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Cross-Border Portfolio Diversification under Trade Linkages

(Nemzetközi portfolió-diverzifikáció és kereskedelem)

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Abstract

This study uncovers a cross-border financial diversification motive related to goods and services trade. Using the IMF CPIS panel data set for a broad set of country pairs and for the period 2001-2012, I find empirical evidence that *the share of equity in a bilateral portfolio decreases with bilateral trade*. An important driving force behind this pattern are holdings of foreign debt, i.e. increasing trade intensity is strongly related to increasing holdings of foreign debt and less so to holdings of foreign equity. The empirical findings are in line with the predictions of a calibrated two-country two-goods portfolio choice model where in equilibrium equity is used to hedge against supply shocks and real bonds are used to hedge against a global preference shock. For reasonable parameter values, strengthening trade linkages induce the risk-averse representative agent to adjust her portfolio of foreign assets away from foreign equity and towards foreign bonds.

JEL: F21, F36, F41, G11.

Keywords: Cross-Border Portfolio Choice, Equity and Debt, Two-Country Two-Goods Model, Coordinated Portfolio Investment Survey (CPIS).

Összefoglaló

A tanulmány a nemzetközi áru és szolgáltatás kereskedelem és a határokon átnyúló portfolió-allokáció kapcsolatát járja körül. Az IMF CPIS bilaterális paneladatbázisnak használatával azt találjuk a 2001 és 2012 közötti időszakra, hogy a bilaterális kereskedelem növekedésével csökken a bilaterális portfóliókban a részvények aránya. A részvények portfolió-beli alacsonyabb arányával egyidőben azonban magasabb lesz a külföldi adósság aránya (kötvények), vagyis az intenzívebb kereskedelem magasabb külföldi kötvényállományt implikál. Az utóbbi empirikusan megfigyelhető kapcsolat jól magyarázható egy két országot és két jószágot tartalmazó portfolió-választási készlet modellel, amelyben a részvényeket a kínálati sokkok míg kötvényeket a globális preferencia sokkok elleni hedge-ként használják. Plauzibilis paraméter értékek esetén, az intenzívebb kereskedelem arra készteti a kockázat-elutasító reprezentatív háztartást, hogy növelje a portfóliójában a kötvények arányát a részvényekhez képest.

1 Introduction

During recent decades cross-border asset holdings have risen strongly while also a high level of cross-border goods and services trade can be observed. An important question that arises is how cross-border asset holdings and goods and services trade are related to one another. This paper aims at looking at this issue by emphasizing that investors are typically concerned with the *composition* of a portfolio that contains both risky assets (equity) and relatively safe assets (debt securities). This distinction is important since debt-driven vs. equity-driven financial integration tend to have different implications for macroeconomic outcomes and financial stability.[1] This study examines the extent to which cross-border goods and services trade is related to the cross-border portfolio composition between equity and debt. In particular, I examine the relationship between goods and services trade and the *share of equity in a bilateral portfolio* which is a very useful measure of cross-border diversification but has not yet gained much attention in the empirical or theoretical literature.

The main contribution of this paper is the uncovering of a cross-border diversification motive that is related to trade linkages. By using the IMF Coordinated Portfolio Investment Survey (CPIS) panel data set for a broad set of country pairs over the sample period 2001-2012, I find that *the share of equity in a bilateral portfolio decreases with bilateral goods and services trade*. For a typical country pair, a 1 percentage point increase in bilateral trade (measured as the value of bilateral trade in terms of a source country's GDP) is related to a decrease in the share of equity in the bilateral portfolio of around 0.9 percentage points. I also find that strengthening trade linkages are strongly linked to rising foreign debt holdings and less so to foreign equity holdings. Bilateral goods trade and bilateral debt-holdings are significantly positively related across various empirical specifications. In comparison, the relationship between bilateral goods trade and bilateral *equity* holdings is always smaller and found to be negative in the case when the according variables are normalized by country aggregates.

I show that the empirical findings are in line with the predictions from a calibrated two-country two-goods endowment model with frictionless financial trade in equities and real bonds. The benchmark model is very similar to the model of Devereux and Sutherland (2010) who study the role of the terms of trade for the external valuation channel. The set up is that each country is endowed with a country specific good that consists of a capital income component and a labour income component. The model allows for supply shocks to the capital and labour income components, imperfect correlation between these supply shocks and a global preference (demand) shock. Each country issues equity which is a claim on future capital endowments and real bonds which, once purchased, pay one unit of the respective country specific good in each period. The degree of steady state home bias in consumption determines the steady state level of trade intensity versus the partner country.

As is relatively standard, in the calibrated model a positive domestic supply shock induces domestic terms of trade to deteriorate, thereby positively affecting the partner country. This effect is amplified with rising trade intensity, implying less need for diversification in equity. This mechanism builds on the work of Cole and Obstfeld (1991) who find that terms of trade movements can potentially even fully insure against supply shocks. Another crucial ingredient of the model is the global preference (demand) shock, introduced as exogenous disturbance to the weight of domestic goods in domestic consumption. This shock is conceptually very different from the supply shocks. When there is a favourable demand shock for the domestic good, the price of the domestic good rises. The terms of trade response is therefore proportional to the relative returns on the real bonds, making foreign real bonds a good hedge against demand shocks. This effect is amplified with a higher trade intensity so that domestic holdings of foreign bonds increase with trade. This all plays an important role in rationalizing the empirical fact discovered in this study, namely that holdings of foreign debt – which are the empirical counterpart to holdings of foreign bonds in the model – are strongly increasing with trade and the share of equity in a bilateral portfolio is decreasing with trade.[2]

The results of this paper relate to a larger literature that is studying the effects of cross-border capital flows and in particular the role of equity versus debt securities. In general, both debt and equity are means of risk-sharing but are conceptually

[1] There is, for example, some evidence that large foreign debt inflows were a major contributor to the boom in credit growth that preceded the recent financial crisis. Cf. discussion below!

[2] As discussed in Coeurdacier et al. (2009), demand shocks can also be interpreted as a change in preferences for goods varieties. As emphasized by Hamano (2015), fluctuations in varieties are an important source of consumption risk, especially in recent years in which the pattern of goods trade is mainly driven by very volatile changes in product varieties (*cf. inter alia* Broda and Weinstein (2004) and Broda and Weinstein (2006)).

very different. Equity investors share profits and losses while debt investments are typically relatively risk free and provide a fixed future income. In an international context, an expansion in debt securities tends to have different implications than an expansion in equity securities. Quadrini (2015) emphasizes that large foreign debt inflows increase the probability of a financial crisis because of asymmetric information in the domestic market for credit. Lane and McQuade (2014) document that domestic credit growth is largely driven by foreign net debt inflows, while foreign net equity flows do not play any particular role. Favara and Imbs (2015) find that increasing credit supply leads to rising house prices. The latter phenomenon is intensively debated when it comes to find origins of the recent financial crisis. There is, for example, evidence that rising house prices endanger financial stability (*cf.* Jorda et al. (2015)). In a different context, Davis (2014) argues that when two countries are integrated in debt-markets than this affects the comovement of their business cycles positively while if they are integrated in equity markets than this affects the comovement of their business cycles negatively. All these findings make it particularly important to question why cross-border portfolio investment is sometimes equity-driven and sometimes debt-driven. The contribution of this paper is to give an answer that is related to goods and services trade.

The empirical results add to a number of empirical papers that study the determinants of cross-border asset holdings and, in particular, the role of goods and services trade. In a seminal paper, Lane and Milesi-Ferretti (2008) find that bilateral equity holdings are increasing with bilateral goods trade. Similar findings are obtained by Aviat and Coeurdacier (2007) and Heathcote and Perri (2013). Coeurdacier and Guibaud (2011) and Pericoli et al. (2013) find that the effect of trade on bilateral equity holdings is reduced after controlling for measures of the correlation of the domestic stock market versus the partner country's stock market or measures of the comovement of the domestic and partner country's business cycles, respectively. The evolution of cross-border holdings of debt securities has received less attention. Some contributions study the determinants of home bias in debt, equivalent to the well documented equity home bias. Fidora et al. (2007) find a positive effect of real exchange rate volatility on the home bias in asset holdings, especially for home bias in debt but also for home bias in equity.

Most of the empirical evidence in this literature is based on cross-sectional analysis and fewer studies focus on the analysis of a panel of country-pairs. Pericoli et al. (2014) emphasize that the main drawback of cross-sectional regressions is that they insufficiently account for country-pair heterogeneity. These drawbacks can be overcome when working with a panel, which is possible for the IMF CPIS data. An appropriate way to account for heterogeneity is, for example, to include country-pair fixed effects. Also, normalizing the variables such that they are better comparable across country pairs helps to control for heterogeneity (cf. Pericoli et al. (2013)).

The major evidence presented in this study is based on panel regression analysis that includes country-pair fixed effects. This overcomes heterogeneity problems and also implies that the evidence is based on time-variation results. The main empirical finding therefore indicates that when a country pair intensifies trade over time, there is an associated decrease in the share of equity in the bilateral portfolio. Interestingly, I find that, when properly accounting for heterogeneity and looking at the time variation, the relationship between goods and services trade and the amount of holdings of foreign equity is more mixed than is suggested in the literature. In particular, when bilateral equity holdings as the dependent variable are normalized by total equity holdings of a source country, country pairs that have no relevant investment relationship are excluded and it is accounted for country-pair fixed effects in the regression, then the relationship between goods trade and foreign equity holdings is significantly negative. On the contrary, the relationship between goods trade and holdings of foreign bonds is always significantly positive.

Concerning the theoretical literature, there are a number of contributions that predict a positive relationship between holdings of foreign assets and foreign goods trade. In a seminal contribution, Obstfeld and Rogoff (2000) make the point that lower iceberg transportation costs reduce frictions to imports and thereby lead to a higher demand for foreign assets. They argue that in this way frictions to goods trade can also explain frictions to financial trade. This implies that a transport cost induced bias towards the domestic good rationalizes the well documented bias towards domestic equity (equity home bias). Lane and Milesi-Ferretti (2004) generalize this model to a N-country set up which supports their empirical cross-section result discussed above. Coeurdacier (2009), however, shows that for more general and realistic assumptions than those made by Obstfeld and Rogoff (2000), the relationship is reversed, such that lower iceberg transportation cost lead to a bias towards *foreign* equity instead of domestic equity.

In a model with production of country specific goods, capital accumulation and trade in equity, Heathcote and Perri (2013) show that returns to investment and returns to labour income are negatively correlated. Domestic equity is therefore a good hedge against labour income risk. The effect is amplified with rising trade intensity, thus making the case for a positive link between goods trade and cross-border equity holdings. There are a number of further explanations for such a positive relationship,

including gravity (Okawa and Wincoop (2012)), informational frictions (Portes and Rey (2005)) or endogenous costs of default related to trade (Rose and Spiegel (2004)). The last explanation is more related to holdings of foreign debt than to holdings of foreign equity. The empirical evidence in favor of the predictions of these models is based on cross-section results and not on results of fixed effects panel regressions that would allow for analysing variation within a country pair.

The role of equity vs. debt has gained increasing attention in the theoretical literature. One branch of this literature builds on the typical international macro models in which the terms of trade mechanism plays an important role (*cf. inter alia* Pavlova and Rigobon (2010); Coeurdacier et al. (2009); Coeurdacier et al. (2010); Devereux and Sutherland (2010); Coeurdacier and Gourinchas (2011)). The main aim of these papers is to explain the well documented equity home bias by including bonds or to study the external valuation channel. None of these studied aims at examining the relationship between goods trade intensity and the *composition* of foreign equity versus foreign debt. In this study a set up borrowed from Devereux and Sutherland (2010) is employed for exactly this purpose. The model counterpart of observed holdings of foreign equity and foreign debt are holdings of foreign equity and foreign real bonds. Trade intensity is determined by the degree of home bias in consumption. Importantly, the two-country structure of the model is consistent with the empirical model where it is focused on time-variation and within country-pair analysis.[3]

The rest of the study is organized in the following way: In the next section the econometric approach is described and the main empirical results of this study are discussed. In section 3 the model setting is introduced. In section 4 the quantitative analysis as well as a sensitivity analysis are conducted. Section 5 concludes.

[3] Cf. Coeurdacier and Rey (2013) for a more detailed review of the literature.

2 Empirical Link between Trade Intensity and Cross-Border Portfolio Diversification

In this section I examine the empirical relationship between the share of equity in a bilateral portfolio and bilateral goods and services trade. I also examine the extent to which bilateral equity and/or bilateral debt holdings are shaping this link. It is thereby taken advantage of the panel structure of the IMF CPIS data (which is described in more detail below). This allows studying the role of changing trade intensity for portfolio diversification for a broad set of country pairs. By doing so it can be controlled for time-invariant heterogeneity by including country-pair fixed effects.[4]

In the following, it is always taken the perspective of the so called *source* country. A source country is a country that holds equity and debt securities from many *host* countries. Host countries are the countries that issue equity and debt securities. One observation point describes the relationship between one source country versus one host country from the perspective of the source country.

In the baseline specification the following fixed effect models is employed:

$$equityshare_{AB,t} = \alpha + \beta'_{trade} trade_{AB,t} + \beta'_{controls} x_{AB,t} + \delta_t + \gamma_{AB} + u_{AB,t} \quad (1)$$

where γ_{AB} denote country pair fixed effects with $\sum_{AB} \gamma_{AB} = 0$. Time dummies δ_t are included in order to control for a common trend and $u_{AB,t}$ is the error term.

The dependent variable is the *share of equity in a bilateral portfolio* which is defined as

$$equityshare_{AB,t} = \frac{equity_{AB,t}}{equity_{AB,t} + debt_{AB,t}} \quad (2)$$

where $equity_{AB,t}$ is the absolute amount of country *B* issued equity that is held by country *A* at the end of period *t* and $debt_{AB,t}$ is the absolute amount of country *B* issued long-term debt securities that is held by country *A* at the end of period *t*.[5]

The majority of existing empirical contributions study the determinants of the *absolute* amount of bilateral equity (or debt) holdings.[6] Focusing instead on the *share* of equity in a bilateral portfolio has several econometric advantages. First, the measure is unit free and can be easily compared across country pairs and time periods. Second, it is not necessary to adjust for inflation or potential non-stationary properties of the time series. Third, importantly, the measure allows to study whether an expansion (or contraction) in foreign assets that is related to trade is equity or debt-driven.

The variable $trade_{AB,t}$ denotes bilateral trade, which is measured in the baseline regression as the sum of bilateral exports of *A* to *B* and bilateral imports of *A* from *B*, divided by the GDP of *A*. This measure is the same as the level of trade intensity defined in the theoretical model studied below.[7] In order to obtain a structural measure, a backward-looking five year moving average of this variable is constructed.

[4] This concerns time-invariant variables like country size, distance, common border and other typical ingredients of gravity equations. Additionally, it can be controlled for other specific factors of global financial markets such as, for example, a potential preference for safe assets of the US or Germany.

[5] Only *long-term* debt securities are included which are assets that have a maturity of more than one year. In a robustness analysis, the sum of both, long-term and short-term debt, are used, which yields similar results. Note that $equity_{ij,t}$ and $debt_{ij,t}$ can in principle also obtain negative values. For such cases one could adjust the definition in (2). In the sample analyzed below such observations do, however, not play a role.

[6] Pericoli et al. (2013) is one exception in which the authors examine the share of bilateral equity in total cross-border equity holdings.

[7] I also report results for the case that the trade variable is normalized by the sum of total exports and total imports of a source country instead of source country GDP.

The vector $x_{AB,t}$ captures following control variables: (1) The share of equity in the portfolio holdings of country A in *third-party* countries. This is computed with equity and debt securities that are held by residents of A and are issued by non-residents of A that live outside the partner country B (rest of the world residents). (2) The ratio of aggregate equity to debt holdings in the domestic market (country A) which takes as input equity and debt securities that are held by residents of A and are also issued by residents of A. (3) The ratio of aggregate equity to debt holdings in the partner country market (country B) which takes as input equity and debt holdings that are issued in the partner country B and are not held by residents of country A. The purpose of including the first two measures is to control for exogenous changes in risk preferences of domestic agents (e.g. changing risk aversion) as well as to control for potential portfolio changes that occur outside of a bilateral relationship. Domestic agents might, for example, hedge against increasing bilateral trade intensity by adjusting their domestic or rest-of-the-world (third-party) portfolio. By including the third control it is aimed at controlling for a potentially changing spread between equity and debt returns in the partner country as well as supply factors and other changes not related to the portfolio choice problem of agents in country A.

2.1 DATA AND SAMPLE

The main data source for the holdings of foreign equity and debt is the IMF CPIS survey. The CPIS covers only so called portfolio investments and does not include foreign direct investment (FDI), reserves or other investments, such as trade loans.[8] The CPIS survey is conducted on an annual basis since 2001. Participating countries report international portfolio investments of their residents. An advantage of the survey is that it gives detailed information about the type of security. The survey covers equity securities, debt securities with an original maturity of over one year (long-term), and debt securities with an original maturity of one year or less (short-term) issued by nonresidents and owned by residents.[9]

The sample includes almost all advanced economies and also many emerging economies as source countries. I follow the literature in excluding economies that have a distinct role as offshore financial center or tax haven both from the sample of source and the sample of host countries.

The source for goods and services trade data is the IMF Directions of Trade statistics (DOT). For computing the share of equity in the cross-border portfolio held in third-party countries I again use the CPIS. In order to control for the ratio of aggregate equity to debt holding in the domestic capital market, such a measure is constructed using the stock market capitalization reported in the Standard & Poors Global Stock Market Factbook and the amount of outstanding debt reported in the BIS Quarterly Review. The same data sources are used to construct the ratio of aggregate equity to debt holdings in the partner country. All important variables and their construction are described in more detail in Appendix A.

In order to select *relevant* cross-border asset trade relationships only, I consider country pairs where the source country portfolio investment in the host country accounts for *at least one per cent* of the source country's total cross-border portfolio investment.[10]

The panel is unbalanced and covers the period from 2001 to 2012. The BIS database is the most restrictive data source since many emerging economies do not report them. This data restriction, however, barely affects advanced economies as source countries. The final sample consists of 2997 observations and covers a broad set of 376 country pairs.[11] The list of source and host countries in the sample can be found in Appendix A. Descriptive statistics of the data set are reported in Table 1.

[8] The IMF classifies cross-border capital flows into five functional categories: portfolio investments, direct investments, reserve assets, financial derivatives other than reserves and other investments (such as trade loans). The functional category of portfolio investment is basically related to consumption smoothing. therefore, studies of international portfolio choice typically analyze capital flows within this category (*e.g. inter alia* Lane and Milesi-Ferretti (2008)).

[9] For an evaluation of the database, cf. Hau and Rey (2009) who find that the aggregate CPIS database is consistent with micro level data.

[10] With this restriction spurious results from irrelevant bilateral investment relations can be avoided. For sensitivity checks I additionally apply an alternative selection of relevant country pairs by instead of using a threshold the original sample is restricted such that only country pairs are considered where both the source and the host country are advanced economies that participate in the CPIS (IMF classification). This alternative yields very similar results.

[11] The final sample does not include two observations where bilateral equity or debt holdings are negative (short holdings).

Table 1
Descriptive statistics. The measures are described from the perspective of a source country. Trade variables are expressed in five-year backward looking moving averages.

Variable	Mean	Median	Std.Dev.	Min	Max
Share of Equity in Bilateral Portfolio	0.341	0.25	0.286	0	1
Total Cross-Border Equity (% GDP)	0.248	0.20	0.223	0.0001	1.0043
Total Cross-Border Debt (% GDP)	0.368	0.34	0.294	0.0013	1.1717
Bilateral Trade (% GDP)	0.043	0.02	0.064	0.0004	0.5287
Bilateral Trade (% Total Trade)	0.058	0.04	0.071	0.0009	0.7641
Total Trade (% GDP)	0.72	0.60	0.409	0.1747	1.7677

2.2 ECONOMETRIC ISSUES

One complication emerges for the estimation due to the fact that the dependent variable is observed to lie within zero and one. The linear model in (1) suffers in such a case under non-normal distributed errors. I follow the literature and employ alternative econometric models for dependent variables that are censored between zero and one, namely a Tobit model including fixed effects and the fractional regression approach introduced by Papke and Wooldridge (2008).[12] In an alternative specification, following Elsas and Florysiak (2015), it is allowed for a lagged dependent variable in the Tobit regression model. In this specification as well as in one additional specification in which a standard random effects Tobit model is estimated, time invariant gravity variables (logarithmic distance, economic size, common language, common currency, common legacy, etc.) are included as control variables. The data source for the gravity variables is the CEPII database from which values of 2005 are used.

A further econometric concern is potential endogeneity of the variables in the regression model given the short sample size (T=12), which – in an alternative specification – is accounted for by using the dynamic system generalized methods of moments (GMM) (*cf.* Arellano and Bover (1995) and Blundell and Bond (1998)). In the two-step system GMM specification with orthogonal deviations all explanatory variables are considered as endogenous variables expect the time dummies which together with logarithmic distance as a time invariant gravity variable serve as exogenous instruments. The endogenous variables enter as GMM style instruments with lag two and longer. The collapse option as proposed by Roodman (2009) is used, which reduces the number of instruments to 67. The two-step estimation corrects for robust standard errors as suggested by Windmeijer (2005). Testing for serial correlation of the residuals in first differences and second differences yields statistics with p-values of 0.000 and greater than 0.10, respectively. This indicates that, as required for the specification, first difference residuals are serially correlated while there is no serial correlation in second differences. The Hansen test of overidentifying restrictions and the difference-in-Hansen test for the exogeneity of a subset of the instruments yield statistics with p-values greater than 0.25, respectively. This gives evidence that the instruments are valid.

2.3 EMPIRICAL FINDINGS

In Table 2 the results for the alternative econometric models discussed in the previous section are reported. Most importantly, the trade variable is – for all estimated models – statistically significant with a negative sign. This indicates that the share of equity in a bilateral portfolio decreases with bilateral trade. The inclusion of controls does not affect the significance of the estimator, it only reduces the impact to some extent (except in the case of the dynamic panel with random effects). In the following statement the main empirical result of this paper are summarized. The quantitative interpretation is based on the system GMM results.

[12] In the Tobit model country-pair dummies are included in order to capture fixed effects. When using the Tobit model for a parametric estimation, the inclusion of fixed-effects leads to biased estimates. Greene (2001) shows, however, that this bias can be neglected in practice. For sensitivity checks a random effects model with time-invariant gravity controls is also estimated, which yields qualitatively similar results (*cf.* Table 2). For the fractional regression approach, time averages of the explanatory variables are included as controls in order to capture country pair fixed effects. Details on this estimation approach can be found in Papke and Wooldridge (2008). The Stata code provided by the authors is used. The procedure involves a pseudo maximum likelihood estimation. The reported values are the computed average partial effects.

Finding 1: The share of equity in a bilateral portfolio *decreases* with bilateral trade. For a typical country pair, a 1 percentage point increase in the share of bilateral trade in total GDP of a source country is associated with a decrease in the share of equity in the bilateral portfolio by around 0.9 percentage points.[13]

This finding can be interpreted as follows. Foreign equity, in general, insures the domestic agent against relative output shocks since the returns on equity are related to the change in relative output. In states of the world where foreign output is high, domestic agents want to increase their imports. A good strategy is to hold foreign equity which has high returns in states of the world where foreign output is high. When countries trade more, they tend to have more correlated output processes.[14] Intuitively, domestic holdings of foreign equity decrease in that case since there is less need for diversification. This line of reasoning provides one possible explanation for the empirical result, namely that foreign equity in the nominator decreases with rising trade. In any case, households may still want to hedge against other sources of changes in relative wealth (for example against risk associated with policy decisions, rare disasters, structural changes, etc.). When the relative returns of bonds are related to the changing pattern of wealth, then holding foreign bonds is a good strategy to hedge against such sources of risk. Intuitively, increasing trade intensity might make the partner country an even better hedging partner. When there is, for example, a rare disaster, agents will likely increase their net imports from countries they have trade relations with. Such a channel makes foreign bonds more attractive when countries increase their trade intensity. As another such source of risk that is not related to supply, Hamano (2015) discusses variety risk in consumption. The idea is that, recently, more and more varieties of goods and services are traded and preferences for one or the other variety change. This implies relative shifts in cross-border wealth that are not related to supply shocks. In the model studied below a global preference shock has a similar interpretation.

In the next section I consider a relatively simple, calibrated, two-country two-goods endowment model with frictionless trade in equity and real bonds as well as supply shocks and a global preference shock. In the model, increasing trade implies a stronger synchronization of output of the two countries in response to supply shocks. This makes foreign equity less attractive. The global preference shock shifts relative wealth from one country to the other country without affecting the endowment of the two countries. In such a case, agents want to hold foreign bonds, and more so with increasing trade intensity. The quantitative results predicted by this model are in line with the empirical results.

The final part of this section is devoted to having a closer look at what is shaping the empirical results. To do this I run the same regression, but use measures of equity, or respectively, measures of debt as the dependent variable. By doing so I study whether the numerator or the denominator in the equity share variable are related to goods and services trade.

The baseline exercise is similar to the regression analysis conducted in Lane and Milesi-Ferretti (2008). In their benchmark empirical model the log of the absolute value of bilateral equity holdings is regressed on the log of the sum of exports and imports, including source and host country dummy variables as well as gravity controls and time varying controls like correlation in GDP growth. An important difference is that Lane and Milesi-Ferretti (2008) study a cross-section for the year 2001, while here the whole panel is employed and it is controlled for heterogeneity by the inclusion of country pair fixed effects. Another difference is that, to be consistent with the other regressions described above, bilateral trade is normalized by source country GDP and the sample excludes country pairs with irrelevant portfolio relations. Additionally, in one specification I follow the approach of Pericoli et al. (2013) who ask a similar question as Lane and Milesi-Ferretti (2008) but normalize the amount of bilateral equity by total cross-border equity holdings of a country. Again, the main difference to their study is a smaller sample. I conduct the same set of regressions for bilateral debt holdings as the dependent variable.

The regressions results are reported in Table 3. For all specifications, bilateral debt holdings increase significantly with trade but the picture is more mixed for equity holdings. In the specification using the log of the absolute values for bilateral equity

[13] I conduct robustness analysis along several dimensions: (1) long-term and short-term debt are included for computing the dependent variable instead of only using long-term debt, (2) a different definition of a *relevant* bilateral portfolio investment relationship is used (*cf.* above), (3) current values of the trade variable enter the right hand side instead of a 5-year backward-looking transformation, and (4) the observationally censored independent variable is transformed with a log-odds transformation $\bar{z}_{ij,t} = \ln(\frac{z_{ij,t}}{1-z_{ij_t}})$ (*cf. inter alia* Wooldridge (2010), Chapter 16) and a linear regression is conducted. In this last case the magnitude of the coefficients can not be interpreted. Importantly, the results are robust across all these alternative specifications.

[14] This relationship is increasingly considered to be a stylized fact. For a discussion cf. *inter alia* Frankel and Rose (1998), Baxter and Kouparitsas (2005), Kose and Yi (2006), Giovanni and Levchenko (2010), Cacciatore and Ghironi (2014) and references therein.

holdings and bilateral trade, I find a significantly positive sign (in line with the results of Lane and Milesi-Feretti Lane and Milesi-Ferretti (2004) and Lane and Milesi-Ferretti (2008)). The results are, however, different for other specifications. Interestingly, when the trade variable is measured in terms of source country GDP and bilateral equity holdings are measured in absolute values (both are log-transformed), then a negative coefficient is obtained. The coefficient is negative and significant when, additionally, host and source country GDP enter as control variables. It is important to note that this specification is the one in which case the model below is best comparable to the empirical model. The sign of the equity variable is also negative and significant once bilateral equity holdings are measured in terms of the source country's total equity holdings and the trade variable in terms of the source country's GDP.[15]

An important result is that the trade coefficient in the specifications with debt holdings is always significant and larger than in the counterparts with equity holdings. This indicates that especially the denominator in the equity share variable moves positively with trade, which explains the negative sign.

Finding 2: Increasing trade leads to relatively large increases in bilateral debt holdings. This effect is so strong that increasing trade tilts the composition of a bilateral portfolio away from equity securities and towards debt securities.

In the next section I discuss the theoretical model and examine the extent to which the empirical findings are in line with the theoretical predictions.

[15] This is different to the finding of Pericoli et al. (2013) who find a positive significant effect in the case of of a normalized left hand side variable. Important differences to their study are that here country pairs which are not defined as having a relevant investment relationship are excluded from the sample and bilateral trade is normalized by source country GDP.

Table 2
Dependent variable: share of equity in the bilateral portfolio. Panel regression, 2001-2012.

	Tobit		Tobit (trade share)		Papke, Wooldridge (2008)		Tobit (random effects)		Tobit (RE, dyn. panel)		System GMM	
Bilateral Trade	-1.736***	-1.708***	-1.661***	-1.567***	-1.682**	-1.753**	-0.707***	-0.593***	-0.448**	-0.532**	-1.045***	-0.887*
	(0.235)	(0.223)	(0.238)	(0.226)	(0.950)	(0.893)	(0.183)	(0.160)	(0.217)	(0.213)	(0.350)	(0.457)
Third-Country Equity Share		0.521***		0.518***		0.458***		0.575***		0.209***		0.364***
		(0.029)		(0.029)		(0.069)		(0.280)		(0.031)		(0.117)
Domestic Equity/Debt Ratio		-0.001		-0.002		-0.003		-0.002		0.009		0.0261**
		(0.003)		(0.003)		(0.006)		(0.003)		(0.005)		(0.012)
Partner Equity/Debt Ratio		0.00003		0.00001		0.00004		0.00003		-0.00002		-0.0004
		(0.0001)		(0.0001)		(0.00004)		(0.0001)		(0.0001)		(0.0008)
Constant	0.792***	0.407***	0.851***	0.465***			0.386***	0.139***	-0.118*	-0.0857	0.032	-0.0234
	(0.030)	(0.036)	(0.032)	(0.037)			(0.027)	(0.026)	(0.069)	(0.068)	(0.040)	(0.064)
Time dummies	x	x	x	x	x	x	x	x	x	x	x	x
Fixed effects	x	x	x	x	x	x					x	x
Gravity controls							x	x	x	x		
Lagged dependent variable									x	x	x	x
N	2977	2977	2977	2977	2977	2977	2977	2977	2493	2493	2493	2493
# Country Pairs	376	376	376	376	376	376	376	376	334	334	334	334

Bilateral trade is measured as the value of bilateral traded of a source country versus a partner country in terms of nominal GDP of a source country (except in the third and fourth column where it is measured as a trade share, i.e. the value of bilateral trade in terms of total trade of source country). Standard deviations are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% confidence level, respectively. In the case of the dynamic panel Tobit and the system GMM specifications there are fewer observations due to missing lagged values in the unbalanced panel.

Table 3
Dependent variable: source country holdings of host country issued equity or debt (respectively). Panel regression, 2001-2012.

	All variables in in log-level		All variables in log-level		LHS in log-level, Trade as log %GDP		LHS in log-level, Trade as log %GDP		LHS in log-level, Trade as log %GDP		LHS expressed as share, Trade/GDP (Tobit)	
	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt
Bilateral Trade	0.690***	1.193***	1.244***	1.348***	-0.175	0.554***	-0.073	0.389***	-0.342***	0.595***	-0.498***	0.477***
	(0.090)	(0.073)	(0.073)	(0.060)	(0.113)	(0.095)	(0.098)	(0.082)	(0.119)	(0.099)	(0.082)	(0.086)
Constant	14.346***	10.626***	4.312**	9.370***	19.758*	23.270***	17.354***	23.483***	1.877*	11.142***	0.180***	0.159***
	(0.796)	(0.644)	(1.988)	(1.685)	(0.441)	(0.369)	(2.455)	(2.027)	(1.456)	(1.199)	(0.010)	(0.011)
Time dummies	x	x	x	x	x	x	x	x	x	x	x	x
Fixed effects	x	x			x	x			x	x	x	x
Gravity controls			x	x			x	x				
controlled for log GDP									x	x		
N	2948	2964	2948	2964	2948	2964	2948	2964	2948	2964	2997	2997
# Country Pairs	371	373	371	373	371	373	371	373	371	373	376	376

The dependent variable is expressed in log of the nominal value of bilateral equity or debt holdings except in the last two columns where the dependent variable is expressed as bilateral equity or debt holdings in terms of total cross-border equity or debt holdings of a source country, respectively. Bilateral trade is measured as the log value of bilateral traded of a source country versus a partner country in terms of nominal GDP of a source country except in the first four columns where it is measured as the log nominal value of bilateral trade. Standard deviations are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% confidence level, respectively. In the case that variables are transformed with a log transformation observations are missing when the variable takes the value 0.

3 Trade and Portfolio Choice in a Two-Country Two-Good Model

I study an infinite horizon two-country two-goods models. In this setting, terms of trade movements lead to changes in relative wealth of the two countries (*cf. inter alia* Cole and Obstfeld (1991), Backus et al. (1992), Heathcote and Perri (2002), Corsetti et al. (2008)). For simplicity, I abstract from production but consider an endowment economy. The benchmark model is a two-country two-goods model borrowed from Devereux and Sutherland (2010).[16] There are two countries, Home and Foreign. The representative agent of each country receives an endowment of a country-specific good. It is assumed that the endowment consists of a capital component and a non-insurable labour component. The difference between the two being that claims to future capital income can be traded on international financial markets. There is uncertainty because of supply shocks to capital output and supply shocks to non-insurable labour income which are imperfectly correlated. Additionally, there is a global preference (demand) shock (similar as in *inter alia* Coeurdacier et al. (2009) or Pavlova and Rigobon (2010)). The representative agents of Home and Foreign are identical in their preferences despite that they are biased towards consumption of the respective country-specific good.

Each country issues equity which is a claim to future capital endowment and real bonds which, once purchased, pay one unit of the country specific good each period. All assets are tradeable in a frictionless international financial market. Since the number of shocks is larger than the number of available assets, financial markets are incomplete.

In a relatively standard way and for reasonable calibration, a domestic supply shock increases the market value of output but also induces domestic terms of trade to deteriorate. In this way a domestic supply shock is also positively affecting the market value of the partner country's endowment.

The global demand shock is a disturbance to the home bias in consumption. It is conceptually very different from the supply shock. When there is a favourable global demand shock for the domestic good the domestic terms of trade appreciate. The market value of the domestic output rises while the market value of the partner country's output drops proportionally, so there is a shift of wealth from one country to the other country.

In the model, real bonds of the partner country are a good hedge against demand shocks since relative returns on real bonds change proportionally with the shock induced change in the terms of trade.

Equity of the partner country is a good hedge against the supply shock. Imagine, for example, that there is a positive supply shock in Foreign. Under perfect risk sharing, Home wants to increase its net imports, therefore it should invest *ex ante* in Foreign equity which is a claim to Foreign future endowment. Because of the imperfect correlation between labour and capital income there is, however, no full diversification in equity and both countries are biased towards domestic equity. For example, in the case of a Foreign supply shock to labour endowment, the market value of Foreign capital income is not increasing proportionally to the market value of Foreign labour income. The market value of Home equity is increasing because the Home terms of trade are appreciating, making Home equity, at least to some extent, a good hedge against the Foreign supply shock.

Under the assumption of incomplete financial markets and for reasonable parameters the equilibrium supports positive holdings of foreign equity and debt, as is observed in the data. Starting from this equilibrium, I assess the effect of changing trade intensity on the composition of cross-border portfolio holdings by looking at variations in the home bias in consumption.[17]

[16] Devereux and Sutherland (2010) study the model in the context of external valuation channels. In the model described here I assume a different maturity for the long-term bonds.

[17] As Kose and Yi (2006) point out, one could alternatively also assess the change in iceberg transportation cost. Betts and Kehoe (2001) show that under complete markets and without capital accumulation, transportation cost and home bias in consumption are isomorphic assumptions. For incomplete markets the two specifications are not equivalent but still lead to the same qualitative implications.

The model is described formally below. Home and the Foreign economy have the same structure (when necessary Home and Foreign are distinguished by an asterisk). It is focused on the Home economy and, unless otherwise stated, the same relations hold equivalently for the Foreign economy. An upper bar denotes a steady state value.

HOUSEHOLD'S CONSUMPTION

The utility function of the representative agent is described by the standard constant relative risk aversion representation[18]

$$U_t = E_t \sum_{\tau=t}^{\infty} \Lambda_\tau \left[\frac{C_\tau^{1-\rho}}{1-\rho} \right] \tag{3}$$

where ρ is the relative risk aversion parameter and the discount factor is determined by $\Lambda_{t+1} = \Lambda_t \beta (C_{A,t}/\overline{C_A})^\eta$ where $0 < \eta < \rho$, $0 < \beta < 1$, $\Lambda_0 = 1$, $C_{A,t}$ denoting aggregate domestic consumption.[19] In this specification the inter-temporal elasticity of substitution is given by $1/\rho$.

The Home consumption good is assumed to be a bundle

$$C_t \equiv \left[\omega_t^{1/\theta} (C_{H,t})^{\frac{\theta-1}{\theta}} + (1-\omega_t)^{1/\theta} (C_{F,t})^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}, \tag{4}$$

where ω_t determines the share of Home goods in the consumption bundle. θ is the elasticity of substitution between Home and Foreign goods. For $\omega_t \geq 0.5$ there is home bias in consumption.

The demand functions of Home for Home and Foreign goods are respectively given by

$$C_{H,t} = \omega_t \left(P_{H,t} \right)^{-\theta} C_t \qquad C_{F,t} = (1-\omega_t) \left(P_{F,t} \right)^{-\theta} C_t. \tag{5}$$

The associated Home consumer price index (CPI) is

$$P_t = \left[\omega_t (P_{H,t})^{1-\theta} + (1-\omega_t)(P_{F,t})^{1-\theta} \right]^{\frac{1}{1-\theta}}. \tag{6}$$

OUTPUT PROCESSES

It is assumed that each economy has an initial endowment that has a capital income component and a labour income component

$$Y_t = Y_{K,t} + Y_{L,t}. \tag{7}$$

The main difference between the capital component and the labour component is that claims to the capital component can be traded internationally without frictions, while, in contrast, the labour income component is non-insurable (i.e. claims to labour income can not be traded on international financial markets).

[18] In the case of $\rho = 1$ the utility function converges to $U_0 = E_0 \sum_{t=0}^{\infty} \beta^t \ln C_t$.

[19] Λ_t is assumed to be taken as exogenous by the agents. This specification ensures stationarity (cf. Schmitt-Grohé and Uribe (2003)).

The income processes follow

$$\log(Y_{K,t}/\bar{Y}_K) = \phi_K \log(Y_{K,t-1}/\bar{Y}_K) + \varepsilon_{K,t} \tag{8}$$

$$\log(Y_{L,t}/\bar{Y}_L) = \phi_L \log(Y_{L,t-1}/\bar{Y}_L) + \varepsilon_{L,t} \tag{9}$$

where $\phi_K, \phi_L \in [0,1]$ and $\varepsilon_K, \varepsilon_L$ are zero mean i.i.d. symmetrically distributed over $[-\epsilon,\epsilon]$ with variance-covariance matrix

$$\Sigma_{K,L} = \begin{pmatrix} \sigma_K^2 & \sigma_{KL} \\ \sigma_{KL} & \sigma_L^2 \end{pmatrix}. \tag{10}$$

A global preference shock shifts the home bias in consumption

$$\omega_t = \bar{\omega} D_t \qquad \omega_t^* = \bar{\omega}^* (-D_t) \tag{11}$$

where

$$\log D_t = \phi_D \log D_{t-1} + \varepsilon_{D,t}, \tag{12}$$

$\phi_D \in [0,1]$ and ε_D is zero mean i.i.d. symmetrically distributed over $[-\epsilon,\epsilon]$ with variance σ_D^2.

It should be noted that a favourable preference shock for Home goods implies increasing domestic and foreign demand for the Home good and decreasing domestic and foreign demand for the Foreign good.

FINANCIAL ASSETS, NET FOREIGN ASSET POSITION AND MARKET CLEARING

Each country issues equity (which is a claim on real capital output) and real bonds. International financial markets are frictionless.

The gross returns of Home and Foreign risky assets (equity) are given by

$$R_{E,t+1} = \frac{Y_{kt+1} P_{H,t+1} + Z_{E,t+1}}{Z_{E,t}} \qquad R_{E^*,t+1} = \frac{Y^*_{k,t+1} P_{F,t+1} + Z_{E^*,t+1}}{Z_{E^*,t}} \tag{13}$$

where R_E, R_E^* and Z_E, Z_E^* denote gross returns and prices of equity (in terms of the Home consumption good).

The presence of risk-free real bonds is assumed. Once they are purchased they yield one unit of the respective good forever, which implies that the gross returns are given by

$$R_{B,t+1} = \frac{P_{H,t+1} + Z_{B,t+1}}{Z_{B,t}} \qquad R_{B^*,t+1} = \frac{P_{F,t+1} + Z_{B^*,t+1}}{Z_{B^*,t}}. \tag{14}$$

where R_B, R_B^* and Z_B, Z_B^* denote gross returns and prices of real bonds (in terms of the Home consumption good).[20]

[20] The maturity of the real bond does not change the basic mechanism of the model. I conduct sensitivity analysis for the case that bonds have maturity of one period and obtain qualitatively similar results.

Home agents can hold shares in domestic and foreign equity as well as domestic and foreign real bonds such that the net foreign asset position of the Home agent evolves as

$$NFA_t = B_{F,t} + s_{E^*,t}Z_{E^*,t} - s^*_{E,t}Z_{E,t} - B^*_{H,t}$$

where $s_{E^*,t}$ are Home agents shares of Foreign equity, $s^*_{E,t}$ are Foreign agents shares of Home equity, $B_{F,t}$ denote Home agents net holdings of Foreign bonds and $B^*_{H,t}$ denote Foreign agents net holdings of Home bonds.

The supply of each share is normalized at unity and real bonds are in zero net supply. This implies that asset markets clear for Home issued assets such that

$$B_{H,t} = -B^*_{H,t} \qquad s_{E,t} + s^*_{E_t} = 1, \tag{15}$$

and for Foreign issued assets

$$B_{F,t} = -B^*_{F,t} \qquad s_{E^*,t} + s^*_{E^*_t} = 1. \tag{16}$$

BUDGET CONSTRAINT AND FINANCIAL ASSET HOLDINGS

The budget constraint of the domestic agent can be expressed in terms of the net foreign asset position

$$NFA_t = NFA_{t-1}r_{B_t} + Y_t * P_{H,t} - C_t + \alpha_{E,t-1}(r_{E,t} - r_{B_t}) + \alpha_{E^*,t-1}(r_{E^*,t} - r_{B_t}) + \alpha_{B^*,t-1}(r_{B^*,t} - r_{B_t}) \tag{17}$$

where $\alpha_{E,t-1}$, $\alpha_{E^*,t-1}$ and $\alpha^*_{B,t-1}$ denote Home's real holdings of Home issued equities, Foreign issued equities and Foreign issued bonds, respectively, with

$$\alpha_{E,t-1} = Z_{E,t-1}(s_{E,t-1} - 1),$$

$$\alpha_{E^*,t-1} = Z_{E^*,t-1}s_{E^*,t-1},$$

$$\alpha_{B^*,t-1} = B_{F,t}.$$

GOODS MARKET CLEARING, REAL EXCHANGE RATE AND TERMS OF TRADE

Global good and services demand clears such that

$$Y_t = C_{H,t} + C^*_{H,t}, \tag{18}$$

$$Y^*_t = C^*_{F,t} + C_{F,t}. \tag{19}$$

The Home real exchange rate Q_t is the ratio of Foreign over Home CPI. Note that the law of one prices holds, which implies that the Home terms of trade TOT_t is given by the relative price of the Foreign good in terms of the Home good

$$Q_t = \frac{P^*_t}{P_t} \qquad TOT_t = \frac{P_{F,t}}{P_{H,t}}. \tag{20}$$

CONSUMPTION EULER EQUATIONS

The first order conditions for Home and and Foreign's asset choice are given by

$$C_t^{-\rho} = \beta E_t[C_{t+1}^{-\rho} R_{E,t+1}], \qquad C_t^{-\rho} = \beta E_t[C_{t+1}^{-\rho} R_{E^*,t+1}], \tag{21}$$

$$C_t^{-\rho} = \beta E_t[C_{t+1}^{-\rho} R_{B,t+1}], \qquad C_t^{-\rho} = \beta E_t[C_{t+1}^{-\rho} R_{B^*,t+1}], \tag{22}$$

$$\frac{C_t^{*-\rho}}{Q_t} = \beta E_t[\frac{C_{t+1}^{*-\rho}}{Q_{t+1}} R_{E,t+1}], \qquad \frac{C_t^{*-\rho}}{Q_t} = \beta E_t[\frac{C_{t+1}^{*-\rho}}{Q_{t+1}} R_{E^*,t+1}], \tag{23}$$

$$\frac{C_t^{*-\rho}}{Q_t} = \beta E_t[\frac{C_{t+1}^{*-\rho}}{Q_{t+1}} R_{B,t+1}], \qquad \frac{C_t^{*-\rho}}{Q_t} = \beta E_t[\frac{C_{t+1}^{*-\rho}}{Q_{t+1}} R_{B^*,t+1}]. \tag{24}$$

3.1 EQUILIBRIUM AND SOLUTION APPROACH

A competitive equilibrium is defined in Appendix B. The model is solved by log-linearization around the non-stochastic steady state. Two problems complicate this approach: (1) the portfolio choice is indeterminate in a steady state that is non-stochastic and (2) a first order approximation yields certainty equivalence and second moments do not affect the policy functions. In order to solve the model it is made use of the approach of Devereux and Sutherland (2011) (DS). The basic idea is to approximate the portfolio choice related equilibrium conditions to a second order and the non-portfolio choice related equilibrium conditions to a first order. This approach allows to solve for the steady state asset holdings.[21]

It is assumed for the steady state that $\overline{NFA} = 0, \bar{Y} = \bar{Y}^*, \bar{C} = \bar{C}^*, r_B = r_{B^*} = r_E = r_{E^*} = 1/\beta$. Up to a second order approximation, the home and foreign FOCs combine to

$$E_{t-1}\left[\left(\hat{C}_t - \hat{C}_t^* - \frac{1}{\rho}\hat{Q}_t\right)\hat{Rx}_{k,t}\right] = 0 \tag{25}$$

where a hat denotes log-linearized variables and $Rx_{k,t}$ describes the vector of excess returns (rate of returns of the respective assets minus rate of return of Home real bond as the numeraire asset).

The solution for the optimal steady state portfolio $\bar{\alpha}$ is given by

$$\bar{\alpha} = \frac{\tilde{\alpha}}{\beta \bar{Y}} \tag{26}$$

$$\tilde{\alpha} = \left[RR_2 \Sigma DD_2' RR_1' - DD_1 RR_2 \Sigma RR_2'\right]^{-1} RR_2 \Sigma DD_2', \tag{27}$$

where $\bar{Y}$ is steady state output, Σ is the variance-covariance matrix of the exogenous shocks and realized excess returns are temporarily treated as auxiliary i.i.d. variable ξ_t such that the two terms in (25) can then be expressed as

$$\hat{Rx}_{k,t} = RR_1 \xi_{t-1} + RR_2 \varepsilon_{t-1}$$

$$\hat{C}_t - \hat{C}_t^* - \frac{1}{\rho}\hat{Q}_t = DD_1 \xi_{t-1} + DD_2 \varepsilon_{t-1}.$$

[21] An alternative approach for solving the model would be global solution methods. Rabitsch et al. (2015) examine the performance of the DS algorithm in comparison to global solution models. They find that for a typical two-country one-good endowment model with standard consumption preferences, the DS algorithm performs reasonably well, so that practically the approximation errors to the policy functions can be neglected. This indicates that the DS algorithm solution is likely to be accurate also in the two-country two-goods model studied here.

4 The Quantitative Impact of Increasing Trade Intensity on the Cross-Border Portfolio Composition

Given the focus of this paper, the interesting question that emerges is how Home adjusts its portfolio composition in Foreign when the two countries intensify bilateral goods trade. In the empirical part, I find that increasing bilateral trade intensity is related to a decreasing share of equity in the bilateral portfolio. I also find that this result is driven by strongly rising holdings of foreign debt. It should be noted that in the empirical part the perspective of a source country is taken that holds equity and debt securities issued by one particular host country. For the model predictions, especially the perspective of the Home economy versus the Foreign country will be taken. I show below that, for reasonable parameter values the model predictions are in line with the empirical findings: increasing trade implies a decrease in the share of equity in Home's portfolio of assets issued by Foreign. Home's holdings of Foreign issued bonds strongly increase since they are held to hedge against the demand shock while Foreign issued equity holdings modestly decrease because they are held to hedge against supply shocks.

4.1 CALIBRATION

For the comparative statics a calibrated model version is studied. The discount factor is set to $\beta = \beta^* = 0.96$ which corresponds roughly to a 4 percent steady state real return rate of equity and real bonds. I follow Coeurdacier et al. (2009) and set the coefficient of relative risk aversion to $\rho = 2$, the steady state share of capital income in total income to 0.4 and the variance of the exogenous shocks to capital income and to labour income to 0.0159^2. The relative risk aversion parameter, which is also the inverse of the intertemporal elasticity of substitution, plays an important role. In the sensitivity analysis other values between $\rho = 1$ and $\rho = 5$ are considered.

There is little empirical evidence on the variance of the global demand shock. In the benchmark model the variance of the demand shock is set equal to the variance of the supply shock. It is important to note that the *relative* size of the shocks matters more than the absolute values. In the sensitivity analysis, I follow Coeurdacier et al. (2009) and consider a variance of the demand shock of 0.01^2 and 0.02^2 , which are values below and above the variance of the supply shock. The autocorrelation parameters of all exogenous processes are set to 0.9.

The correlation between labour and capital income is set to -0.228 in order to match the average share of equity in a bilateral portfolio in the data at a steady state trade intensity of 0.70. Assuming such a negative correlation is supported by empirical evidence (*cf. inter alia* Bottazzi et al. (1996), Julliard (2003) and Lustig and Nieuwerburgh (2008)).

A crucial parameter is the elasticity of substitution between Home and Foreign goods. There is no consensus in the literature about how this parameter should be calibrated. In macroeconomic models this parameter is typically calibrated to a relatively low value where often a distinction is made between values below and above one. I study two different cases: In the first case the elasticity is set equal to $\theta = 1.5$ (*cf. inter alia* Backus et al. (1992)). For the second case it is followed Heathcote and Perri (2002) who argue in favor of an elasticity below one $\theta = 0.9$.

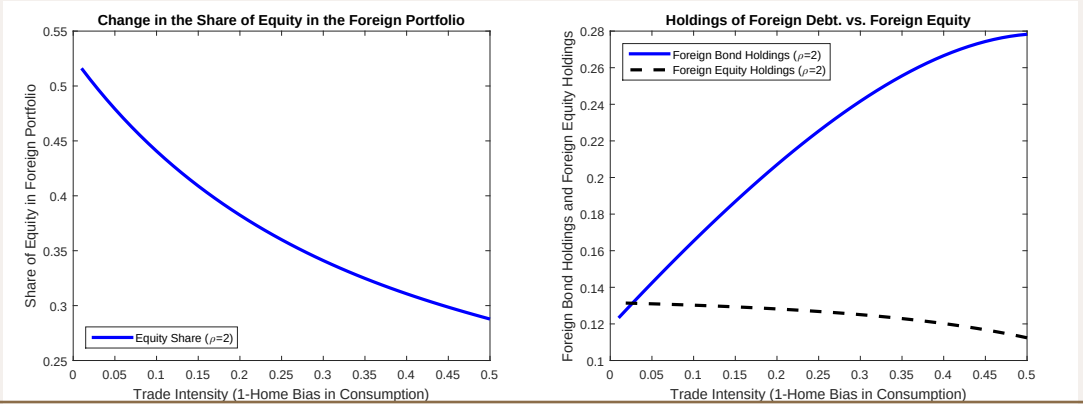
The comparative statics look at variation in the steady state trade intensity which is given by $1 - \overline{\omega}$ where $\overline{\omega}$ is the steady state preference parameter for home goods. In the analysis below a range of parameter values that is consistent with a home bias in consumption $\overline{\omega} \in [0.5, 1]$ will be studied. In all calibrations Home and Foreign have the same degree of steady state home bias in consumption $\overline{\omega}=\overline{\omega}^*$ which is equal to imports divided by domestic GDP (note that steady state GDP in the model is normalized to 1).

4.2 HOW DOES A CHANGE IN THE TRADE INTENSITY AFFECT THE SHARE OF EQUITY IN THE BILATERAL PORTFOLIO?

In the following exercise I study the comparative statics of a change in the steady state trade intensity. The results are reported in Figure 1. It shows how a changing steady state trade intensity (1-$\overline{\omega}$) affects the equity share in the bilateral portfolio as well as the absolute amount of Home's holdings of Foreign issued equity and Foreign issued real bonds.[22]

Figure 1

The effect of a change in goods trade intensity on the share of equity in the cross-border portfolio as well as on domestic holdings of foreign equity and foreign bonds. (Elasticity of substitution $\theta = 1.5$, relative risk aversion $\rho = 2$, benchmark variance for the global demand shock).



Importantly, the calibrated model predicts a *negative* relation between the steady state trade intensity and the equity share in the bilateral portfolio. At a steady state trade intensity of 0.70 – which corresponds to the median in the data (*cf.* Table 1) – a one step decrease in the home bias in consumption leads to a 0.34 percentage point decrease in the equity share in the cross-border portfolio. This is driven by a strong increase in the holdings of partner country real bonds, relative to a very modest decrease in the holdings of partner country equity. Importantly, the pattern is in line with the empirical results of Finding 1 and Finding 2.

In the following the main mechanism driving the results will be discussed. It should be noted that the empirical results are larger in magnitude than the model predictions, mainly because in the data an even stronger increase of foreign debt holdings in response to increasing trade is found. Later, the role of the elasticity of substitution, the relative risk aversion and the relative size of the shocks for the magnitude of the results will be therefore discussed.

As described above, Foreign equity is a good hedge against the supply shock and Foreign bond holdings are a good hedge against demand shocks. Furthermore, when the labour income and the capital income component are imperfectly correlated, there is no full diversification in equity obtained, but agents prefer to hold a larger amount of domestic equity.

In case of a positive global demand shock (in favour of Home goods), Home becomes relatively richer because the market value of the Home endowment increases proportionally to the terms of trade. Home goods become more expensive, at the same time Foreign goods become cheaper. This means that the purchasing power of a Home agent increases. In order to share this consumption risk with Foreign, Home agents want to hold Foreign bonds that pay badly in such states so that the purchasing power is stabilized. When trade intensity is rising, the amount of Foreign goods in the Home consumption basket increases. This makes Home agents hold a larger amount of Foreign bonds in order to ensure stabilized purchasing power. To summarize, Home holdings of Foreign bonds increase with trade because of the demand shock.

In the case of a positive Foreign supply shock, Foreign goods become cheaper in order to absorb the additional supply, while at the same time Home goods become relatively more expensive. This has two effects on Home. First, the market value of the Home endowment goes up. Under financial autarky and for a sufficiently high elasticity of substitution (as in the cases discussed

[22] Note that in the whole analysis, the steady state equity and bond holdings are normalized by the steady state asset price. The steady state asset price is equal to $\beta/(1-\beta)$, both for equity and for real bonds.

here) Home would be relatively poorer compared to Foreign. When trade in equity is possible, agents would therefore like to hold Foreign equity. Nevertheless, the market value of Home equity is high in such a case, so to some extent also Home equity can be used to hedge against the Foreign supply shock. This is actually the case because labour income and capital income are imperfectly correlated. Second, since there is home bias in consumption, the increase in the price of Home goods makes consumption more expensive. In general, Home equity but also Home bonds are a good hedge against this risk.

With rising trade intensity both effects matter in shaping foreign asset holdings. An important mechanism is that rising trade intensity leads to a stronger response of the terms of trade to supply shocks. Consider the example when there is a Foreign supply shock to the labour income. When Foreign and Home have a large home bias in consumption then the additional supply will mainly be absorbed by the relatively richer Foreign agents, such that prices do not have to respond much. For lower home bias in consumption, less of the additional supply is absorbed by the relatively richer Foreign agents. This implies that Foreign prices have to go down by more and the terms of trade are responding stronger.[23] In this case the market value of Home equity is relatively higher compared to Foreign equity. Then with higher trade intensity Home equity is a better hedge against Foreign supply shocks compared to Foreign equity. As an implication, holdings of Foreign equity are decreasing with trade because of the supply shock.

The supply shock can still have an effect on holdings of Foreign bonds, especially related to the second effect described above. It should be noted that rising trade intensity leads to the effect that Home goods become even more expensive after a Foreign supply shock. This negative effect on the purchasing power of the Home agent is partly offset by the stronger preference for Foreign goods that become even cheaper, however, it can still make Home bonds relatively more attractive compared to Foreign bonds. In such a case Foreign bonds are actually decreasing with rising trade because of the supply shock.

To summarize, foreign equity is basically a good hedge against the supply shock and foreign bond holdings are a good hedge against demand shocks. In case of a decreasing home bias in consumption trade intensity rises. The effect on foreign equity holdings is negative because of the supply shocks. The sign of the effect on foreign bond holdings is in general ambiguous. In our benchmark model (Figure 1) the effect is strongly positive.

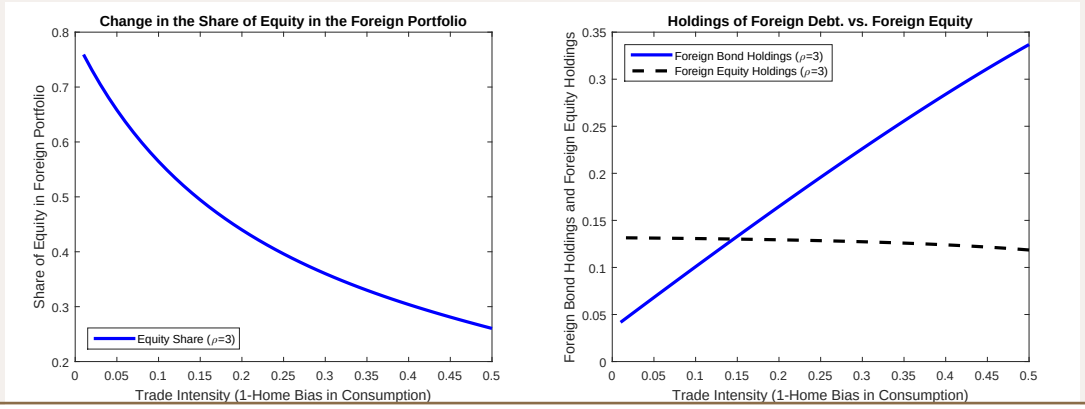
In the sensitivity analysis below a larger range of values of (1) the relative risk aversion, (2) the elasticity of substitution and (3) the relative size of the demand shock will be studied. In a nutshell, holdings of foreign bonds are typically increasing with trade intensity. There is, however, a limited range of parameter values where this is not the case. In particular, the prediction is not robust for low values of the relative risk aversion parameter. Especially in the case of a relative risk aversion of unity, demand shocks do not change the pattern of foreign bonds. On the contrary, for a sufficiently high relative risk aversion the effect is clearly positive and in line with the empirical results.

As a final quantitative exercise I also want to consider the special case of a low elasticity $\theta = 0.9$ (which is used in Heathcote and Perri (2002)). In this case the prediction of a negative link between the trade intensity and the share of equity in the cross-border portfolio is robust for a large set of parameter combinations (*cf.* the sensitivity analysis below). For illustrative purposes, I change the relative risk aversion to a higher value of $\rho = 3$ and set the variance of the global demand shock to 0.02^2 so that it is slightly larger than the variance of the supply shock. The model predictions are reported in Figure 2.

At a steady state trade intensity of 0.70 – which corresponds to the median in the data (*cf.* Table 1) – a one step decrease in the home bias in consumption leads to a 0.65 percentage point decrease in the equity share in the cross-border portfolio. The model prediction under this calibration is within the range of values reported in Table 2 and in comparison with the benchmark case quantitatively better matching the magnitude of the empirical results. Compared to the benchmark model, domestic holdings of foreign bonds are increasing more strongly with trade and the share of equity in the cross-border portfolio decreases more strongly. The magnitude of the change in domestic holdings of foreign equity is slightly smaller. As shown in the sensitivity analysis below, the empirical findings are best matched with a high relative risk aversion. Very high values of relative risk aversion are not common in the macroeconomic literature but very common in asset pricing studies (*cf.* for example Bansal and Yaron (2004)).

[23] In general, the response of the terms of trade can be different, as discussed in Kose and Yi (2006). In the examples discussed here and in the sensitivity analysis, the terms of trade respond in the described way.

Figure 2
The effect of a change in goods trade intensity on the share of equity in the cross-border portfolio as well as on domestic holdings of foreign equity and foreign bonds. (Elasticity of substitution $\theta = 0.9$, $\rho = 3$, high variance for the global demand shock).



4.3 THE ROLE OF INCOMPLETE FINANCIAL MARKETS

In the benchmark model there are more than two relative shocks and only two assets issued in each country, which implies that financial markets are incomplete. Here it is discussed why all shocks are nevertheless required in order to obtain positive holdings of foreign equity and debt (which is consistent with the data; cf. Coeurdacier et al. (2009) and Table 1). For this purpose I will consider two special cases of the model: (1) the case with perfect correlation between the capital and labour income supply shocks, and (2) the case with no demand shocks. Studying these cases shows that a too simple structure as compared to the assumed one leads to corner solution in equity holdings for all possible levels of trade intensity. Conducting comparative statics would then not be meaningful.

The first case (1) concerns a perfect correlation between the capital and labour income supply shock. As already mentioned above, in that case full diversification in equities is obtained as in Lucas (1982) $s_{E,t-1} = 0.5$. This means that the supply shock is hedged by holding the world portfolio. The remaining risk from the supply and the demand shocks is hedged by holding foreign bonds. This outcome for equity holdings does not depend on any model parameter, in particular not on the home bias in consumption. The amount of foreign bonds depends on the relative risk aversion σ. For a value of relative risk aversion above unity Home agents want to hold a negative amount of foreign bonds because of the supply shock. They prefer to hold assets that pay more when their aggregate price index is higher. Supply shocks cause terms of trade movements and typically a positive supply shock at Home induces a terms of trade deterioration. With home bias in consumption the CPI goes down. With risk-aversion above unity, it is optimal to hold a positive amount of badly paying domestic assets and a negative amount of well paying foreign assets. The demand shock also plays a role but in the opposite direction. Agents want to stabilize consumption. In case of a positive demand shock Home goods become more expensive and Home becomes relatively richer, while at the same time Foreign goods become cheaper. For risk-aversion above unity, agents want to hold assets that pay badly in such states, so they want to hold Foreign bonds.

As explored by Devereux and Sutherland (2010) in the case without the demand shock (2), $\sigma_D^2 = 0$, the model supports full equity home bias $s_{E,t-1} = 1$. This outcome does again not depend on any model parameter, in particular not on the home bias in consumption. The reason for this result is the imperfect correlation between capital and labour income (not necessarily negative).[24] In this special case, bonds are used for hedging the risk coming from the terms of trade response to the supply shock. A Home output shock typically induces Home prices to decrease. Viani (2011) shows that for values of the elasticity of substitution between home and foreign goods above $\tilde{\theta} \equiv \frac{\rho+2\overline{\omega}-1}{2\rho\overline{\omega}}$ the Home country is relatively poorer after a domestic supply shock while it would be relatively richer in the case the elasticity is below this threshold. The foreign bond holdings are then negative $B_{F,t} < 0$ in case of a high elasticity and positive $B_{F,t} > 0$ in case of a low elasticity. For a elasticity of substitution exactly equal the threshold $\theta = \tilde{\theta} \equiv \frac{\rho+2\overline{\omega}-1}{2\rho\overline{\omega}}$, the model nests the case discussed by Cole and Obstfeld (1991) where, in equilibrium, no foreign assets are held and risk sharing is solely achieved by terms of trade movements.

[24] With perfect correlation the equilibrium would not be uniquely determined.

Note that neither full equity home bias nor full equity diversification are supported by the data. Also, these solutions yield a negative foreign bond position for some reasonable parameter values such as, for example, a relative risk aversion of 2 and an elasticity of substitution between Foreign and Home goods of 1.5. In the general model studied in the previous section, the demand shock together with supply shocks and an imperfect correlation between capital and labour endowment are therefore crucial in matching the optimal holdings predicted by the model with the data.

4.4 SENSITIVITY ANALYSIS

Going back to the model with incomplete financial markets a number of sensitivity checks are conducted. It is still focused on the two cases of elasticity of substitution of $\theta = 1.5$ and elasticity of substitution of $\theta = 0.9$ but a wider range of parameter values for the steady state Home bias in consumption $\overline{\omega}$ and the relative risk aversion ρ is reported graphically. Additionally, also results for a low variance of the demand shock of 0.01^2 are reported. The results are plotted in Figures 1-4 in Appendix C. There it is shown how Home's holdings of Foreign issued equity and Foreign issued real bonds as well as the share of equity in Home's cross-border portfolio change with the home bias in consumption and the relative risk aversion.

The overall conclusion is that the empirical findings are in line with the model predictions for a wide range of parameters. Importantly, the model predicts that, as in the data, holdings of foreign debt are increasing strongly with trade intensity while the response of holdings of foreign equity is modest. This pattern shapes the prediction that the share of equity is decreasing with bilateral trade. In this way the model can successfully replicate the empirical findings.

5 Conclusion

In this paper, I uncover a cross-border financial diversification motive related to goods and services trade. I use the IMF CPIS panel data set for a broad set of country pairs and for the period 2001-2012 and find empirical evidence that the share of equity in a bilateral portfolio decreases with bilateral trade. Holdings of foreign debt are the driving force behind this pattern. Rising trade intensity is strongly related to rising holdings of foreign debt and less so to holdings of foreign equity.

In the theoretical part of this paper I study in a two country model (very similar to the model studied in Devereux and Sutherland (2010)), how the variation in the trade intensity between the two countries changes the composition of equity and debt in the cross-border portfolio. The representative agent in each country is active in frictionless trade in equity and real bonds. Uncertainty comes from supply shocks to capital income and to non-insurable labour income as well as from a global preference shock.

For a reasonable calibration, the model predicts positive holdings of foreign equity and foreign bonds as well as equity home bias (all of which is consistent with the data). Foreign equity is used to hedge against the supply shocks while foreign bonds are used to hedge against the global preference shock. Starting from this benchmark, I conduct comparative statics by allowing for variations in the home bias in consumption. The qualitative results are in line with the empirical findings. A lower home bias in consumption increases the trade intensity and leads to a strong increase in the holdings of foreign bonds and a very small decrease in foreign equity. This implies that the share of equity in the cross-border portfolio decreases with goods and services trade. This pattern is in line with the empirical findings.

The findings have important implications for cross-border linkages. In the introduction some evidence is discussed on that in many countries large foreign debt inflows majorly fueled the boom in credit supply that contributed to the housing boom and bust cycle which preceded the recent financial crisis. In general, there is some consensus that financial integration has different effects on macroeconomic outcomes and financial stability when it is debt-driven as opposed to when it is equity-driven. In this study I argue that bilateral trade shapes the composition of a bilateral portfolio. Increasing trade intensity leads to a decline in the share of equity in the portfolio, making financial integration more debt-driven.

Important issues remain. In the model it is abstracted from production but instead an endowment economy is considered. One reason is that in a model with many different sources of uncertainty and relative prices it is more intuitive to study an endowment economy than an production economy. More importantly, the labour supply decision of the agent and the investment decision of the firm complicate the analysis. Coeurdacier et al. (2010) study a two-country model with production and capital accumulation where equity and bonds are traded without frictions across two countries. They focus on explaining the equity home bias and how it changes with trade. For reasonable parameter values, their model yield negative holdings of foreign bonds and the holdings of foreign bonds *decrease* with foreign trade. These predictions are at odds with the evidence presented in this study.

Another remaining question is the role of higher order effects. In the model studied here the choice between foreign equity and foreign bonds is shaped by first order effects and the absolute variance of the shock processes does not have much of an impact on the composition of the cross-border portfolio. Intuitively, higher order effects might also play a role in the choice between equity and debt. This drawback of the model is related to the well known problem of macroeconomic models to match the equity premium. It can potentially be solved by studying a different class of preferences, as, for example, in Epstein and Zin (1989).

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Appendix A: Data description and variable construction

5.1 LIST OF SOURCE COUNTRIES IN THE FINAL SAMPLE

Argentina, Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Israel, Italy, Japan, Malaysia, Netherlands, Norway, Poland, Portugal, Russian Federation, Slovak Republic, Spain, Sweden, Thailand, Turkey, United Kingdom, United States

5.2 LIST OF HOST COUNTRIES IN THE FINAL SAMPLE

Argentina, Australia, Austria, Belgium, Canada, China, P.R.: Mainland, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, Japan, Malaysia, Netherlands, Norway, Poland, Portugal, Russian Federation, Slovak Republic, Slovenia, Spain, Sweden, Thailand, Turkey, United Kingdom, United States

5.3 DESCRIPTION OF THE EMPIRICAL VARIABLES

Bilateral portfolio equity holdings: Portfolio equity securities issued by host country residents and held by source country residents for 2001-2012. Source: IMF Coordinated Portfolio Investment Survey.

Bilateral portfolio long-term debt holdings: Portfolio long-term debt securities issued by host country residents and held by source country residents for 2001-2012. Source: IMF Coordinated Portfolio Investment Survey.

Share of equity in a bilateral portfolio: Bilateral portfolio equity holdings divided by sum of bilateral portfolio equity holdings and bilateral portfolio long-term debt holdings.

Third-country portfolio equity holdings: Total source country cross-border portfolio equity holdings minus bilateral portfolio equity holdings.

Third-country portfolio long-term debt holdings: Total source country cross-border portfolio long-term debt holdings minus bilateral portfolio long-term debt holdings.

Third-country equity share: Third-country portfolio equity holdings divided by sum of third-country portfolio equity holdings and third-country portfolio long-term debt holdings.

Domestic portfolio equity holdings: Domestic stock market capitalization (Source: Standard & Poors Global Stock Market Factbook) minus aggregate of foreign residents held domestic equity (Source: IMF CPIS).

Domestic portfolio debt holdings: Domestic debt market capitalization (Source: BIS Quarterly Review: December 2014, Table 18) minus aggregate of foreign resident held domestic long-term debt (Source: IMF CPIS).

Domestic equity-debt ratio: Domestic portfolio equity holdings divided by domestic portfolio debt holdings.

Partner portfolio equity holdings: Partner country stock market capitalization (Source: Standard & Poors Global Stock Market Factbook) minus bilateral portfolio equity holdings (Source: IMF CPIS).

Partner portfolio debt holdings: Partner country debt market capitalization (Source: BIS Quarterly Review: December 2014, Table 18) minus bilateral portfolio long-term debt holdings (Source: IMF CPIS).

Partner equity-debt ratio: Partner portfolio equity holdings divided by partner portfolio debt holdings.

Bilateral trade: Sum of imports plus exports between source and host country. Bilateral trade is in most specifications normalized by source country GDP or source country total trade. Also, it is measured as a 5-years backward looking moving average. Source: International Monetary Fund, Direction of Trade Statistics.

Gravity variables (2005 values): Log distance between capitals, contiguity, common language dummy, log of area of host and source country, former colony dummy, time difference in hours, common currency dummy, common legacy dummy, log of population in host and source country. Source: CEPII database.

Appendix B: Definition of Equilibrium

An equilibrium is a set of quantities C_t, C_t^*, $C_{H,t}$, $C_{F,t}$, $C_{H,t}^*$, $C_{F,t}^*$, Y_t, $Y_{K,t}$, $Y_{L,t}$, Y_t^*, $Y_{K,t}^*$, $Y_{L,t}^*$, prices P_t, P_t^*, $P_{H,t}$, $P_{H,t}^*$, $P_{F,t}$, $P_{F,t}^*$, $Z_{E,t}$, $Z_{E^*,t}$, $Z_{B,t}$, $Z_{B^*,t}$ rate of returns $R_{E,t}$, $R_{E^*,t}$, $R_{B,t}$, $R_{B^*,t}$, shocks D_t, $\varepsilon_{K,t}$, $\varepsilon_{L,t}$, $\varepsilon_{K,t}^*$, $\varepsilon_{L,t}^*$ and steady-state asset holdings $\overline{\alpha}_E$, $\overline{\alpha}_{E^*}$, $\overline{\alpha}_B$, $\overline{\alpha}_{B^*}$ for all $t \geq 0$, which satisfy the following conditions:

1. The market clearing conditions for the Home and Foreign final good (18,19).
2. The market clearing conditions for equity and real bonds (15,16).
3. The Home household's budget constraint (17) and the Foreign equivalent.
4. The household's first order conditions for asset purchases (21, 22, 23, 24).

Appendix C: Sensitivity Analysis

Changing relative risk aversion ρ in the case of $\theta = 1.5$

Figure 3
Sensitivity analysis with $\theta = 1.5$ and benchmark variance for the demand shock.

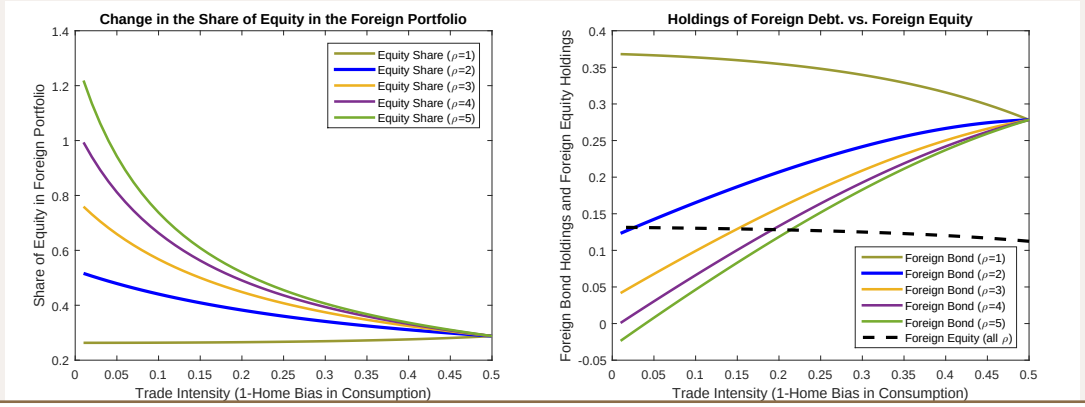
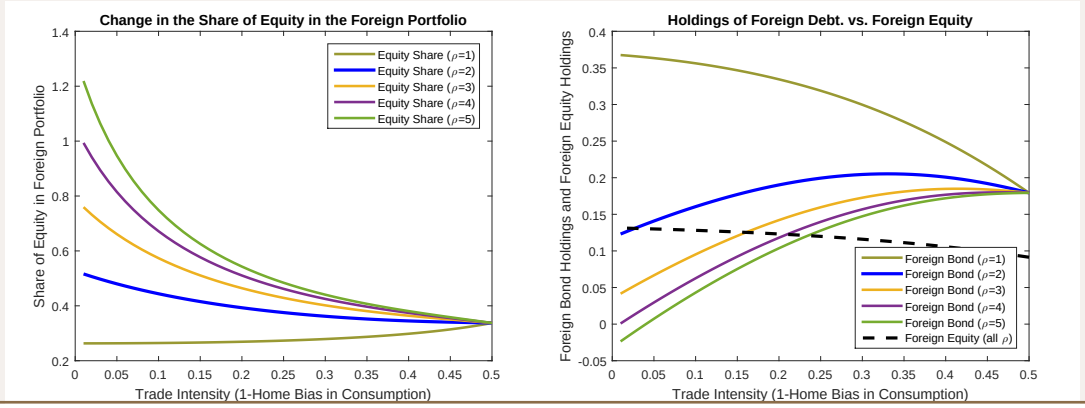


Figure 4
Sensitivity analysis with $\theta = 1.5$ and low variance for the demand shock.



Changing relative risk aversion ρ in the case of $\theta = 0.9$

Figure 5
Sensitivity analysis with $\theta = 0.9$ and benchmark variance for the demand shock.

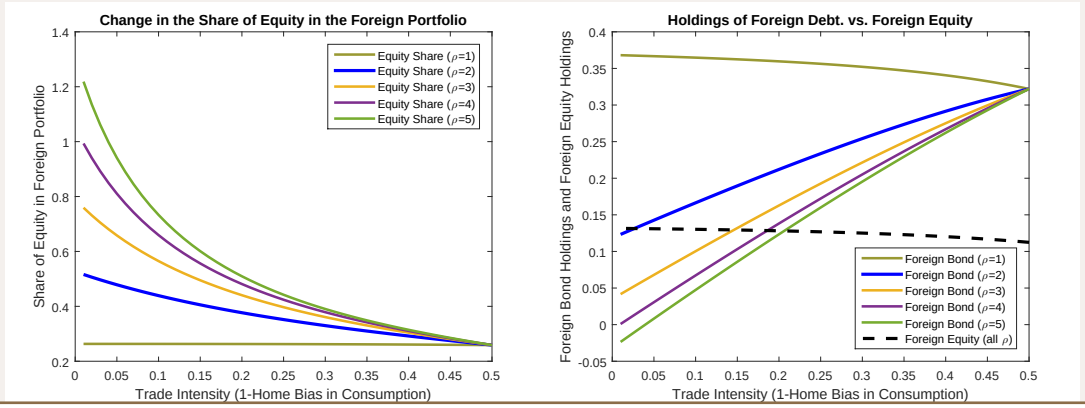
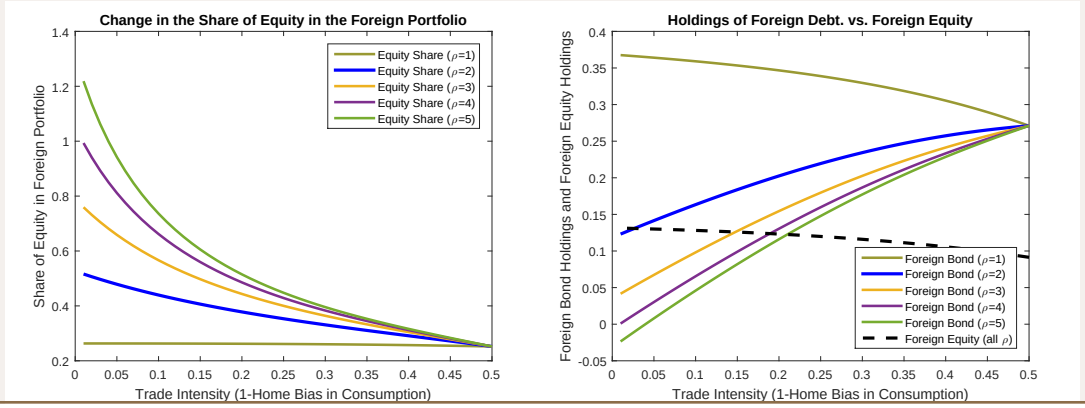


Figure 6
Sensitivity analysis with $\theta = 0.9$ and low variance for the demand shock.



MNB Working Papers 2

Cross-Border Portfolio Diversification under Trade Linkages

Budapest, January 2017