AN ABSTRACT OF THE THESIS OF

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Title: The Effects of Population Age on Trade.

Abstract approved:

Patrick M. Emerson

This paper empirically examines the effects of population aging on international trade using a cross-country panel data set for a select group of 22 OECD countries. Other recent studies have examined the effects of population age on other economic variables such as growth, savings, and investment but none till now have considered age related effects on international trade. I use a simple linear empirical model to capture any age related effects on trade along with two different model specifications in this paper; one is a simple OLS and the other is a fixed effects linear trend adjusted OLS specification. The estimated results are then adjusted for heteroskedasticity and autocorrelation via the use of the Newey-West HAC estimator to account for problems common to cross-county panel data sets. I conclude that there is indeed, a positive and statistically significant (though not very robust relationship) between a country's

population age and its export to GDP ratio. There are no statistically significant effects on other total trade, trade balance or import variables.

The Effects of Population Age on Trade

by

Zack T. Peterson

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Zack T. Peterson, Author

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1 Introduction:

The average population age in the developed world is increasing at previously unobserved rates. Current low birth rates coupled with longer life expectancies in the developed world are generally responsible for this trend. Also, with the near retirement of the baby boomer generation the developed worlds labor supply is in real danger of decreasing and in extreme cases, such as Japan, the working age population has been decreasing since 1998. With an increasingly elderly population coupled with a slower growing and, in some cases, decreasing working population (as people begin to retire) this has the real possibility of retarding economic growth to the extent which economic growth relies on the size of the workforce.

Population aging might affects some key variables of economic growth such as consumption, investment, savings, and government spending in several ways. Older retired generations might be expected to spend less money than younger working ones as they generally have a lower income. Investment and savings might be expected to be less as money is taken out of savings because the old consume more than they produce, and government spending might increase as government entitlement programs such as social security and medical care have to be expanded as the population ages. Policies to counteract such trends include the encouragement of greater labor force participation, promote fertility, and increased international trade through more efficient trade policy. With this in mind, it is imperative that the

relationships between population aging and the components of economic growth such as consumption, investment, government spending, savings rate, and international trade be fully understood in order to make efficient well informed policy choices to minimize the potential welfare loss during this demographic transition. In this study I seek to empirically examine one of these relationships: the relationship between population age and international trade.

Some economists have already begun arguing that changes in the age structure of a population will affect some key economic variables such as growth rates, investment rates, income and consumption spending rates (see Lindh and Malmberg (1998) or Higgins (1998)). Indeed, there have been studies that have explored some theoretical and empirical aspects of the economic effects of an age related demographic shift. However, until relatively recently, this has not garnered much attention and has not been applied to the channel of international trade as far as I know.

Currently, the effects of the aging demographic of the population in developed countries is already being felt. Some of the most politically contentious issues in the United States and abroad have to do with rising healthcare costs which only increase at faster rates the older we get and the social security programs that were originally designed when the average life expectancy was around 62 years of age. Today that figure is more than fifteen years higher for many of the developed world economies. Tough political choices will have to be made in order to make the current

demographic age shifts economically sustainable in the long run so it is becoming increasingly important to understand more about the economic effects of an aging population in order to design more effective policies that reflect this new reality.

The future rates of population aging can be seen below in figure 1 with all developed countries expecting a large increase in the ratio of those above the age of 65 to that of the active working population.

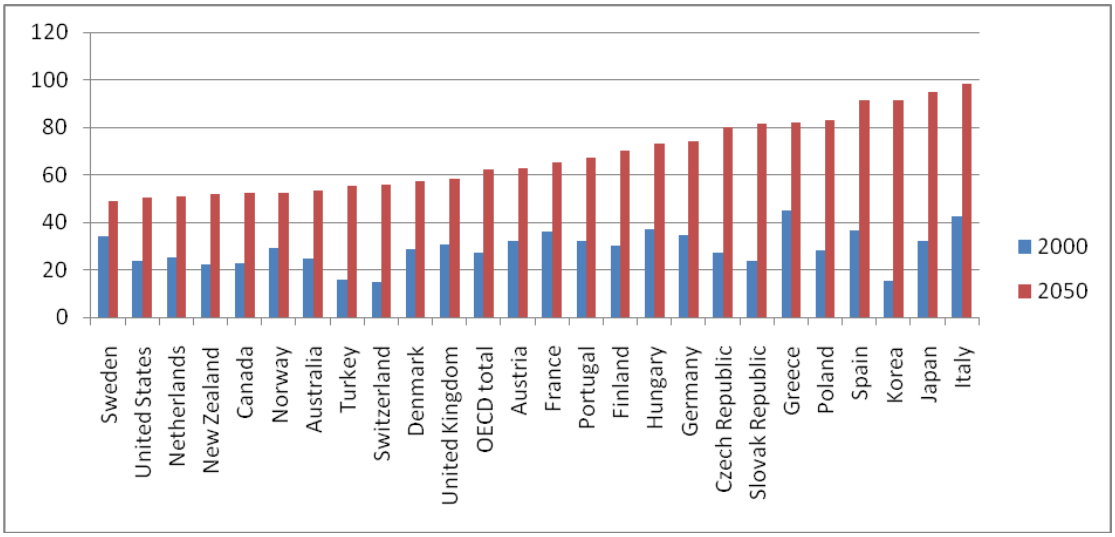

Figure 1: Ratio of the population age 65 and over to the active labor force.

After all, so far as economics is the study of the choices people make and the circumstances that have the potential to effect those choices, it becomes essential to periodically re-evaluate some basic economic models and concepts based on any new change in those circumstances. That is, the fundamental variables that might

characterize most choices should not be thought of as constant or homogeneous. Any new or unprecedented trend (social, demographic, political, or environmental) that has the potential of affecting the choices people make needs to be theoretically and empirically explored by economists. And the unprecedented population aging rates currently seen is among one of those fundamental core circumstances that has the possibility to affect economics through the basic channel of consumer choice and spending priorities. Also, to the extent that policy makers use economics to justify a particular policy, it becomes particularly important to keep abreast of the current trends in order to avoid the use of some potentially harmful policy choices that don't reflect the present reality or cause of a problem.

The rest of this paper proceeds with the following sections: Section II acquaints the reader with some of the background literature surrounding population aging as well as attempting to put this paper in the broader context of international trade literature. Section III presents some basic theoretical justification of the presumed effect of population aging on international trade under a set of highlighted assumptions. Section IV provides some information regarding the data and empirical model specification. Section V presents the results and provides a brief discussion. Section VI concludes and offers further topics and justification.

2 Literature review:

The potential effects of a large demographic shift have been studied before; theoretically, numerically and empirically. In its simplest form, from a theoretical point of view, any change in the demographic age structure has the potential to either increase or decrease the amount of labor in the workforce – a common factor of production in any model. Numerically, some of the first studies on population aging were conducted during the 1980's due to the perceived demographic footprint of the baby-boomers and the relative accuracy of forecasting age data. Empirically, the demographic shifts are just becoming observable in some data sets, particularly in Japan, and have garnered some recent attention as the developed world has to come to terms with the economic implications of baby-boomer retirement.

In terms of the literature that has grown up around the description of purely age related effects on nontrade specific economic variables we start with some numerical papers published in the late 1980's. These numerical approaches have been used to address the problems and predict the effects of population aging. Auerbach et al (1989) uses computer simulations based on past and forecasted demographic data in order to show how population aging effects the economic performance of Germany, Japan, Sweden and the United States up to the year 2050. First, they calibrate their model based on data up to 1985 for the four different countries and then they run simulations for a number of years up to 2050. They show that tax rates generally

increase as the countries age, social security contribution rates increase but eventually level off, savings rates for all countries decline, and real wages for every country, except Sweden, increase as capital labor ratios increase. Next, they simulate the effects of changes in policy. They simulate, for example, the raising in the retirement age by 2 years, a reduction in retirement benefits by 20%, and consider the case of an open economy. In the case of increasing the retirement age and decreasing the retirement benefits the authors show that welfare gains by some generations can only be achieved by welfare decreases in others. In simulating the open economy, increases in the Japanese and the United States saving rates are observed but not much else changes from the baseline results.

Another numerical/theoretical calibrated life cycle model was conducted using 18 OECD countries by Domeij and Floden (2006) in which the authors use a neoclassical growth model to track international capital flows in a world with exogenous demographic change. They find that, by ignoring all other factors that determine capital flows abroad and focusing on a model where those capital flows are generated by changes in a country's age structure alone, their model explains a small but statistically significant fraction of capital flows between the 18 selected OECD countries. They also find that their results generally improve if they focus on the time frame after 1985 as they argue that capital became universally more mobile after that year. Finally they then use their data to calibrate a capital flow forecast based on forecasted age data where they find that insights into how capital flows will behave in

the future if nothing else changes.

Starting relatively recently, some new empirical studies have taken advantage of the resulting demographic shift and began to look at the effects of age structure on several economic variables. Higgins (1998) empirically examines the relationship between national savings, capital flows, and population age structure for a panel dataset of 100 countries over 30 years. Higgins finds that dependency ratios for both the young and old are substantially associated with lower savings rates as well as lower current accounts. Also, in the following year, another paper was published relating economic growth to population age structure: Lindh and Malmberg (1999). This paper included five-year data from OECD countries over the forty years from 1950-1990 and concluded that the population aged 50-64 contributed positively to economic growth while the over 65 population had a negative impact on growth with ambiguous effects for other population cohorts.

In another paper by Lindh and Malmberg (2009), age cohorts along with other control variables included in the Higgins (1998) paper are used to explain investment and national savings rates for OECD countries only. This paper includes more data than any previous study on age effects and focuses on a narrow range of similar countries. The results of this paper are opposite of what Higgins concluded; namely that old age cohorts are associated with higher not lower savings rates. These differences are in part due to the narrowness of the sample size as well, perhaps, because of more detailed age data. This paper also examines the mechanisms through

which age might affect investment rates. For example, different sectors of investment (Private business, Housing, and inventory investment) were regressed on all control variables which conclude that age cohorts do effect different sectors of investment differently.

In terms of specific case studies, Japan has been used as a testing ground so-to-speak because of its extremely rapid demographic shifts over the last few decades. In fact, as pointed out earlier, the labor force in Japan has begun to decrease by about 1% every year since 1998 as the population ages and begins to retire as pointed out in a paper by Mak J. et al (2004) who studied the impact of population aging on Japanese international travel. It is important to note that Japan's demographic shift is an early harbinger of similar demographic changes for the rest of the developed world in the years to come.

Some other recent studies have focused on some possible solutions to some of the problems associated with population aging. Again, looking at the Japanese case, an OECD Economics Department paper by Jones (2008) looked at the possibility of reforming the Japanese labor market in order to stem the age related decrease of the workforce. The reforms necessary in order to combat population aging centers on the need to reduce the upward trend in non-regular employment as well as increasing the amount of childcare facilities and paying more attention to work-life balance in order to encourage more female labor force participation.

The literature that has grown up around demographic structure and trade is

relatively thin. In a recent theoretical work by Naito and Zhao (2009) they motivate their model off previous overlapping generational model studies and adapt it to a two-country, two-good, and two-factor model under some of the classic Heckscher-Ohlin assumptions regarding trade (trade is motivated by factor endowments). The theoretical literature usually addresses population aging as an exogenous variable and applies it to an overlapping generations model. They find that first, an aging country becomes the capital intensive good exporter and behaves like a small open economy while the younger country dominates the world economy by setting world prices. And second, even though they find that uncompensated trade cannot be Pareto superior to autarky, there does exist a compensation mechanism through which free trade is Pareto optimal compared to autarky. The authors then suggest that their model could be further improved under several different assumptions: treating population aging as an endogenous variable, make government act strategically with respect to trade policy, and the incorporation of the differentiated products assumption.

Other economic literature more specifically related to trade and not directly related to demographic effects are also suggestive and should be included in this report in order to provide us with some further intuition of, perhaps, indirect channels through which population aging might effect trade. One such trade-based literature centers around the gravity equation. Originally developed by Tinbergen (1962), this body of work uses a remarkably simple equation (with the same functional specification as that of Newton’s gravity model) that rather accurately predicts

bilateral trade between two countries. What the gravity equation suggests is that the volume of trade between two countries depends upon both countries relative sizes and their distance from each other. That is, trade should be positively related to the countries GDP/income and negatively related to the distance between them. Now, in relation to the population aging problem, the gravity model might suggest an indirect path through which age might effect trade through an aging countries output/income. As noted earlier, I suggest that older people have less income on average. By the use of the gravity framework alone, this would suggest that as income for the older country decreases then so to does trade volume.

More empirical studies that use the gravity equation framework in order to describe trades' effect on income include papers by Frankel and Romer (1999) and Frankel and Rose (2002). The former identifies a positive, robust and moderately significant effect of trade on income while the latter analyzes the specific effectiveness of using common currencies to increase trade and income. With this fairly well established positive relationship between trade and income, countries that are experiencing a decrease in earnings, possibly due to old age, might be expected to increase trade volumes as a means of increasing a diminishing domestic income.

Another interesting set of results studied via the gravity equation is the curious phenomenon of the home country bias first presented by McCallum (1995) who studied the bilateral trade between different Canadian provinces and trade between Canadian provinces and states in the United States. What he found was that intra

province trade was much larger than province to state trade even when distance and relative size were accounted for. This home country bias as it has come to be called has been subsequently studied and confirmed for numerous different countries. A natural question then, relating this home bias effect of countries and population aging, is whether or not the home bias effect diminishes as populations age.

3 Theory:

In order to provide the reader with some basic justification for how we might expect population aging to affect trade I offer three possibilities:

1. Simple demand shifts in a partial equilibrium model
2. Heckscher-Ohlin consequences for changing factor endowments
3. New trade theory economies of scale

In the context of a partial equilibrium model, domestic demand for a particular good can be disaggregated into two different demands (the demand of the working population and the demand of the old retired population). If we make the simplifying assumptions that the world price in this hypothetical market is constant and the older population has a more restrictive budget constraint then the quantity demanded by the older population is less than the quantity demanded by the younger population. As a consequence the price elasticity of demand for the older population is larger than that of the younger population. Retired people tend to be more sensitive to price changes due to the fact that they have less money to spend than the younger population on average. It's also conceivable that older people spend more of their money on price distorted services such as health care or save for bequest and as such, they don't participate as much in markets with tradable goods. And lastly, another assumption driving this little scenario would be the assuming away of any marginal productivity effects in the labor market or at the very least, assuming that any marginal change in

productivity is dominated by the loss of productivity that's a result of the loss of human capital due to retirement. This is contrary to standard labor market theory whereby if labor shrinks its productivity should increase thus total payments and thereby total consumption might not fall necessarily. This is not as unreasonable as it might first appear because wages tend to adjust slowly to labor supply shocks and there is a real possibility to observe changes in productivity if the rate of retirement outpaces the change in wages.

Now, if the ratio of the retired population to the working population increases *ceteris paribus*, we would expect that the domestic market's equilibrium quantity for this hypothetical good in this market would decrease. If this is an average representation for every trade-able good in the economy then output would decrease because domestic demand would be diminishing, becoming more elastic as the population ages. That is, in order for the firm in this simple model to grow, it would have to export relatively more of its products to a different market or shift its production overseas to more lucrative markets.

If companies expanded exports while the domestic demand diminishes with age then this has the potential to counteract some of the effects of the assumed aging problem on economic growth. In order to increase trade, one obvious solution is for the Government to reduce trade barriers (lifting tariffs and subsidies on goods). For instance, reducing trade barriers would re-allocate labor to more productive sectors of the economy and reduce prices of goods consumed. In the partial equilibrium

framework, this would have the effect of lowering the world price potentially increasing both home market consumption and the number of exports.

We might also expect the factor content of trade to change as well. Even though this is not, strictly speaking, a part of this study the decrease in labor via retirement will increase the capital labor ratio. According to the Hecksher-Ohlin model of trade, this change in endowments could cause an increase in the capital intensiveness of trade. By this reckoning, countries with decreasing working age populations become the relatively capital intensive exporters but this question is better addressed separately.

Another approach for addressing the potential pitfalls associated with population aging relies on some of the arguments about the production of goods put forth in the new trade theory originally developed by Krugman and expanded upon since the 1980s. In this case, economies of scale are an important factor in keeping firms costs down but as the labor force declines through the aging of the population, domestic firms begin to experience an upward movement along their average cost curves (See Krugman 1979) making them less competitive (especially in a Bertrand competitive setting) for one and would give these firms more incentives to find other export markets or to simply move production to other more lucrative markets with stronger demand and more labor. This has the potential to reduce domestic production and might lead to greater import quantities.

4 Empirical Model and Data:

This study uses a country cross section panel data set from 1971 to 2006 for 22 OECD countries: Australia, Austria, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The other members of the OECD that were left out of the data set were done so for one of two reasons: they either lacked data in one of the control variables for a sufficiently long period of time (Mexico, South Korea, and the former eastern block countries), or, they were clear outliers such as Luxembourg whose economy is relatively small and extremely interdependent on its neighbors. In the empirical model, I use the STATA computer software to regress several different trade measures on a number of control variable specifications and a measure of population age.

4.1 Empirical Model

The empirical model for this study and from which the OLS results, presented later in the results section, are derived from a form of the following empirical simple linear specification:

$$TRADE = \alpha + \beta_1 AGE + \beta_2 X + \varepsilon \qquad (1)$$

This specification was chosen in part because of the ease in which I could obtain the data and it addresses a country's overall trade and not just bilateral country trade as

the gravity model would necessitate.

The dependent variables in equation 1 are functions of three variables; exports, imports and GDP. Out of these three variables I construct four dependent variables; total trade, exports, imports, and trade balance all divided by GDP. This will allow me to study the various affects that age will have on all these measures of trade. First I want to see if there is a relationship between age and total trade. Then I want to break this relationship up and test the effect of age on the components of total trade (exports and imports). And lastly, I would like to see if there is any age relationship with the trade balance.

The AGE variable in equation 1 can be any measure of a populations age but for this study, the AGE variable is the ratio of a country's population over the age of 65 to the working population. This is a crude measure that hopes to capture the retirement effect.

Also, in equation 1, X is the set of control variables in order to specify the model and avoid the econometric problems associated with underspecification. The control variables used to characterize this model are; Growth, Capital, Size, Education, fixed effect dummy variables for both time and country, and a linear trend variable. The Growth variable represents the economic growth in %GDP because growth has long been considered to effect trade though the effect has been considered to be endogenous (see Frankel Romer (1999)). Capital and Education are variables that specify the theoretical importance of both physical and human capital in

determining trade which is extensively talked about in the Hecksher-Ohlin trade literature specifically. Tertiary education was chosen to represent human capital in this model because it can be argued that a college education is of more economic importance than primary or secondary education in today's world for developed economies. Finally, the size variable is an attempt to introduce the importance of a country's size in determining trade from the gravity model specification and the new trade theory which suggests that a countries size is important in determining trade flows (see Krugman (1980)). The fixed effect dummies account for any unobserved or unobservable variables and take the value of 1 for a specific year or country and zero otherwise. The linear trend variable for a specific country takes the value of 1 for 1971, 2 for 1972… and 36 for 2006. This is an attempt to capture any effects that are specific to a country and increases linearly with time rather than being time invariant. Other variables such as more detailed age cohorts might also be added to this empirical specification for a more in depth look at different age effects on trade. Some other explanatory variables were considered but did not significantly affect the AGE variable.

In all estimations I use cross-country panel data. Included in some regressions are country dummies that control for country specific, yet unobserved fixed effects, due to cultural, geographic, and institutional differences that are fixed over time but vary across countries. Also included in some regressions are time dummies that control for time specific unobserved effects that vary across time such as business

cycle noise.

Descriptions of the variables used and from where they were obtained are listed below:

- Trade dependent variable set (OECD country statistical database stats.oecd.org)

  exports/GDP

  imports/GDP

  (exports-imports)/GDP

  (exports+imports)/GDP

- Age (OECD country statistical database stats.oecd.org)

  Ratio of the population aged 65 and over

- Growth (OECD country statistical database stats.oecd.org)

  Percentage of annual growth of real GDP

- Capital (OECD country statistical database stats.oecd.org)

  Gross fixed capital formation percentage of GDP

- Size (OECD country statistical database stats.oecd.org)

  Ratio of country real GDP by sample real GDP

- Education (UN database)

  Tertiary enrollment rate (These data were slightly extrapolated as they were only available in 5 year increments from 1970 to 1980 so I made them linearly increasing for those years in-between (1971-74 and 1976-79))

Summary statistics are presented below in table one in order for the reader to get a feel for the data that was used.

Table1: Summary Statistics (all in percents)

Variables	Max	Min	Mean	Std. Dev.
Export/GDP	72.5	1.4	21.9	13.5
Import/GDP	56.1	2.3	22.6	11
Exp-imp/GDP	28.3	-23.4	- 0.7	5.8
Exp+imp/GDP	92.2	4.2	29.156	13.29
Age	20.8	4.2	12.975	3.04
Growth	13.1	-7.3	2.97	2.475
Capital	37.1	14.8	22.486	3.978
Size	37.8	0.02	3.82	6.82
Education	95.211	4.974	38.248	20.862

4.2 Statistical issues:

Some potential problems that confront any macroeconomic cross-country panel data are those of parameter heterogeneity, autocorrelation and heteroskedasticity. In the case of addressing parameter heterogeneity, the selection the 22 OECD countries with broadly similar institutional setups should go a long way to alleviate this problem. As a further precaution, I also create a linear trend variable in the model specification that controls for this issue. To address the other two concerns, standard errors and t-statistics are computed using the heteroskedasticity and autocorrelation consistent (HAC) estimator developed by Newey-West (1987).

Heteroskedasticity might be a problem in that, when we have various different countries in the sample (the United States and Australia for example) they will

certainly have very different trade volumes and most likely different variances associated with those volumes of trade. Secondly, autocorrelation is common to a lot of time series estimates. Trade in 1972 for example, might indeed, partly depend on the amount traded in 1971 for any given country and so on. Both autocorrelation and heteroskedasticity do not cause estimation bias or inconsistency but, rather, cause the standard errors to be underestimated and thus prevent the researcher from being able to confidently identify any statistically significant results. What the Newey-West HAC estimator does, is correct for both these problems by adjusting the covariance matrix of the models estimated parameters.

The results that are reported are OLS instead of the perhaps theoretically more appropriate but less robust GMM model specification. After all, it is known that OLS fixed effects estimates, when applied to a dynamic panel, are biased but that bias tends to zero as time is allowed to increase while the cross country dimension remains fixed (Nickel, 1981). In our case the bias would be 1 over 36 and would only get smaller as more time periods are considered. This is not cause for much concern considering that the estimates obtained were a good deal larger than this bias. It is also reported from Attanasio, Picci and Scoru (2000) that dynamic panel model estimation bias when using OLS is generally so small that the trade-off of precision to that of the less robust GMM estimators generally favors OLS estimates.

5 Results:

5.1 Main Results

Using methodology explained in the previous section, OLS estimates for each parameter are obtained for a variety of specifications of equation (1). Also described in the previous section, the t-statistics are corrected for autocorrelation and heteroskedasticity using the Newey-West HAC estimator. Results are displayed in Table 2 below.

Table 2: Total trade OLS estimates of several specifications

	OLS	OLS	OLS	OLS FE trend	OLS FE trend	OLS FE trend
Dependent variable: Exp+Imp/GDP	1	2	3	1	2	3
Intercept	12.27 (4.87)	29.32 (5.95)	24.56 (4.78)	9.92 (3.66)	15.18 (1.33)	17.20 (1.46)
Age >=65 %	**1.11** **(6.53)**	**1.00** **(5.39)**	**0.735** **(4.00)**	0.356 (1.82)	0.310 (1.51)	0.069 (0.34)
Growth	**0.800** **(2.74)**	**0.856** **(3.18)**	**0.792** **(2.98)**	**0.248** **(4.71)**	**0.260** **(4.71)**	**0.254** **(4.55)**
Capital		**-0.543** **(-3.93)**	**-0.344** **(-2.28)**		-0.046 (-0.78)	-0.0267 (-0.45)
Size		**-0.937** **(-13.21)**	**-1.01** **(-13.89)**		-0.096 (-0.36)	-0.130 (-0.47)
Enrolment rate (tertiary)			**0.114** **(3.66)**			0.021 (0.92)
N	792	792	756	792	792	756
R^2	0.0684	0.1136	0.1142	0.9763	0.9848	0.9862
F value	24.31	68.59	90.23	339.96	342.41	348.63
p-value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

Note: All tables presented form here on out have the following addendums: Results in bold are significant at the 5% level. Newey-West t-statistics are presented in parenthesis. All regressions except for the ones containing enrolment rate include the full sample of 22 OECD countries for 792 observations. The regressions containing the enrolment rate variable exclude data from Germany due to its unavailability and so contains 756 observations.

In Table 2 I report coefficient estimates for different specifications under the OLS framework (first three columns) as well as fixed time/country effects and an assumed linear trend variable (last three columns). Since the standard errors were corrected for heteroskedasticity and autocorrelation I report those adjusted t-statistics in parenthesis for all estimates (bold values represent significance at the 5% level). Also note that the last column 3 in both the OLS and OLS FE trend cases excludes data from Germany due to lack of data for a sufficiently long period of time.

The standard pooled OLS results in the first three columns indicate that there is a positive and statistically significant effect of the age variable on total trade. Growth also has a positive and significant effect for all three of the first columns. Capital and size on the other hand appear to have a negative and significant effect on total trade and when tertiary enrolment rate is added it has a positive and significant effect on total trade.

However, there are many legitimate reasons to be concerned with the results obtained in the first three columns. For one, total trade can be affected by country specific effects that are not included in the regressions for the first three columns and will lead to all the problems associated with model misspecification. That is, unobserved variables such as cultural, geographic and institutional differences that vary across countries but are fixed across time. The same can also be said about time specific effects that are unobserved variables that vary across time but not by country such as business cycle noise. Finally, there is also real danger that parameters will be hetero-

geneous over time. In this case, the parameters of the variables for a given country might increase or decrease over time. Therefore, I address these concerns in the OLS fixed effects with a trend variable presented in the last three columns in table 2.

In the last three columns in table 2, the F-statistic tests whether or not the fixed effects and trend variables are important. From the high F-statistic values we can conclude that these effects are important at a very high level. We can also see that the AGE variable is positively related to trade and achieves significance at the 10% level in the fourth column in table 2 though it not at a very high significance level for the other specifications. Growth is still positive and significant for all specifications while capital, size and education all lose their statistical significance.

From a practical point of view, if we only look at the statistically significant parameters in the last column in table 2 we can conclude that a 1% increase in economic growth will cause a 0.254% increase in total trades share of GDP. Given this dataset we can't really say, with confidence, anything about the change in magnitude with respect to a change in the population over the age of 65 but it does tend to have a positive relationship with the total trade. Next we should probably look at the various constituents of total trade (exports and imports) in order to see if there is a significant age effect on either of those variables.

Table 3: Export/GDP OLS estimates of several specifications.

	OLS	OLS	OLS	OLS FE trend	OLS FE trend	OLS FE trend
Dependent variable: Exp/GDP	1	2	3	1	2	3
Intercept	1.06 (0.45)	18.85 (3.99)	13.35 (2.60)	0.518 (0.14)	3.06 (0.22)	4.60 (0.34)
Age >=65 %	**1.48** **(8.97)**	**1.35** **(7.48)**	**0.905** **(4.98)**	**0.730** **(2.91)**	**0.601** **(2.45)**	0.464 (1.78)
Growth	**0.533** **(1.81)**	**0.620** **(2.20)**	0.522 (1.91)	**0.155** **(2.87)**	**0.221** **(3.96)**	**0.227** **(4.04)**
Capital		**-0.609** **(-4.16)**	**-0.352** **(-2.21)**		**-0.334** **(-5.09)**	**-0.320** **(-4.66)**
Size		**-0.697** **(-13.49)**	**-0.835** **(-14.30)**		0.150 (0.45)	0.258 (0.80)
Enrolment rate (tertiary)			**0.161** **(4.68)**			**-0.051** **(-2.68)**
N	792	792	756	792	792	756
R^2	0.0783	0.1467	0.1477	0.9686	0.9713	0.9737
F value	40.33	72.01	63.24	169.77	188.65	187.13
p-value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

Now, changes in the AGE variable are both positive and significant at the 5% level for the first five columns and at the 10% level for the last column. This was in fact, the original hypothesis: that as a country gets older they would begin to export more or at least exports would become a relatively more important share of GDP. And in terms of the magnitude of this effect, a 1% increase in the percentage of people over the age of 65 will cause between a 0.46% to a 0.73% increase (depending on the specification used in the last three columns) in the amount of exports as a percentage of GDP. The growth variable is once again both positive and significant throughout. Capital is negative and significant for all regressions with its inclusion while size ceases to be a significant variable in the last two regressions. Another interesting

outcome presented in this table has to do with the sign change of the tertiary enrollment rate variable as we move from a simple OLS to an OLS fixed trend effects model. It's positive in the first case and, perhaps more realistically, negative in the second case as people stop working when they enroll in school instead of producing exportable goods perhaps.

Table 4: Import/GDP OLS estimates of several specifications.

	OLS	OLS	OLS	OLS FE trend	OLS FE trend	OLS FE trend
Dependent variable: Imp/GDP	1	2	3	1	2	3
Intercept	4.81 (2.38)	11.01 (2.74)	7.66 (1.78)	13.11 (3.81)	33.38 (1.92)	33.98 (1.89)
Age >=65 %	**1.27** **(9.06)**	**1.24** **(8.69)**	**1.06** **(7.26)**	0.313 (1.45)	0.281 (1.20)	0.221 (0.83)
Growth	**0.421** **(2.12)**	**0.410** **(2.22)**	0.356 (1.94)	**0.282** **(5.86)**	**0.244** **(4.99)**	**0.242** **(4.82)**
Capital		-0.150 (-1.16)	-0.013 (-0.09)		**0.254** **(2.58)**	**0.254** **(2.53)**
Size		**-0.642** **(-10.84)**	**-0.697** **(-11.77)**		-0.642 (-1.57)	-0.675 (-1.59)
Enrolment rate (tertiary)			**0.080** **(3.09)**			0.016 (0.70)
N	792	792	756	792	792	756
R^2	0.0153	0.1038	0.1076	0.955	0.9601	0.9614
F value	41.71	58.85	50.92	134.84	134.48	126
p-value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

This last set of results shows that the AGE variable, once again, is no longer significant and this can perhaps account for the lack of any significant AGE effect finding in the trade balance and the total trade regressions. Growth, however, is both positive and a significant factor in determining exports and imports. Another

intriguing result comes from the positive and significant impact of capital on imports. This suggests that countries are importing capital rather than just pure consumption goods. Finally, both size and education cease to be important when determining imports.

Next in table 5 I regress the trade balance on the set of age and control variables to see if there is any effect of age on a country's trade balance

Table 5: Trade balance OLS estimates of several specifications

	OLS	OLS	OLS	OLS FE trend	OLS FE trend	OLS FE trend
Dependent variable: Exp-Imp/GDP	1	2	3	1	2	3
Intercept	-3.75 (-3.78)	7.84 (3.91)	5.68 (2.48)	-12.60 (-3.50)	-30.31 (-2.49)	-29.37 (-2.49)
Age >=65 %	**0.210** **(2.85)**	0.105 (1.41)	-0.160 (-1.90)	0.416 (1.64)	0.320 (1.44)	0.243 (1.01)
Growth	0.112 (0.84)	0.209 (1.63)	0.166 (1.35)	**-0.126** **(-2.73)**	-0.023 (-0.55)	-0.014 (-0.35)
Capital		**-0.458** **(-5.95)**	**-0.339** **(-3.96)**		**-0.588** **(-8.20)**	**-0.574** **(-8.13)**
Size		-0.055 (-1.77)	**-0.137** **(-3.72)**		**0.793** **(2.74)**	**0.934** **(3.36)**
Enrolment rate (tertiary)			**0.081** **(4.20)**			**-0.068** **(-4.85)**
N	792	792	756	792	792	756
R^2	0.0118	0.1036	0.1047	0.8611	0.8967	0.9012
F value	4.12	9.85	10.43	54.43	51.07	50.78
p-value	0.0166	<.0001	<.0001	<.0001	<.0001	<.0001

If we only look at the statistically significant parameters in the last column in table 2 we can conclude that a 1% positive capital investment will cause a 0.57% decline in the trade balance, a 1% increase in country size will cause a 0.93% rise in

the trade balance, and a 1% increase in tertiary enrollment rate will cause a 0.07% decrease in a country's trade balance as potential workers enroll in school perhaps. Given this dataset we can't really say, with confidence, anything about the change in magnitude with respect to a change in the population over the age of 65 but it does tend to have a positive relationship with the trade balance. Also the growth variable ceases to be significant for most of the regressions in table 5.

5.2 Robustness:

In terms of the robustness of these results it is worth pointing out that the conclusions we can arrive at depend on our model specification. In Table 6 below I present the results of the fixed effect model without any linear trend term.

Table 6: Export OLS fixed effects estimates.

	OLS FE
Dependent variable:	Exp/GDP
Intercept	63.37 (10.32)
Age >=65 %	**-0.912** **(-4.25)**
Growth	**0.378** **(3.96)**
Capital	**-0.276** **(-3.24)**
Size	**-0.941** **(-6.65)**
N	792
R^2	0.9357
F value	109.13
p-value	<.0001

If you compare these results from those of table 3 you can see that the sign of the AGE variable changes from being positive in table 3 to negative in the above table 6. That is, the results are not very robust and the conclusions one can derive depend on the model specification used. This discrepancy could be because there is indeed a linear trend and this trend effect causes the sign difference. However, the results presented with the addition of the linear trend variable in table 3 is the least naïve of the models considered in this paper and so my conclusions are based off of those results.

6 Conclusions:

This study finds that as the ratio of the population over the age of 65 increases so does the export to GDP ratio. However, this study has difficulty finding any significant old age effects on some of the broader trade measures that are functions of three variables; exports, imports, and GDP. That said, when regressions are performed on exports divided by GDP alone, we see that the old age variable has a positive and significant effect on exports to GDP ratio. And not surprisingly, when regressions are run using the ratio of imports to GDP alone, we see a non significant effect of old age on imports. I also concede that these results are not very robust and depend on model specification.

According to these empirical results, an increase in the population share of those 65 years or older will have a positive effect on the exports per GDP ratio and increase the relative importance of exports for that country. In terms of the theoretical framework presented in this paper, this would simply mean that companies are exporting relatively more and more of their products due to a decrease in domestic demand. In terms of the policy implications of these findings, it might behoove policy makers in older developed countries to try and devise policies to increase the amount of exports as this can be an important driver of economic growth. Japan for example, the country with the highest ratio of 65 year olds on the planet, relies heavily on exports as a means of driving economic growth. On the other hand, any trade policy

that might restrict the amount of exports has the danger of creating incentives for companies that did operate domestically to leave and operate in a country with stronger market conditions causing a loss of domestic job opportunities and tax revenues.

Though this study does provide some justification and evidence that a country with a higher ratio of people over the age of 65 will export more, there are still some concerns over the validity of the empirical work. For one, it appears that the problem of parameter heterogeneity might still be a problem and causes inconsistent parameter estimates based on the choice of regression and model selection. Secondly, autocorrelation and heteroskedasticity might not have been dealt with rigorously enough and may still cause inflated t-statistics which might undermine the significance of my findings.

Finally, though this empirical study was designed to find out if there was any age related effects on international trade, the mechanisms through which this effect occurs is not at all well understood. Some future research in this area might include more detailed age data in order to see the effects of different population age cohorts on trade and, perhaps, the inclusion of more detailed trade data by industrial classification in order to possibly identify any sectors that are particularly sensitive to age related shocks. It might also be possible to extend this study using other proven empirical model specifications for determining trade flows such as the use of the gravity equation in a panel or other data setting. All of these suggestions and more are

possible ways in which to expand on this literature; the effects of age on trade.

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