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# The Long-Run Relationship Between R&D Spending and Current Account Balances: A Panel Data Analysis

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# AR-GE Harcamaları ve Cari İşlemler Dengesi Uzun Dönemli İlişkisi: Panel Veri Analizi

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**Abstract**

This study aims to find out the long-run relationship between R&D spending and the current account balances. The panel data analysis is carried out for the period between 1996 and 2018. 64 developing and developed countries are included in the study. Panel cointegration is applied to test the long-run relationships. There are significant and positive long-run relationships between the R&D spending with current account balances for four different country groups which are high income, all countries except industrial, all countries except industrial and African, and all countries groups. Results show that R&D spending is an important factor for both developing and developed countries to improve their current account balances positively. 1% increase in R&D spending improves 3.29% current account surplus for all countries, 4.55% for high income countries group.

**Keywords**: Current account balances, R&D spending, panel data analysis, panel cointegration.

**Makale Bilgileri**
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**Öz**

*Bu çalışmada AR-GE harcamaları ile cari işlemler dengesi arasında uzun dönemli bir ilişkinin varlığı araştırılmıştır. Panel veri analizi, 64 gelişmiş ve gelişmekte olan ülkeler ile 1996 ve 2018 yılları için uygulanmıştır. Uzun dönemli ilişkiyi araştırmak için panel eşbütünleşme analizi kullanılmıştır. Dört farklı ülke grubu için AR-GE harcamaları ile cari işlemler dengesi arasında pozitif, anlamlı ve uzun dönemli bir ilişki olduğu sonucuna ulaşılmıştır. Bu gruplar, yüksek gelirli ülkeler, sanayileşmiş ülkeler hariç tüm ülkeler, Afrika ve sanayileşmiş ülkeler hariç tüm ülkeler ve tüm ülkeler gruplarıdır. AR-GE harcamalarının sadece gelişmiş ülkelerin cari işlemler dengesi üzerinde değil gelişmekte olan ülkelerin cari işlemler dengesi üzerinde de olumlu etkisi olduğu tespit edilmiştir. Tüm ülkeler grubu için, AR-GE harcamalarındaki %1 artış cari işlemler fazlasını %3,29 arttırırken, yüksek gelirli ülkelerde cari işlemler fazlasını %4,55 arttırmaktadır.*

***Anahtar Kelimeler**: Cari işlemler dengesi, AR-GE harcamaları, panel veri analizi, panel eşbütünleşme.*

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## 1. Introduction

The stages of development hypothesis explain that all the developed countries are expected to run current account surpluses. And all the developing countries are expected to run current account deficits (Fischer and Frenkel, 1974) But today a lot of developed countries are running deficits and also some of the developing counties are running surpluses. One of the important questions is how these developing countries were able to start running surpluses. And some of them already became developed countries. Innovation, R&D, human capital play key role for their development especially for Far East Asian countries. In Far East Asia, Japan (since 1981), South Korea, Malaysia, and Singapore (since 1998) have significant current account surpluses. China has current account surpluses for 25 years since 1994. Figure 1 shows the global current account balances starting from 2001.When viewed globally, the USA's current account deficit was less than 2% of GDP in 1997. It increased to 5.8% of GDP in 2006. After the global financial crisis, it decreased to 2.3% of GDP in 2009 and it remains 2.6% in 2019. The USA has current account deficits since 1992. Some other industrial countries like New Zealand, Canada, and Australia are running current account deficits for many years. In Europe, developed countries like Italy, UK, Greece, Portugal, and France have run current account deficits for years. Italy and Portugal have just started to run surpluses since 2013. On the other hand, Germany has high current account surpluses since 2002. In Latin America, most of the developing countries are running deficits, for instance Brazil has deficits since 2008. Mexico has deficits since 1988.

Developing countries that are running current account deficits, generally export labor intensive products, raw materials and some low and medium technology products. This causes a terms of trade problem for these developing countries and effects their current account balances negatively. R&D is key for all countries to be able to produce more high-tech products. It is especially important for developing countries with current account deficits. So, in this study it will be investigated if increasing R&D spending will affect current account balances positively for all countries.

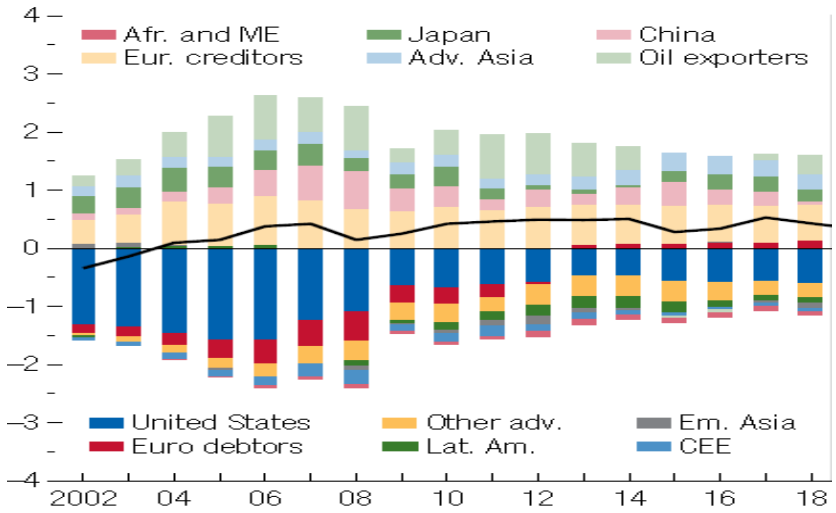


**Figure 1.** Global Current Account Balance (Percent of world GDP)

**Source**: IMF World Economic Outlook (2019)

**Note**: Adv. Asia = advanced Asia (Hong Kong SAR, Korea, Singapore, Taiwan Province of China); Afr. and ME = Africa and the Middle East (Democratic Republic of the Congo, Egypt, Ethiopia, Ghana, Jordan, Kenya, Lebanon, Morocco, South Africa, Sudan, Tanzania, Tunisia); CEE = central and eastern Europe (Belarus, Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Slovak Republic, Turkey, Ukraine); Em. Asia = emerging Asia (India, Indonesia, Pakistan, Philippines, Thailand, Vietnam); Eur. creditors = European creditors (Austria, Belgium, Denmark, Finland, Germany, Luxembourg, Netherlands, Norway, Sweden, Switzerland); Euro debtors = euro area debtors (S.Cyprus, Greece, Ireland, Italy, Portugal, Spain, Slovenia); Lat. Am. = Latin America (Argentina, Brazil, Chile, Colombia, Mexico, Peru, Uruguay); Oil exporters = Algeria, Azerbaijan, Iran, Kazakhstan, Kuwait, Nigeria, Oman, Qatar, Russia, Saudi Arabia, United Arab Emirates, Venezuela; Other adv. = other advanced economies (Australia, Canada, France, Iceland, New Zealand, United Kingdom).

This study contributes and extends the previous empirical studies in three ways. Firstly, the study tries to find out the role of R&D spending directly in current account balances. Other studies are concentrated only on the export or the high technology export. Secondly, in literature highest number of countries in the longest time period (22 years) are included in this study. 64 developing and developed countries are included. 37 high income, 27 developing countries are added. Finally, results show that R&D spending is an important factor for both developing and developed countries' current account balances, to increase the surpluses or to decrease the deficits. There are significant and positive long-run relationships between the R&D spending with current account balances for four different country groups. Exports of goods and services is also added in the study to understand the relationship directly between R&D spending and export. Also, growth rate, fiscal balance, and real effective exchange rate are added in current account balance equation as control parameters. But it is not identified any cointegration relationships between them.

## 2. Literature

There are several studies in the literature that show human capital, innovation and R&D are some of the most important factors of economic growth (Lucas, 1988; Mankiw et al., 1992; De La Fuente and Domenech, 2006). These studies are both related with the effect of level (so-called level effect) by its effect through labor productivity (Romer, 1990), and the rate effect by its increased competitive advantage through innovation and diffusion technology (Horwitz, 2005).

Labor productivity is regarded as an exogenous factor in the classical theory for economic growth. It depends on the ratio between workforce and physical capital and other factors. The effect of education is not considered as a factor for potential growth of productivity. The new theory of economic growth includes the importance of human capital such as education and innovation in long-term economic growth. Several studies in the literature support that new growth theory. Self and Grabowski (2004) find that primary education has a strong effect on economic growth for India by using time series techniques. Pereira and St. Aubyn (2009) show for Portugal that increasing the education at all school levels except tertiary has a positive and significant effect on growth by estimating several vectors autoregressions. Blundell et al. (1999) explain that the growth rate of output depends on the rate of human capital and innovation.

In literature there are also several studies that show the importance of R&D spending on international trade. Landesmann and Pfaffmayr (1997) work the relationship between R&D spending and export for OECD countries for the period between 1967 and 1987. They use OLS and fixed effect models for each country separately. R&D spending has positive effect on the total export of the USA, the UK and Japan. And it has negative effect for Germany and France. It is argued that that R&D effort is especially effective in catching-up economies and relatively mature economies such as Japan and the USA which must maintain their position on the technology frontier. On the other hand, countries which had their major catching-up phases sometimes in the past such as Germany and France, may be less effective in their R&D effort. The reason could be the decreasing returns in their case to their increased R&D efforts after the earlier high returns from catching up ended and/or that the labor market dynamics might be such that improvements in productivity or product quality get compensated in higher wage demands and/or upgrading of the labor force. Braunerhjelm and Thulin (2008) work with 19 OECD countries between 1981 and 1990. Panel data analysis is used in the study. Panel regressions with fixed effects models are used to estimate the impact of R&D spending. It is showed that, 1% increase in R&D spending increases 3% high-tech product export. Harris and Li (2009) find a positive relationship between R&D spending and export between 1998 and 2000 for UK. Özer and Çiftçi (2009) find that there is high significant and positive relationship between R&D spending and the total export for OECD countries between 1990 and 2005 by using panel data analysis random and fixed models.

Halpern and Muraközy (2011) find out a positive relationship between R&D spending and export for Hungary between 2004 and 2006. Yıldırım and Keskinoğlu (2012) find causality relationship between the export and R&D spending for Turkey between 1996 and 2008 by using the causality analysis based on GMM-system estimation and Wald test. Göçer (2013) shows that an increase by 1% in R&D expenditures, increased the high technology export by 6.5%, the information-communication technology exports by 0.6% and the economic growth by 0.43%, for 11 Asian developing countries for the period between 1996 and 2012. Panel data analysis is used in the study. Panel causality and panel cointegration tests are applied. It is not found out causality relationship between the total export and R&D spending. He cannot also find a significant relationship between the total export and R&D spending. He finds out an insignificant positive relationship. Şahbaz et al. (2014) find causality relationship between R&D spending and the export for 17 European and Turkey for the period between 1996 and 2011. Panel causality tests are applied. Özçelik et al. (2018) find out long-run and causality relationship between R&D spending and high technology export for the selected 10 OECD countries for the period between 1996 and 2014 by using panel cointegration and causality tests.

It is expected that more R&D spending will cause higher technology goods and services production. More value-added products will be produced. This will improve terms of trade positions of the countries that have more R&D spending. More high technology goods and services will increase the growth rate and the total amount of export. Trade balance will improve. Eventually current account balances will improve. It will be tested if current balances will improve with increased R&D spending in this study.

## 3. Data and Methodology

This study aims to find out the long-run relationship between R&D spending and the current account balances by using panel data analysis method. The analysis is carried out for the period between 1996 and 2018 for 64 developing and developed countries. 37 high-income and 27 developing countries are included in the study (Table 1). The R&D spending data is available only for 64 countries. Other countries are not included in the study because of huge R&D spending missing data. It is impossible to complete cointegration analyses with this huge amount of R&D spending missing data. Again, before 1996 R&D spending data availability is limited for large country groups. So, 64 countries for the period between 1996 and 2018 are added in this study. Exports of goods and services is added in the study to understand the relationship directly between R&D spending and export. Also, growth rate, fiscal balance and real effective exchange rate are added in current account balance equation as control parameters.

### 3.1. Data and Model

Since there is a large degree of heterogeneity across the diverse set of countries, five different county groups are analyzed, separately. Panel cointegration is applied to examine the long-run relationships. Current account balances and R&D spending data are collected from the World Bank (Table 2). Control parameters growth rate, fiscal balance and real effective exchange rate are added in current account balance equation. Data are collected from World Bank and Brugel economic tink tank (Table 2). High-income and developing countries are selected based on World Bank country classification. Full sample is the combination of high income and developing countries. Although industrial countries are in high-income countries group, they can be accepted as a smaller more developed country group. Removing industrial and African countries from full sample may create a more homogenous country group. So, in total five country groups are created.

Three models are used. To identify the role of the R&D spending in current account balances, it is regressed on current account balances. Where CA is the current account balances, R is a vector of R&D spending. To identify the role of the R&D spending in exports of goods and services, it is regressed on exports of goods and services. EXP represents exports of goods and services. Fiscal balance, growth rate and real effective exchange rate are added in the first equation as control parameters. These variables are shown as $X_{it}$ in the third equation. Fiscal balance, growth rate and real effective exchange rate are identified as determinants of current account balances in many studies. Altayligil and Çetrez (2020) is one of the latest studies which these three variables are found as determinants of current account balances for different country groups.

$$CA_{it} = \alpha_{it} + \beta R_{it} + u_{it} \quad (1)$$

$$EXP_{it} = \alpha_{it} + \beta R_{it} + u_{it} \quad (2)$$

$$CA_{it} = \alpha_{it} + \beta R_{it} + \beta_2 X_{it} + u_{it} \quad (3)$$

**Table 1.** Country Groups

| |
|---|
| **High Income** |
| Austria, Belgium, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, S. Korea, Latvia, Lithuanian, Luxembourg, Holland, Norway, Poland, Portugal, Singapore, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom, USA, Uruguay, S. Cyprus, Malta, Panama, Romania. |
| **Developing** |
| Argentina, Russia, Armenia, Azerbaijan, Belarus, Brazil, Bulgaria, Costa Rica, China, Colombia, Egypt, India, Kazakhstan, Kirghizstan, N. Macedonia, Madagascar, Mexico, Moldova, Mongolia, Peru, Serbia, South Africa, Tajikistan, Thailand, Tunisia, Turkey, Ukraine. |
| **Full Sample** |
| Austria, Belgium, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, S. Korea, Latvia, Lithuanian, Luxembourg, Holland, Norway, Poland, Portugal, Singapore, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom, USA, Uruguay, S. Cyprus, Malta, Panama, Romania, Argentina, Russia, Armenia, Azerbaijan, Belarus, Brazil, Bulgaria, Costa Rica, China, Colombia, Egypt, India, Kazakhstan, Kirghizstan, N. Macedonia, Madagascar, Mexico, Moldova, Mongolia, Peru, Serbia, South Africa, Tajikistan, Thailand, Tunisia, Turkey, Ukraine. |
| **Full Sample Except Industrial Countries** |
| Croatia, Czech Republic, Estonia, Hungary, Israel, S. Korea, Latvia, Lithuanian, Luxembourg, Poland, Singapore, Slovak Republic, Slovenia, Uruguay, S. Cyprus, Malta, Panama, Romania, Argentina, Russia, Armenia, Azerbaijan, Belarus, Brazil, Bulgaria, Costa Rica, China, Colombia, Egypt, India, Kazakhstan, Kirghizstan, N. Macedonia, Madagascar, Mexico, Moldova, Mongolia, Peru, Serbia, South Africa, Tajikistan, Thailand, Tunisia, Turkey, Ukraine. |
| **Full Sample Except Industrial and African Countries** |
| Croatia, Czech Republic, Estonia, Hungary, Israel, S. Korea, Latvia, Lithuanian, Luxembourg, Poland, Singapore, Slovak Republic, Slovenia, Uruguay, S. Cyprus, Malta, Panama, Romania, Argentina, Russia, Armenia, Azerbaijan, Belarus, Brazil, Bulgaria, Costa Rica, China, Colombia, India, Kazakhstan, Kirghizstan, N. Macedonia, Mexico, Moldova, Mongolia, Peru, Serbia, Tajikistan, Thailand, Turkey, Ukraine. |

**Table 2.** Sources of the Data

| | Variables | Number of Observations | Data Source |
|---|---|---|---|
| **1** | Current Account/GDP (%) | 1467 | World Bank |
| **2** | R&D Spending/GDP (%) | 1367 | World Bank |
| **3** | Exports of Goods and Services/GDP (%) | 1471 | World Bank |
| **4** | Real Effective Exchange Rate | 1442 | Bruegel Think Tank |
| **5** | Fiscal Balance (% of GDP) | 1378 | World Bank |
| **6** | Growth Rate (annual %) | 1449 | World Bank |

### 3.2. Econometric Methodology

Panel data analysis method is used to find out the long-run relationship between R&D spending, the current account balances, and exports of goods and services. Our model comprises annual data. The panel data set is unbalanced which means some of the variables have the missing data. These steps are followed in the study. Panel datasets may show cross-sectional dependency. Pesaran test (2004) is used to check the cross-sectional dependency among the variables. First generation unit root tests do not consider the cross-sectional dependency among the variables. On the other hand, it is seen there is always cross-sectional dependency among them. Second generation root tests must be used when the cross-sectional dependency is observed. So, second generation Pesaran (2007) panel root test is used. Pesaran (2007) unit root test results show that all the variables are not stationary.

Cointegration tests are performed when time series are nonstationary to be able to understand if they have a solid, long-run relationship. Nonstationary time series have a mean or variance that varies over time. Some nonstationary time series are stationary if you first difference them. Nonstationary time series tend to wander. Cointegration shows that they wander together which means that there is a long-run relationship among the series.

So, it is decided to use panel cointegration analysis. The cointegration tests and estimation methods are selected according to the parameters' homogeneity and cross-sectional dependency. Therefore, cross sectional dependence and homogeneity must be tested first before panel cointegration and estimations. Pesaran (2004) cross sectional dependency and Swamy (1971) S homogeneity tests are used. Pesaran (2004) test results show that all the variables have cross sectional dependency (Table 5).

Swamy (1971) test results show that parameters are not homogenous. Second generation panel cointegration tests are more reliable in the presence of cross-sectional dependency. Second generation panel cointegration tests are grouped as homogenous and heterogeneous estimators. It is decided to use Gengenbach, Urbain and Westerlund (Gengenbach et al., 2016) panel cointegration since there is cross sectional dependency and parameters are not homogeneous.

If there are cross sectional dependency second generation estimators are used, because first generation estimators may be deviated. Second generation estimators are grouped into two as homogenous and heterogenous estimators. Second generation Dynamic Ordinary Least Squares Mean Group (DOLSMG) estimator (Pedroni, 2001) is used to find out the long-run estimation of the cointegration model, because models are cross sectional dependent and heterogeneous.

## 4. Results

Pesaran test (2004) is used to check the cross-sectional dependence among all variables. First generation unit root tests do not consider the cross-sectional dependency among the variables. On the other hand, it is seen there is always cross-sectional dependency among all variables (Table 3). CD test statistics values can be seen in the table, Null hypothesis saying that there is no cross-sectional dependence, is rejected.

**Table 3.** Pesaran Cross Sectional Dependence Test Results for Variables

| | **High Income** | **Developing** | **Full Sample-Industrial** | **Full Sample-Africa&Indus** | **Full Sample** |
|---|---|---|---|---|---|
| | **CD-test** | **CD-test** | **CD-test** | **CD-test** | **CD-test** |
| **CAB** | (12.15)*** | (8.74)*** | (9.76)*** | (10.45)*** | (11.02)*** |
| **EXPORT** | (54.54)*** | (15.17)*** | (31.05)*** | (26.36)*** | (58.19)*** |
| **R&D** | (33.86)*** | (3.34)*** | (8.63)*** | (8.90)*** | (27.23)*** |
| **Reer** | (31.49)*** | (9.85)*** | (25.28)*** | (29.02)*** | (32.78)*** |
| **Fbalance** | (37.95)*** | (11.64)*** | (17.30)*** | (16.71)*** | (36.53)*** |
| **Growth** | (60.16)*** | (23.55)*** | (42.46)*** | (39.44)*** | (70.66)*** |

CD test statistics are in parenthesis. *, **, *** indicate significance level at 10%, 5%, 1%.

Second generation root tests must be used when the cross-sectional dependency is observed. Second generation Pesaran (2007) panel root test is used. Pesaran (2007) unit root test results show that none of the variables are stationary. Cointegration analysis will be carried out for these country groups with the variables when first differences are stationary for all country groups (Table 4). First differences of exports of goods and services, and R&D spending are not stationary for some of the country groups. And growth rate itself for all country groups, real effective exchange rate for high income countries, are stationary So, they will not be included in the cointegration analyses, either.

**Table 4.** Pesaran Unit Root Test Results for Variables

| | **High Income** | **Developing** | **Full Sample-Industrial** | **Full Sample-Africa&Indust** | **Full Sample** |
|---|---|---|---|---|---|
| **I(0)** | **Z[t-bar]** | **Z[t-bar]** | **Z[t-bar]** | **Z[t-bar]** | **Z[t-bar]** |
| **CAB** | (0.338) | (1.630) | (6.729) | (5.548) | (5.754) |
| **EXPORT** | (-0.728) | (2.465) | (2.442) | (3.219) | (0.120) |
| **R&D** | (2.936) | (-0.232) | (1.148) | (1.986) | (3.163) |
| **Reer** | (-3.047)*** | (1.832) | (1.959) | (1.019) | (0.731) |
| **Fbalance** | (1.534) | (3.266) | (1.921) | (2.551) | (0.970) |
| **Growth** | (-4.230)*** | (-2.725)*** | (-2.577)*** | (-2.474)*** | (-3.840)*** |
| **I(1)** | **Z[t-bar]** | **Z[t-bar]** | **Z[t-bar]** | **Z[t-bar]** | **Z[t-bar]** |
| **CAB** | (-10.909)*** | (-8.231)*** | (-10.909)*** | (-10.368)*** | (-12.58)*** |
| **EXPORT** | (0.048) | (-0.921) | (-1.709)** | (-1.375)* | (-1.737)** |
| **R&D** | (6.14)*** | (0.15) | (3.93)*** | (3.03)*** | (7.98)*** |
| **Reer** | (-6.944)*** | (-6.531)*** | (-7.147)*** | (-6.683)*** | (-9.203)*** |
| **Fbalance** | (-10.174)*** | (-8.754)*** | (-10.358)*** | (-10.062)*** | (-11.954)*** |
| **Growth** | (-12.224)*** | (-10.879)*** | (-13.878)*** | (-12.606)*** | (-16.149)*** |

t- statistics are in parenthesis. *, **, *** indicate significance at 10%, 5%, 1%.

The cointegration test and estimation method are selected according to the parameters' homogeneity and cross-sectional dependency. Therefore, cross sectional dependency and homogeneity must be tested first before panel cointegration and estimations. Pesaran (2004) cross sectional test result shows that there is cross sectional dependency for the equations (Table 5).

**Table 5.** Pesaran Cross Sectional Dependence Test Results for Cointegration Analysis

| | **High Income** | **Develop.** | **Full Sample-Industrial** | **Full Sample - Africa&Ind.** | **Full Sample** |
|---|---|---|---|---|---|
| | CD-test | CD-test | CD-test | CD-test | CD-test |
| **CAB-R&D** | (9.79)*** | | (9.36)*** | (8.25)*** | (11.14)*** |
| **EXP-R&D** | | | (16.54)*** | (13.11)*** | (27.96)*** |
| **CAB-R&D-Reer** | | (2.17)** | (5.49)*** | (5.20)*** | (6.27)*** |
| **CAB-R&D-Fbalance** | (12.54)*** | (9.18)*** | (13.96)*** | (11.72)*** | (16.66)*** |

CD test statistics are in parenthesis. *, **, *** indicate significance at 10%, 5%, 1%.

Swamy (1971) S homogeneity test is used. Swamy S test result shows that parameters are not homogenous for the equations (Table 6).

**Table 6.** Swamy S Homogeneity Test Results

| | High Income | Developing | Full Sample-Industrial | Full Sample - Africa&Indus. | Full Sample |
|---|---|---|---|---|---|
| | Prob>chi2 | Prob>chi2 | Prob>chi2 | Prob>chi2 | Prob>chi2 |
| **CAB-R&D** | 0.0000 | | 0.0000 | 0.0000 | 0.0000 |
| **EXP-R&D** | | | 0.0000 | 0.0000 | 0.0000 |
| **CAB-R&D-Reer** | | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| **CAB-R&D-Fbalance** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Second generation panel cointegration tests are grouped as homogenous and heterogeneous estimators. It is decided to use Gengenbach, Urbain and Westerlund panel cointegration (Gengenbach et al. 2016) since there is cross sectional dependency and parameters are not homogenous. The estimated cointegration test results can be seen in (Table 7). All variables are significant at 1% or 10% level, and there are cointegration relationships between R&D spending and current account balances for all country groups except the developing countries. But there are not any cointegration relationships between export and R&D spending, between current account balances, R&D spending and real effective exchange rate, between current account balance, R&D spending and fiscal balance.

**Table 7.** Gengenbach, Urbain and Westerlund Panel Cointegration Test Results

| | High Income | Developing | Full Sample - Industrial | Full Sample-Africa&Ind. | Full Sample |
|---|---|---|---|---|---|
| | P-val* | P-val* | P-val* | P-val* | P-val* |
| **CAB-R&D** | <=0.1 | | <=0.1 | <=0.01 | <=0.1 |
| **EXP-R&D** | | | >0.1 | >0.1 | >0.1 |
| **CAB-R&D-Reer** | | >0.1 | >0.1 | >0.1 | >0.1 |
| **CAB-R&D-Fbalance** | >0.1 | >0.1 | >0.1 | >0.1 | >0.1 |

Dynamic Ordinary Least Squares Mean Group (DOLSMG) estimator (Pedroni, 2001) is used to find out the long-term estimation of the cointegration model except for developing countries. Results show that all variables are significant 1% level, and there are cointegration relationships between current account balances and R&D spending. R&D spending is found to have positive and statistically significant long-run relationships with current account balances for high income, all countries except industrial, all countries except African and industrial, and all countries groups (Table 8). Beta is long-term parameter for the estimation between current account balances and R&D spending.

There are significant and positive long-run relationships between the R&D spending with current account balances for all country groups. Results show that R&D spending is an important factor for both developing and developed countries' current account balances to increase the surpluses or to decrease the deficits. Table 9 shows the results for all countries. From 37 high income countries there are 27 positive relationships and 19 of them significant positive relationships. From 27 developing countries there are 16 positive relationships and 12 of them significant positive relationships.

**Table 8.** DOLSMG Estimation Results

| | High Income | Full Sample-Industrial | Full Sample - Africa&Indus | Full Sample |
|---|---|---|---|---|
| | Beta | Beta | Beta | Beta |
| **CAB-R&D** | (4.554)*** | (3.016)*** | (1.813)*** | (3.29)*** |

Beta values are in parenthesis. *, **, *** İndicate significance at 10%, 5%, 1%.

This study supports, developing countries which suffer from current account deficits must give high priority on research and development. R&D will support developing countries' terms of trade and current account balance positions by helping them to produce higher technology products. Results also show higher number of high-income countries see positive effect of R&D spending on current account balances. 1% increase in R&D spending increases 3.29% current account surplus for all countries group, 4.55% for high income countries group, 3.016% for all countries except industrial countries, 1.813% for all countries except African and industrial countries group.

In developing countries highest R&D spending with significant positive effect in current account balances are: Russia 0.99%, Serbia 0.92%, S. Africa 0.83%, Bulgaria 0.76%, India 0.65%. In high income countries highest R&D spending are: S. Korea 4.8%, Sweden 3.3%, Germany 3.09%, Denmark 3.06%, France 2.2%, Singapore 1.94%, Slovenia 1.94%, United Kingdom 1.72% It can be easily seen that high income countries invest on R&D more than developing countries. And most of them see the benefit in their current account balances.

Negative and insignificant positive relationships may show that these countries cannot get pay back from R&D spending in their current account balances. Especially for these developing countries R&D spending may play an important role for their local market products rather than export products. One other alternative is R&D spending may be used for less value-added products in other words not high technology goods. And this doesn't help them to improve their current account balances. Similar possibilities can be considered for some of the high-income countries as well. Landesmann and Pfaffmayr (1997) argue for some industrial countries which had their major catching-up phases sometimes in the past, maybe less effective in their R&D effort. The reason could be the decreasing returns in their case to increased R&D efforts after the earlier high returns from catching up exhausted.

**Table 9.** DOLSMG Estimation Results and R&D Spending (2018) for all Countries

| # | Developing | Beta | t-stat | (%)GDP | High Income | Beta | t-stat | (%)GDP |
|---|---|---|---|---|---|---|---|---|
| 1 | Ukraine | 14.9 | (3.428)*** | 0.47134 | Ireland | 11.5 | (2.417)** | 1.14647 |
| 2 | Russia | 28.38 | (28.38)*** | 0.98988 | S.Korea | 1.685 | (2.485)** | 4.81009 |
| 3 | South Africa | 7.441 | (2.73)** | 0.83215[2] | Canada | 14.3 | (8.335)*** | 1.56625 |
| 4 | Tunisia | 52.99 | (9.095)*** | 0.60353[3] | Czech Rep. | 4.285 | (4.285)*** | 1.92829 |
| 5 | Bulgaria | 55.43 | (2.674)** | 0.76803 | Denmark | 7.782 | (11.29)*** | 3.06408 |
| 6 | India | 8.232 | (3.524)*** | 0.64998 | Estonia | 12.4 | (12.4)*** | 1.42515 |
| 7 | Kyrgyz Rep. | 39.47 | (4.829)*** | 0.10707[2] | Hungary | 28.46 | (5.274)*** | 1.55484 |
| 8 | Madagascar | 22.89 | (2.756)** | 0.01465[2] | France | .6379 | (2.663)** | 2.20002 |
| 9 | Mexico | 18.47 | (2.523)** | 0.31223 | Germany | 13.76 | (2.458)** | 3.09415 |
| 10 | Mongolia | 84.9 | (1.669)* | 0.10293 | Luxembourg | 13.64 | (15.46)*** | 1.23562 |
| 11 | Peru | 13.42 | (5.639)*** | 0.12704 | Poland | 5.084 | (1.832)* | 1.21228 |
| 12 | Serbia | 16.2 | (1.763)* | 0.92132 | Portugal | 7.035 | (1.919)* | 1.36552 |
| 13 | N.Macedonia | 3.833 | (.8959) | 0.36398 | Singapore | 13.51 | (2.24)** | 1.94431[2] |
| 14 | Armenia | 1.204 | (.0763) | 0.18913 | Slovak Rep. | 8.627 | (3.893)*** | 0.83252 |
| 15 | Belarus | 7.256 | (1.476) | 0.60817 | Slovenia | 3.89 | (5.761)*** | 1.94221 |
| 16 | Colombia | 33.28 | (1.612) | 0.23699 | Panama | 14.26 | (5.007)*** | 0.14699[2] |
| 17 | Egypt | -22.03 | (-7.127)*** | 0.72388 | Sweden | 15.25 | (3.767)*** | 3.33937 |
| 18 | Moldova | -13.3 | (-7.58)*** | 0.25498 | United King. | 21.53 | (3.458)*** | 1.72412 |
| 19 | Tajikistan | -28.63 | (-1.693)* | 0.09703 | Uruguay | 21.01 | (5.865)*** | 0.48393[2] |
| 20 | Turkey | -21.88 | (-3.267)** | 0.96105[2] | Israel | 2.531 | (1.256) | 4.95278 |
| 21 | Azerbaijan | -78.01 | (-2.626)** | 0.18484 | Italy | 1.032 | (.1124) | 1.39909 |
| 22 | Argentina | -57.88 | (-1.77)* | 0.54152[2] | Lithuania | 31.04 | (1.607) | 0.94496 |
| 23 | Brazil | -43.7 | (-2.102)** | 1.26326[2] | United States | 9.761 | (.9846) | 2.83766 |
| 24 | Costa Rica | -15.62 | (-1.899)* | 0.34736 | Malta | 18.05 | (1.01) | 0.57462 |
| 25 | China | -2.653 | (-.8515) | 2.18568 | Austria | 1.556 | (.741) | 3.17177 |
| 26 | Thailand | -28.02 | (-1.239) | 1.00403[2] | Japan | 4.172 | (.7702) | 3.26451 |
| 27 | Kazakhstan | -.1966 | (-.02789) | 0.12286 | Finland | 1.824 | (.6379) | 2.77381 |
| 28 | | | | | Netherlands | -15.5 | (-2.792)** | 2.16374 |
| 29 | | | | | Norway | -30.08 | (-3.045)** | 2.06985 |
| 30 | | | | | Spain | -10.23 | (-2.656)** | 1.237 |
| 31 | | | | | Romania | -22.99 | (-2.985)** | 0.5051 |
| 32 | | | | | Croatia | -18.7 | (-3.599)*** | 0.97489 |
| 33 | | | | | Iceland | -12.43 | (-5.308)*** | 2.02994 |
| 34 | | | | | Belgium | -6.965 | (-1.665)* | 2.82119 |
| 35 | | | | | S.Cyprus | -28.98 | (-1.432) | 0.55859 |
| 36 | | | | | Latvia | -45.2 | (-1.068) | 0.63068 |
| 37 | | | | | Greece | -.0923 | (-.01389) | 1.17732 |

t- statistics are in parenthesis. *, **, *** indicate significance at 10%, 5%, 1%. ([2]) for 2017, ([3]) for 2016.

## 5. Conclusions

This study aims to find out the long-run relationship between R&D spending and the current account balances. The panel data analysis is carried out for the period between 1996 and 2018. 64 developing and developed countries are included in the study. Panel cointegration is applied to test the long-run relationships. There are significant and positive long-run relationships between the R&D spending with current account balances for four different country groups. These country groups are high income, all countries except industrial countries, all countries except industrial and African countries, and all countries groups. 1% increase in R&D spending improves 3.29% current account surplus for all countries group, 4.55% for high income countries group.

This study contributes and extends the previous empirical studies in three ways. Firstly, the study tries to find out the role of R&D spending directly in current account balances. Other studies are concentrated on only the export or the high technology export. Secondly, in literature highest number of countries are included in this study. 64 developing and developed countries are included. 37 high income, 27 developing countries are added. Finally, results show R&D spending is an important factor for both developing and developed countries' current account balances, to increase the surpluses or to decrease the deficits. There are significant and positive long-run relationships between the R&D spending with current account balances for four different country groups. These country groups are high income, all countries except industrial countries, all countries except industrial and African countries, and all countries groups. Exports of goods and services is also added in the study to understand the relationship directly between R&D spending. But it is not identified any cointegration relationship. Fiscal balance, growth rate and real effective exchange rate are added in the current account balances equation as control parameters. But it is not identified any cointegration relationships for control parameters.

Results support developing countries which suffer from current account deficits must give high priority on research and development. R&D will support developing countries' terms of trade and current account balance positions. Results also show higher number of high-income countries see positive effect of R&D spending on current account balances. High income countries invest on R&D more than developing countries. And most of them see the benefit in their current account balances. From 37 high income countries there are 27 positive relationships and 19 of them significant positive relationships. From 27 developing countries there are 16 positive relationships and 12 of them significant positive relationships. Governments' policies to support R&D is key especially for developing countries which suffer from current account deficits.

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