar on the variable means the average in each region and Ω represents the factors other than age structure. In Equation (2), the left hand side is the difference of trade openness between the two regions. In the right hand side, $\beta^{Europe}{}_1$ ( $\overline{Working^{Europe}}$ - $\overline{Working^{R}}$ ) is endowment effect and explains the difference of the share of the working-age population between two regions and $(\beta^{Europe}{}_1 - \beta^{R}{}_1)\,\overline{Working^{R}}$ is coefficient effect and explains the difference of the coefficients for the two regions.[19]

Tables 4 and 5 present empirical results with non-logged and logged dependent variables, respectively. In the first columns from the left of these tables, regions to compare with Europe are indicated. These table show the difference of trade openness, and endowment and coefficient effects of age structure. Tables 4 and 5 have many common characteristics. First, trade openness in Europe is higher than any other region, and significantly different from other

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[19] Equation (2) can also be expressed as follows.

$$\overline{Openness^{Europe}} - \overline{Openness^{R}} = \beta^{R}{}_1 \left( \overline{Working^{Europe}} - \overline{Working^{R}} \right) + (\beta^{Europe}{}_1 - \beta^{R}{}_1)\,\overline{Working^{Europe}} + \Omega \qquad (2')$$

We suggest that Equation (2) can provide more suitable endowment effect of age structure than Equation (2'). In Europe, GDP per capita is higher and free trade has developed more than any other region, so the deviation from the appropriate consumption structure of tradable and non-tradable goods in each generation may be small. Therefore, we use $\beta^{Europe}{}_1$, not $\beta^{R}{}_1$, as components of endowment effect of age structure.

regions. Next, the endowment effect is significant for all three regions and it is indicated that the share of the working-age population in Europe is higher than any other region. On the other hand, coefficient effect for only between Europe and Africa is significant.

< Insert Tables 4 and 5 >

The results indicate that the endowment effect of age structure plays an important role in difference of trade openness between Europe and Asia and between Europe and America.[20] In Table 4, endowment effect of age structure (0.111) can explain most of the difference of trade openness between Europe and Asia (0.111). Moreover, the endowment effect of age structure (0.166) can explain a large part of the difference of trade openness between Europe and America (0.249). That is, effects of various factors other than age structure offset each other, and the difference of trade openness can be explained mostly by the share of the working-age population. The difference of trade openness between Europe and Africa is influenced by not only endowment effect but also coefficient effect of age structure. In Table 4, the sum of endowment and coefficient effects of age structure (1.356) are much more than the difference of trade openness between Europe and Africa (0.174). It, therefore, seems that factors other than age structure increases trade openness more in Africa than Europe. This implies that the difference of trade openness between Europe and Africa will not decrease even if the share of working age population increases in Africa and age structure in Africa become similar to that

[20] Results of Table 5 are similar to Table 4, so we only discuss Table 4.

in Europe. According to Tables 4 and 5, whether or not trade openness is logged influences the results of the Blinder-Oaxaca decomposition. Nevertheless, significance is not different, so age structure would definitely contribute to high trade openness in Europe.

## 5. Conclusions

In this research, we focus attention on age structure as a reason why trade openness is higher in Europe than Asia, America, or Africa. Our empirical results by region based on fixed-effects models showed that the share of the working-age population has a significantly positive effect on trade openness for the three regions of Europe, Asia and America, except Africa. In addition, we investigated the difference of trade openness in Europe and other regions based on the Blinder-Oaxaca decomposition. According to the result, only endowment effect of age structure is significant for Asia and America, and both endowment and coefficient effects of age structure are significant for Africa.

Our empirical results lead to the following conclusions. If the share of the working-age population were equal in the four regions, the influence of age structure on the difference in trade openness would not be different in Europe, Asia or America. In reality, the share of the working-age population is high in Europe, which may cause high trade openness in the region. On the other hand, trade openness may not increase in Africa even if increases in the share of the working-age population raise trade openness in other regions. In Africa, the fact that the relationship between age structure and trade openness is weak could be a factor for the empirical result that the coefficient effect of age structure is significant in Blinder-Oaxaca decomposition for Europe and Africa.

**Acknowledgements**

We appreciate Professors Andrew Mason, Mitoshi Yamaguchi, Ryozo Miyao, Taro Esaka, Hidehiko Kamiya, Machiko Watanabe, Makoto Shimizu, Adam M. Majoe, Adam Bestenbostel, Tomokazu Nomura and Takayuki Ogawa for their valuable comments and this paper has been improved greatly thanks to their comments. This work was supported by JSPS KAKENHI Grant Numbers JP26292118 and JP24310031, and the OUE travel grant for international conferences.

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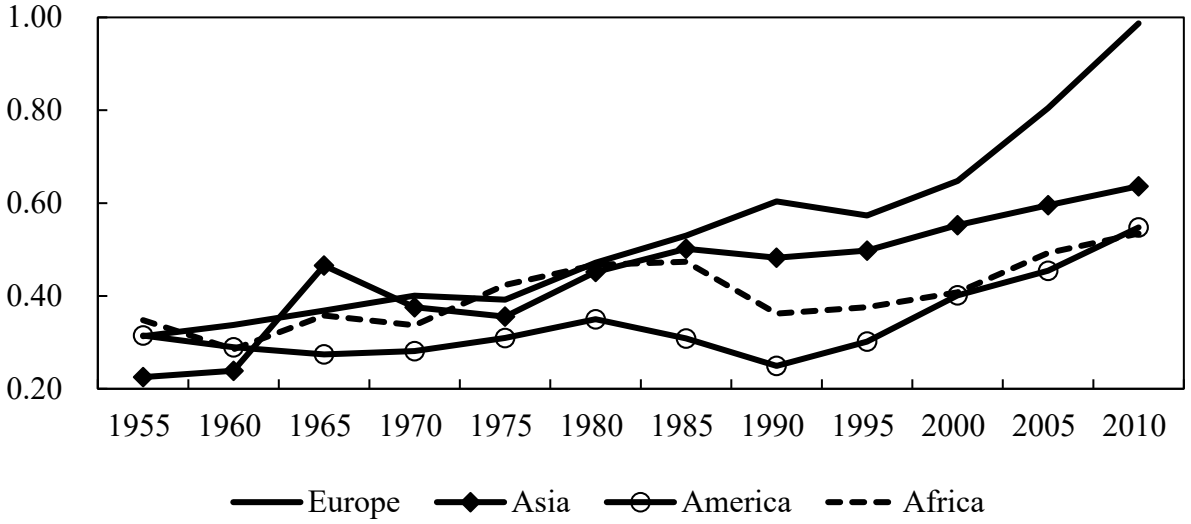
**Figure 1. Line graphs of trade openness and share of working-age population**

(a) Trade openness




(b) Share of working-age population

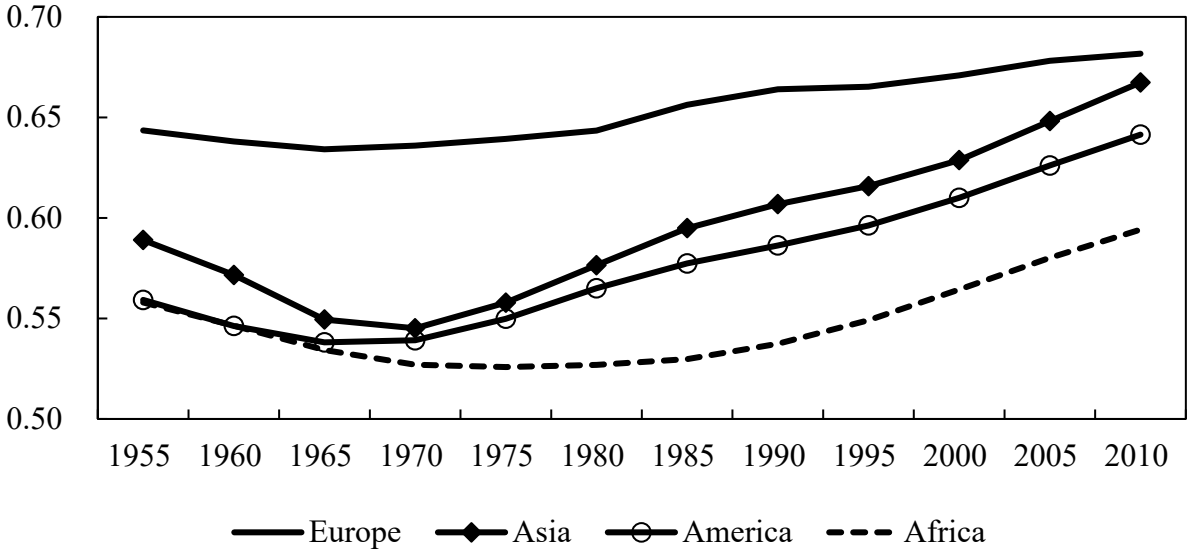
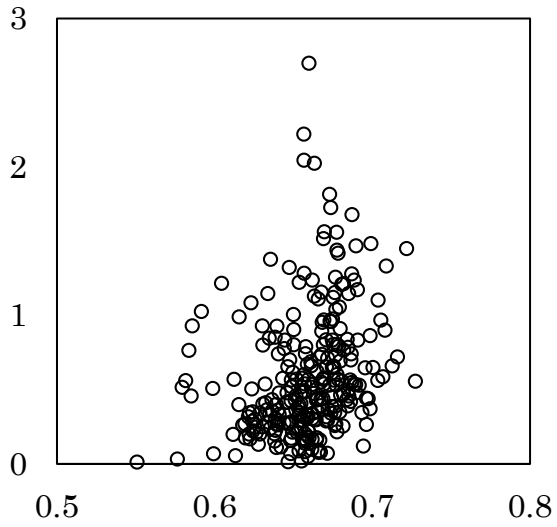
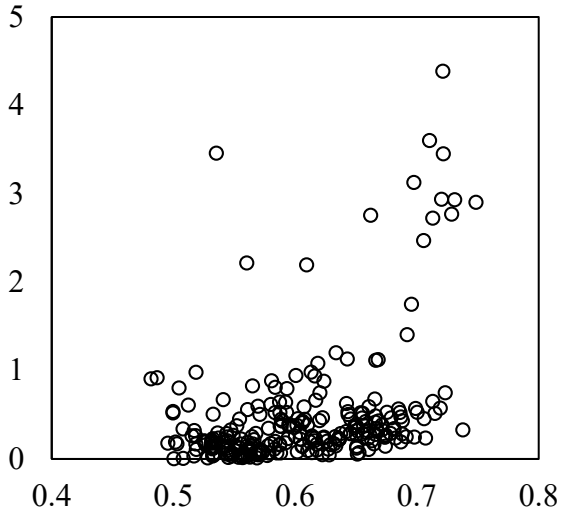


**Figure 2. Scatter plots of trade openness and share of working-age population**

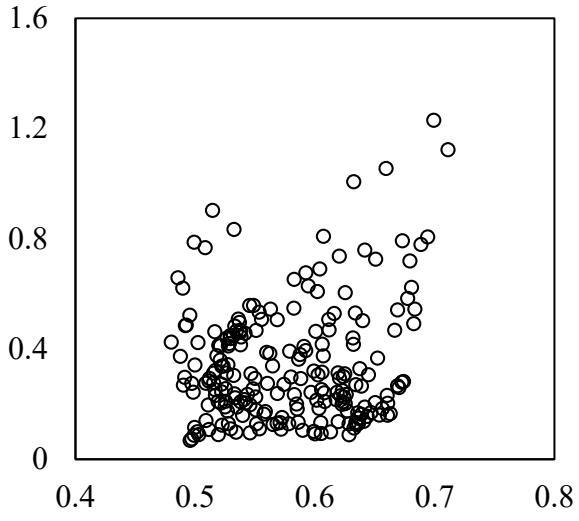
(a) Europe



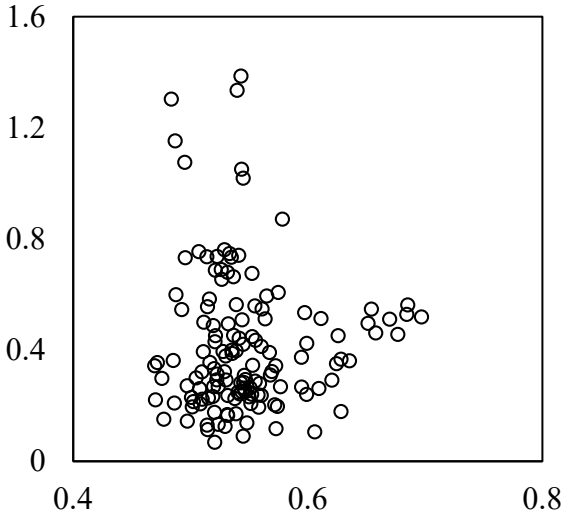

(b) Asia




(c) America



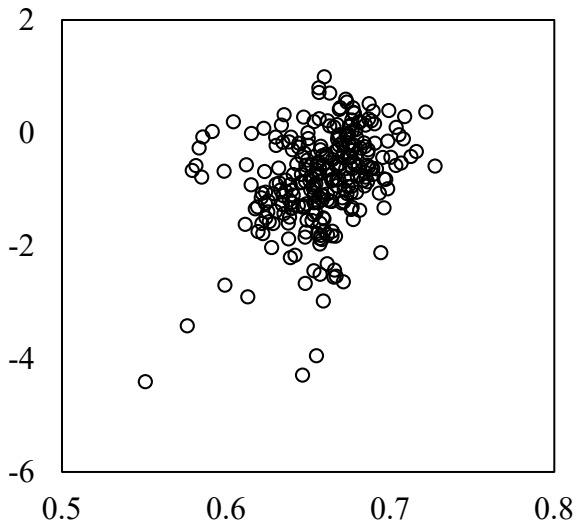

(d) Africa



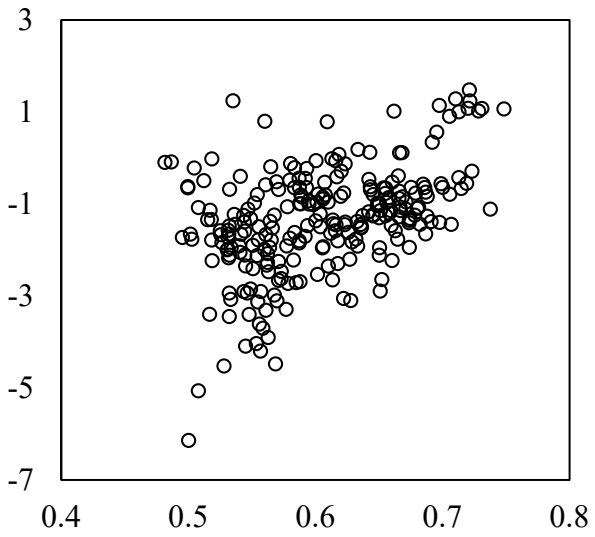

Note: The vertical axis is trade openness and the horizontal axis is the share of working-age population.

**Figure 3. Scatter plots of logged trade openness and share of working-age population**

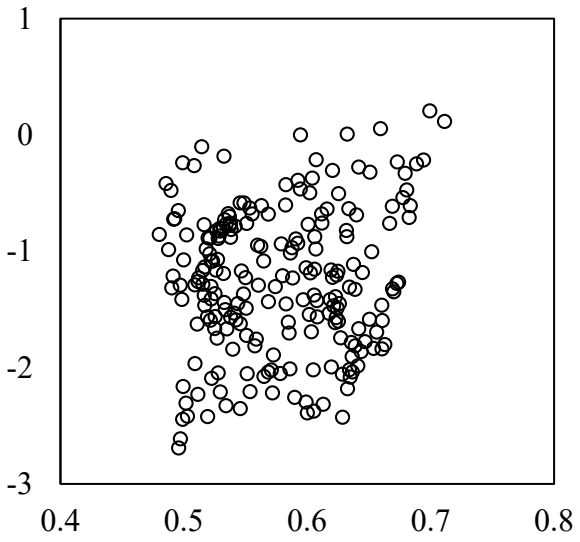
(a) Europe



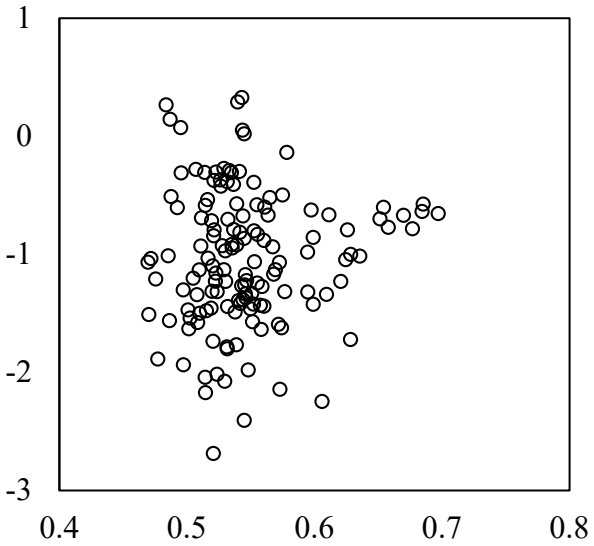

(b) Asia




(c) America




(d) Africa




Note: The vertical axis is logged trade openness and the horizontal axis is the share of working-age population.

**Table 1. Descriptive statistics**

(a) Europe

| Variable | Obs. | Mean | S. D. | Min | Max |
|---|---|---|---|---|---|
| Trade openness | 274 | 0.589 | 0.424 | 0.012 | 2.698 |
| ln (Trade openness) | 274 | -0.808 | 0.833 | -4.405 | 0.993 |
| Share of the working-age population | 274 | 0.659 | 0.027 | 0.551 | 0.727 |
| Government consumption share of GDP | 274 | 0.195 | 0.070 | 0.052 | 0.526 |
| ln (Population) | 274 | 2.414 | 1.062 | 0.294 | 4.412 |
| ln (GDP per capita) | 274 | 9.367 | 0.682 | 7.108 | 10.697 |

(b) Asia

| Variable | Obs. | Mean | S. D. | Min | Max |
|---|---|---|---|---|---|
| Trade openness | 250 | 0.478 | 0.683 | 0.002 | 4.386 |
| ln (Trade openness) | 250 | -1.362 | 1.163 | -6.142 | 1.478 |
| Share of the working-age population | 250 | 0.605 | 0.061 | 0.482 | 0.749 |
| Government consumption share of GDP | 250 | 0.202 | 0.112 | 0.042 | 0.606 |
| ln (Population) | 250 | 3.046 | 1.773 | -0.144 | 7.174 |
| ln (GDP per capita) | 250 | 8.454 | 1.020 | 6.651 | 10.774 |

(c) America

| Variable | Obs. | Mean | S. D. | Min | Max |
|---|---|---|---|---|---|
| Trade openness | 215 | 0.340 | 0.213 | 0.068 | 1.229 |
| ln (Trade openness) | 215 | -1.262 | 0.616 | -2.691 | 0.207 |
| Share of the working-age population | 215 | 0.578 | 0.057 | 0.480 | 0.711 |
| Government consumption share of GDP | 215 | 0.141 | 0.054 | 0.034 | 0.413 |
| ln (Population) | 215 | 2.254 | 1.524 | -0.370 | 5.720 |
| ln (GDP per capita) | 215 | 8.579 | 0.765 | 7.288 | 10.655 |

(d) Africa

| Variable | Obs. | Mean | S. D. | Min | Max |
|---|---|---|---|---|---|
| Trade openness | 139 | 0.416 | 0.252 | 0.068 | 1.386 |
| ln (Trade openness) | 139 | -1.040 | 0.575 | -2.687 | 0.327 |
| Share of the working-age population | 139 | 0.547 | 0.046 | 0.470 | 0.697 |
| Government consumption share of GDP | 139 | 0.191 | 0.094 | 0.040 | 0.501 |
| ln (Population) | 139 | 1.818 | 1.451 | -0.744 | 4.361 |
| ln (GDP per capita) | 139 | 8.022 | 0.730 | 6.210 | 9.678 |

Note: ln (X) means that variable X is natural logged.

**Table 2. Empirical results for non-logged trade openness based on fixed-effects models**

| Independent variable | | Europe | | Asia | | America | | Africa | |
|---|---|---|---|---|---|---|---|---|---|
| *Working* | Coef. | 2.060 | * | 1.448 | ** | 1.401 | ** | 0.003 | |
| | S. E. | 1.032 | | 0.657 | | 0.657 | | 0.765 | |
| *Gov* | Coef. | 0.128 | | -0.171 | | -0.005 | | -0.599 | |
| | S. E. | 0.393 | | 0.218 | | 0.244 | | 0.519 | |
| *Pop* | Coef. | -0.806 | ** | 0.007 | | -0.359 | ** | -0.567 | * |
| | S. E. | 0.396 | | 0.113 | | 0.133 | | 0.261 | |
| *GDP/Pop* | Coef. | -0.104 | | 0.061 | | -0.162 | ** | -0.244 | ** |
| | S. E. | 0.101 | | 0.099 | | 0.064 | | 0.094 | |
| *D*(1956-1960) | Coef. | 0.087 | *** | -0.032 | | 0.044 | ** | 0.079 | * |
| | S. E. | 0.031 | | 0.044 | | 0.020 | | 0.040 | |
| *D*(1961-1965) | Coef. | 0.208 | *** | -0.035 | | 0.105 | ** | 0.129 | |
| | S. E. | 0.065 | | 0.090 | | 0.038 | | 0.077 | |
| *D*(1966-1970) | Coef. | 0.298 | *** | -0.140 | | 0.172 | *** | 0.222 | * |
| | S. E. | 0.094 | | 0.090 | | 0.053 | | 0.116 | |
| *D*(1971-1975) | Coef. | 0.419 | *** | -0.145 | | 0.249 | *** | 0.379 | ** |
| | S. E. | 0.120 | | 0.102 | | 0.074 | | 0.172 | |
| *D*(1976-1980) | Coef. | 0.530 | *** | -0.077 | | 0.321 | *** | 0.557 | ** |
| | S. E. | 0.146 | | 0.113 | | 0.089 | | 0.235 | |
| *D*(1981-1985) | Coef. | 0.583 | *** | -0.059 | | 0.300 | *** | 0.672 | ** |
| | S. E. | 0.165 | | 0.122 | | 0.093 | | 0.296 | |
| *D*(1986-1990) | Coef. | 0.668 | *** | -0.111 | | 0.267 | ** | 0.609 | * |
| | S. E. | 0.191 | | 0.138 | | 0.094 | | 0.292 | |
| *D*(1991-1995) | Coef. | 0.757 | *** | 0.015 | | 0.355 | *** | 0.682 | * |
| | S. E. | 0.218 | | 0.173 | | 0.107 | | 0.329 | |
| *D*(1996-2000) | Coef. | 0.837 | *** | 0.047 | | 0.484 | *** | 0.785 | * |
| | S. E. | 0.229 | | 0.165 | | 0.124 | | 0.367 | |
| *D*(2001-2005) | Coef. | 1.003 | *** | 0.045 | | 0.547 | *** | 0.942 | ** |
| | S. E. | 0.251 | | 0.153 | | 0.136 | | 0.431 | |
| *D*(2006-2010) | Coef. | 1.205 | *** | 0.038 | | 0.671 | *** | 1.074 | ** |
| | S. E. | 0.283 | | 0.164 | | 0.147 | | 0.432 | |
| Adjusted R-squered | | 0.751 | | 0.309 | | 0.502 | | 0.209 | |
| Number of observations | | 274 | | 250 | | 215 | | 139 | |
| Number of countries | | 33 | | 28 | | 18 | | 13 | |

Note: The dependent variable is trade openness. The estimates of country dummies are not reported. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

**Table 3. Empirical results for logged trade openness based on fixed-effects models**

| | | Europe | | Asia | | America | | Africa | |
|---|---|---|---|---|---|---|---|---|---|
| *Working* | Coef. | 5.447 | * | 7.135 | ** | 2.774 | | 1.675 | |
| | S. E. | 3.011 | | 2.786 | | 1.783 | | 1.886 | |
| *Gov* | Coef. | 0.496 | | -0.585 | | -0.782 | | -0.205 | |
| | S. E. | 0.902 | | 0.812 | | 0.733 | | 0.987 | |
| *Pop* | Coef. | -0.939 | | -0.496 | | -0.917 | *** | -1.130 | |
| | S. E. | 1.048 | | 0.338 | | 0.311 | | 0.654 | |
| *GDP/Pop* | Coef. | -0.044 | | -0.169 | | -0.325 | ** | -0.486 | ** |
| | S. E. | 0.397 | | 0.182 | | 0.137 | | 0.169 | |
| *D*(1956-1960) | Coef. | 0.180 | * | -0.156 | | 0.083 | | 0.134 | |
| | S. E. | 0.091 | | 0.139 | | 0.058 | | 0.086 | |
| *D*(1961-1965) | Coef. | 0.281 | | 0.085 | | 0.216 | * | 0.140 | |
| | S. E. | 0.255 | | 0.192 | | 0.110 | | 0.195 | |
| *D*(1966-1970) | Coef. | 0.441 | | 0.098 | | 0.362 | ** | 0.282 | |
| | S. E. | 0.328 | | 0.226 | | 0.158 | | 0.286 | |
| *D*(1971-1975) | Coef. | 0.595 | * | 0.053 | | 0.568 | *** | 0.613 | |
| | S. E. | 0.323 | | 0.326 | | 0.196 | | 0.400 | |
| *D*(1976-1980) | Coef. | 0.867 | ** | 0.303 | | 0.818 | *** | 0.929 | |
| | S. E. | 0.373 | | 0.343 | | 0.225 | | 0.535 | |
| *D*(1981-1985) | Coef. | 0.931 | ** | 0.392 | | 0.795 | *** | 1.056 | |
| | S. E. | 0.394 | | 0.388 | | 0.232 | | 0.670 | |
| *D*(1986-1990) | Coef. | 0.996 | ** | 0.296 | | 0.664 | ** | 0.960 | |
| | S. E. | 0.441 | | 0.453 | | 0.249 | | 0.695 | |
| *D*(1991-1995) | Coef. | 1.162 | ** | 0.508 | | 0.965 | *** | 1.183 | |
| | S. E. | 0.496 | | 0.492 | | 0.269 | | 0.751 | |
| *D*(1996-2000) | Coef. | 1.329 | ** | 0.853 | | 1.311 | *** | 1.398 | |
| | S. E. | 0.545 | | 0.514 | | 0.292 | | 0.825 | |
| *D*(2001-2005) | Coef. | 1.581 | ** | 0.944 | * | 1.454 | *** | 1.655 | * |
| | S. E. | 0.601 | | 0.553 | | 0.314 | | 0.917 | |
| *D*(2006-2010) | Coef. | 1.796 | ** | 1.034 | | 1.748 | *** | 1.960 | * |
| | S. E. | 0.672 | | 0.609 | | 0.361 | | 0.993 | |
| Adjusted R-squered | | 0.725 | | 0.477 | | 0.481 | | 0.291 | |
| Number of observations | | 274 | | 250 | | 215 | | 139 | |
| Number of countries | | 33 | | 28 | | 18 | | 13 | |

Note: The dependent variable is logged trade openness. The estimates of country dummies are not reported. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

**Table 4. Empirical results for Blinder-Oaxaca decomposition in case of non-logged trade openness**

| Geographic region | | Difference in trade openness | Contribution of age structure | |
|---|---|---|---|---|
| | | | Endowment effect | Coefficient effect |
| Asia | Coef. | 0.111 *** | 0.111 *** | 0.370 |
| | S. E. | 0.051 | 0.037 | 0.563 |
| America | Coef. | 0.249 *** | 0.166 *** | 0.381 |
| | S. E. | 0.030 | 0.055 | 0.434 |
| Africa | Coef. | 0.174 *** | 0.230 *** | 1.126 ** |
| | S. E. | 0.034 | 0.076 | 0.474 |

Note: The results other than the share of the working-age population are not reported. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively. Europe is set as a benchmark.

**Table 5. Empirical results for Blinder-Oaxaca decomposition in case of logged trade openness**

| Geographic region | | Difference in trade openness | Contribution of age structure | |
|---|---|---|---|---|
| | | | Endowment effect | Coefficient effect |
| Asia | Coef. | 0.554 *** | 0.293 *** | -1.021 |
| | S. E. | 0.090 | 0.079 | 1.215 |
| America | Coef. | 0.453 *** | 0.440 *** | 1.545 |
| | S. E. | 0.066 | 0.116 | 0.962 |
| Africa | Coef. | 0.232 *** | 0.608 *** | 2.064 ** |
| | S. E. | 0.071 | 0.158 | 0.969 |

Note: See note of Table 4.

**Appendix Table. List of countries**

| Countries | Period |
|---|---|
| **Europe: 33 countries** | |
| Albania | 1971-2010 |
| Austria | 1951-2010 |
| Belarus | 1991-2010 |
| Belgium | 1951-2010 |
| Bosnia and Herzegovina | 1991-2010 |
| Bulgaria | 1971-2010 |
| Croatia | 1991-2010 |
| Czech Republic | 1991-2010 |
| Denmark | 1951-2010 |
| Estonia | 1991-2010 |
| Finland | 1951-2010 |
| France | 1951-2010 |
| Germany | 1951-2010 |
| Greece | 1951-2010 |
| Hungary | 1971-2010 |
| Ireland | 1951-2010 |
| Italy | 1951-2010 |
| Latvia | 1991-2010 |
| Lithuania | 1991-2010 |
| Netherlands | 1951-2010 |
| Poland | 1971-2010 |
| Portugal | 1951-2010 |
| Republic of Moldova | 1991-2010 |
| Romania | 1961-2010 |
| Serbia | 1991-2010 |
| Slovakia | 1991-2010 |
| Slovenia | 1991-2010 |
| Spain | 1951-2010 |
| Sweden | 1951-2010 |
| Switzerland | 1951-2010 |
| TFYR Macedonia | 1991-2010 |
| Ukraine | 1991-2010 |
| United Kingdom | 1951-2010 |
| **Asia: 28 countries** | |
| Armenia | 1991-2010 |
| Australia | 1951-2010 |
| Azerbaijan | 1991-2010 |
| **Asia: *continued*** | |
| Malaysia | 1956-2010 |
| Mongolia | 1971-2010 |
| New Zealand | 1951-2010 |
| Pakistan | 1951-2010 |
| Philippines | 1951-2010 |
| Republic of Korea | 1956-2010 |
| Singapore | 1961-2010 |
| Sri Lanka | 1951-2010 |
| Tajikistan | 1991-2010 |
| Thailand | 1951-2010 |
| Turkey | 1951-2010 |
| Turkmenistan | 1991-2010 |
| Uzbekistan | 1991-2010 |
| Viet Nam | 1971-2010 |
| **America: 18 countries** | |
| Argentina | 1951-2010 |
| Bolivia | 1951-2010 |
| Brazil | 1951-2010 |
| Canada | 1951-2010 |
| Chile | 1951-2010 |
| Colombia | 1951-2010 |
| Costa Rica | 1951-2010 |
| Dominican Republic | 1951-2010 |
| Guatemala | 1951-2010 |
| Honduras | 1951-2010 |
| Jamaica | 1956-2010 |
| Mexico | 1951-2010 |
| Panama | 1951-2010 |
| Paraguay | 1951-2010 |
| Peru | 1951-2010 |
| Trinidad and Tobago | 1951-2010 |
| United States | 1951-2010 |
| Uruguay | 1951-2010 |
| **Africa: 13 countries** | |
| Cameroon | 1961-2010 |
| Congo | 1961-2010 |

| | | | |
|---|---|---|---|
| China | 1956-2010 | Côte d'Ivoire | 1961-2010 |
| Georgia | 1991-2010 | Egypt | 1951-2010 |
| Hong Kong | 1961-2010 | Gabon | 1961-2010 |
| India | 1951-2010 | Ghana | 1956-2010 |
| Indonesia | 1961-2010 | Kenya | 1951-2010 |
| Israel | 1951-2010 | Mauritius | 1951-2010 |
| Japan | 1951-2010 | Morocco | 1951-2010 |
| Jordan | 1956-2010 | Namibia | 1961-2010 |
| Kazakhstan | 1991-2010 | South Africa | 1951-2010 |
| Kyrgyzstan | 1991-2010 | Swaziland | 1971-2010 |
| Lebanon | 1971-2010 | Tunisia | 1961-2010 |

Note: This table lists sample countries and periods. Oceania countries that can be included in the sample are only Australia and New Zealand. These two countries are included in Asia in our analysis because they are close to Asia compared with other region and have strong connection with Asia in terms of trade. Small countries, highly oil-dependent countries, countries with extremely high or low trade openness, and countries classified as LDCs are not included, as discussed in Section 2. We regard countries with population less than 1,000,000 in 2005–2010 as small countries. Bahrain and Norway are also considered to be highly oil-dependent countries. Trade openness and share of government consumption in GDP of El Salvador are extremely large in some periods, and the trade openness of Zimbabwe is extremely small in 1956–60; they seemed to be an outlier. The United Nations, Department of Economic and Social Affairs, Committee for Development Policy (2015) lists 48 countries as LDCs. We also exclude Botswana, which was classified as an LDCs. Finally, the following 71 countries are excluded from the sample: Angola, Antigua and Barbuda, Bahamas, Bahrain, Bangladesh, Barbados, Belize, Benin, Bhutan, Botswana, Brunei Darussalam, Burkina Faso, Burundi, Cabo Verde, Cambodia, Central African Republic, Chad, Comoros, Cyprus, Democratic Republic of the Congo, Djibouti, Ecuador, El Salvador, Equatorial Guinea, Ethiopia, Fiji, Gambia, Grenada, Guinea, Guinea-Bissau, Iceland, Iran, Iraq, Kuwait, Lao People's Democratic Republic, Lesotho, Liberia, Luxembourg, Macao, Madagascar, Malawi, Maldives, Mali, Malta, Mauritania, Montenegro, Mozambique, Nepal, Niger, Nigeria, Norway, Oman, Qatar, Russian Federation, Rwanda, Saint Lucia, Saint Vincent and the Grenadines, Sao Tome and Principe, Saudi Arabia, Senegal, Sierra Leone, Sudan, Suriname, Syrian Arab Republic, Togo, Uganda, United Republic of Tanzania, Venezuela, Yemen, Zambia, and Zimbabwe.