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, we find empirical evidence that the share of equity in a bilateral portfolio decreases with bilateral trade. The 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 with supply and preference shocks and frictionless cross-border trade in equity and real bonds. For reasonable parameter values, increasing goods trade induces the risk-averse representative agent to adjust her portfolio of bilateral assets away from foreign equity and towards foreign bonds. The findings of this study provide an explanation for why cross-border portfolio investments are sometimes dominated by equity investments and sometimes dominated by debt investments. This is important since both are means of risk-sharing but differ with respect to their effects on macroeconomic outcomes and financial stability.

JEL Codes: F21, F36, F41, G11

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

During recent decades cross-border asset holdings have risen strongly while we also observe a high level of cross-border goods and services trade. 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, we 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, we 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 the bilateral trade share is related to a decrease in the share of equity in the bilateral portfolio of 1.2 percentage points. We 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 for some specifications not significant or even significantly negative.

We 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

\(^1\)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!
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 steady state home bias in consumption determines the steady state level of trade intensity versus the partner country.

As is relatively standard, for reasonable parameter values 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. The supply shock alone can not account for a positive amount of holdings of foreign equity and a positive amount of holdings of foreign bonds as observed in the data. A crucial ingredient of the model is therefore the global preference (demand) shock, modeled 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 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 have important implications for interpreting the macroeconomic effects of cross-border linkages. In general, both debt and equity are means of risk-sharing but are conceptually 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 (2013)

²As 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 where 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).
document that in the Euro area 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 such increasing credit supply leads to rising housing prices, which causes greater financial instability (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 then 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 vs. the partner country’s stock market or measures of the comovement of the domestic and partner country’s business cycles, respectively. These findings provide some evidence hinting towards a diversification motive in cross-border equity holdings that is related to trade. 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 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, we 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 we normalize the variables properly, exclude country pairs that have no relevant investment relationship and account for country-pair fixed effects in the regression, then the evidence on the relationship between goods trade and foreign equity holdings is for some important specifications insignificant or even significantly negative. On the contrary, the relationship between goods trade and holdings of foreign bonds is significantly positive independent of the specification.

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 van 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 where the terms of trade mechanism plays an important role (cf. inter alia Pavlova and Rigobon 2010; Coeurdacier et al. 2009,2010; 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. We employ a set up borrowed from Devereux and Sutherland (2010) 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 home bias in consumption. Importantly, the two-country structure of the model is consistent with the empirical model where we focus on within country-pair analysis.³

The rest of the study is organized in the following way: In the next section we describe the econometric approach and present the main empirical results of this study. In section 3 we introduce the model setting. In section 4 we conduct the quantitative analysis as well as a sensitivity analysis. We conclude in section 5.

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

In this section we examine the empirical relationship between the share of equity in a bilateral portfolio and bilateral goods and services trade. We also examine the extent to which bilateral equity and/or bilateral debt holdings are shaping the results. We take advantage of the panel structure of the IMF CPIS data (which is described in more detail below). This allows us to study the role of changing trade intensity for portfolio diversification for a broad set of country pairs. By doing so we are able to control for time-invariant heterogeneity by including country-pair fixed effects.⁴

³Cf. Coeurdacier and Rey (2013) for a more detailed review of the literature.
⁴This concerns time-invariant variables like country size, distance, common border and other typical ingredients of gravity equations. Additionally, we can control for other
In the following, we will always take 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.

The underlying econometric model is based on the following fixed effects panel model specification:

\[
equityshare_{AB,t} = \alpha + \beta_{\text{trade}}^{t} \text{trade}_{AB,t} + \beta_{\text{controls}}^{t} \text{controls}_{AB,t} + \delta_{t} + \gamma_{AB} + u_{AB,t}. \tag{1}
\]

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

\[
equityshare_{AB,t} = \frac{\text{equity}_{AB,t}}{\text{equity}_{AB,t} + \text{debt}_{AB,t}} \tag{2}
\]

where \(\text{equity}_{AB,t}\) is the absolute amount of country B issued equity that is held by country A at the end of period \(t\) and \(\text{debt}_{AB,t}\) 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 variable can be interpreted as a measure of how risky aggregate portfolio holdings of country A in a country B are.\(^6\)

The majority of existing empirical contributions study the determinants of the absolute amount of bilateral equity (or debt) holdings.\(^7\) 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, we do not have to adjust for inflation or potential non-stationary properties of the time series. Third, the variable is not affected by the economic size of the source or the host country (e.g. size, population or market capitalization). Fourth, importantly, the measure allows us to study whether an expansion or (contraction) in foreign assets that is related to trade is equity or debt-driven.

\(^5\)We only include long-term debt securities, which are assets that have a maturity of more than one year. In a robustness analysis, we use the sum of both, long-term and short-term debt and the analysis yields similar results.

\(^6\)Note that \(\text{equity}_{ij,t}\) and \(\text{debt}_{ij,t}\) 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.

\(^7\)Pericoli et al. (2013) is one exception, where the authors examine the share of bilateral equity in total cross-border equity holdings.
The variable \( \text{trade}_{AB,t} \) denotes bilateral trade, which we measure in the baseline regression as the sum of bilateral exports of \( A \) to \( B \) and bilateral imports of \( A \) from \( B \), divided by the sum of exports and imports of \( A \) to and from the rest of the world. In order to obtain a measure that described the level of trade integration, we take a backward-looking five year moving average of this variable.\(^8\)

The vector \( x_{AB,t} \) captures control variables which include some measures of the share of equity in the domestic portfolio and the share of equity in the portfolio holdings in third-party countries (rest of the world). With the domestic portfolio we refer to equity and debt securities that are held by residents and also issued by residents. The third-party country portfolio describes equity and debt securities that are held by residents and issued by non-residents that live outside the partner country of interest. The purpose of including these measures is to control for exogenous changes in risk preferences of agents (e.g. changing risk aversion) as well as to control for potential portfolio changes that occur outside of a bilateral relationship. Agents might, for example, hedge against increasing bilateral trade intensity by adjusting their domestic or rest-of-the-world (third-party) portfolio. In the set of controls we also include a variable that measures debt safety in the partner country. By doing so we aim at controlling for a potentially changing spread between equity and debt returns. The variable construction and the data sources are explained in more detail below and in Appendix A.

In most of the specifications we assume fixed effects \( \gamma_{AB} \) where \( \sum_{AB} \gamma_{AB} = 0 \) and \( u_{AB,t} \) is the error term. We include time dummies \( \delta_t \) in order to control for a common trend.

### 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 portfolio investments and does not include foreign direct investment (FDI), reserves or other investments, such as trade loans.\(^9\) The CPIS survey is conducted on an annual basis, starting

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\(^8\)We also report results where we normalize the variables by source country GDP instead of trade with the rest of the world. In some specifications we also use a two dimensional vector with bilateral exports (divided by total exports) and bilateral imports (divided by total imports) in order to distinguish the role of the two. The results are also robust if we do not take a five year backward looking moving average, but consider only the current observation.

\(^9\)The IMF classifies cross-border capital flows into five functional categories: portfolio investments, direct investments, reserve assets, financial derivatives other than reserves and
from 2001. Participating countries report international portfolio investments of their residents. A big 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.

The panel includes almost all advanced economies and also many emerging economies. We follow the literature in excluding small open economies with main financial centers (such as Luxembourg, Bermuda and the Cayman Islands) both as source and as host countries (cf. Lane and Milesi-Ferretti 2008). Additionally, we exclude bigger countries that are known as tax havens (Switzerland, Singapore, Hong Kong, Ireland) also both as source and as host countries.

For goods and services trade data we make use of the IMF Directions of Trade statistics (DOT). In order to control for the share of equity in the domestic portfolio of agents we employ stock and debt market capitalization from the Standard & Poors Global Stock Market Factbook and from the BIS Quarterly Review, respectively. For computing the share of equity in the cross-border portfolio held in third-party countries we again use the CPIS. We use a measure of foreign debt market safety from the International Country Risk Guide. Data for GDP is obtained from the IMF World Economic Outlook. 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, we 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.\footnote{With this restriction spurious results from irrelevant bilateral investment relations can be avoided. For sensitivity checks, we use two alternatives for identifying relevant cross-border asset trade relationship. (1) we consider a higher threshold, such that bilateral portfolio investments have to account for more than ten per cent of the source country’s total cross-border portfolio investment and (2) we do not use a threshold but restrict the original sample 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). Both alternatives yield similar results.}

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).

\footnote{For an evaluation of the database, cf. Hau and Rey (2009) who find that the aggregate CPIS database is consistent with micro level data.}
<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>Std.Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of Equity in Bilateral Portfolio</td>
<td>0.352</td>
<td>0.27</td>
<td>0.290</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total Cross-Border Equity (% GDP)</td>
<td>0.249</td>
<td>0.19</td>
<td>0.222</td>
<td>0.0001</td>
<td>1.0043</td>
</tr>
<tr>
<td>Total Cross-Border Debt (% GDP)</td>
<td>0.356</td>
<td>0.32</td>
<td>0.293</td>
<td>0.0013</td>
<td>1.1716</td>
</tr>
<tr>
<td>Bilateral Trade (% GDP)</td>
<td>0.042</td>
<td>0.02</td>
<td>0.062</td>
<td>0.0003</td>
<td>0.5287</td>
</tr>
<tr>
<td>Bilateral Trade (% Total Trade)</td>
<td>0.058</td>
<td>0.04</td>
<td>0.070</td>
<td>0.0009</td>
<td>0.7641</td>
</tr>
<tr>
<td>Total Trade (% GDP)</td>
<td>0.718</td>
<td>0.60</td>
<td>0.412</td>
<td>0.1747</td>
<td>1.767</td>
</tr>
</tbody>
</table>

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.

The panel is unbalanced and cover 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 3111 observations and covers a broad set of 344 country pairs. The list of source countries in the sample can be found in Appendix A. Descriptive statistics of the dataset are reported in Table 1.

2.2 Dealing with a fractional dependent variable

One complication emerges for the estimation due to the fact that the dependent variable is observed to lie within zero and one. For censored variables OLS estimators of the linear model in (1) are inconsistent. We follow the literature and employ three alternative econometric models for dependent variables that are censored between zero and one: (1) A log-odds transformation $\ln\left(\frac{z_{ij,t}}{1-z_{ij,t}}\right)$ of all fractional variables (cf. inter alia Wooldridge 2010, Chapter 16); (2) a fixed effects Tobit model and (3) the fractional regression approach introduced by Papke and Wooldridge (2008).

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12 An indication of this problem is that estimating the linear model produces non-normal distributed residuals.

13 For the log-odds transformation all censored variables in the regression are transformed. Note that the transformation is monotone, which implies that the estimation reveals the correct sign of the coefficients but the parameters are not informative and a straightforward re-transformation can not be obtained (as discussed in Wooldridge 2010). Another disadvantage of this approach is that observed zeros and ones can not be trans-
2.3 Empirical Findings

In Table 2 we present the results for all three alternative approaches of dealing with a dependent variable that is observed to lie between zero and one. 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. In the following statement we summarize the main empirical result of this paper. 

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 trade share (i.e. the share of bilateral trade in the total trade of a source country) is associated with a decrease in the share of equity in the bilateral portfolio by approximately 1.2 percentage points. 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 1.4 percentage points.

We conduct robustness analysis along several dimensions: (1) We included long-term and short-term debt in computing the dependent variable instead of only using long-term debt; (2) we used different definitions of a relevant bilateral portfolio investment relationship as described above; (3) we measured the trade variables not as a 5-year backward-looking transformation but in current values and (4) we included foreign direct investment (FDI) as an independent variable. For the last case we use FDI data from the IMF Coordinated Direct Investment Survey (CDIS), which shortens the sample to the time period 2009-2012. Importantly, the results are similar in all four cases.

In another empirical exercise we run the same regression as in the benchmark case but instead of using trade as independent variable we include exports and imports such that...
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. 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 that foreign equity 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 bond 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 we 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 the two variables are allowed to have different coefficients. Exports are always highly significant and negative. The pattern is a little bit different for imports. In the relevant regressions including controls the variable is either significantly negative or insignificant with a positive sign. In order to identify such a stronger role of exports, one should study a model of global imbalances. We leave this for future research and for the moment follow Lane and Milesi-Ferretti (2008) in reporting results only for the aggregate trade variable.

16 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), di Giovanni and Levchenko (2010), Cacciatore and Ghironi (2014) and references therein.
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 we run the same regression, but use measures of equity, or respectively, measures of debt as the dependent variable. By doing so we study whether the numerator or the denominator in the equity share variable are related to goods and services trade.

The baseline exercise is very 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. An important difference is that Lane and Milesi-Ferretti (2008) study a cross-section for the year 2001, while we employ a whole panel, where we control for heterogeneity by including country pair fixed effects. Another difference is that, to be consistent with the other regressions described above, we use the sample that excludes country pairs with irrelevant portfolio relations. Additionally, we re-estimate some of the regressions 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, we differ from their study by having a smaller sample. Finally, we repeat all the regressions for bilateral debt holdings.

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, we find a significantly positive sign (in line with the results in Lane and Milesi-Ferretti 2004; 2008). However, we do not always obtain significant results when the dependent variable is measured in relative terms. For example, in the case where we measure the trade variable in terms of the source country GDP and bilateral equity holdings in absolute values (both log-transformed), we obtain a very small and insignificant coefficient. Note that this case is the one where the model below is best comparable to the empirical model. Interestingly, the sign of the equity variable is even negative and highly significant once we measure the bilateral equity holdings in terms

\footnote{Pericoli et al. (2014) also use the whole CPIS panel and further econometric models to reassess the findings in Lane and Milesi-Ferretti (2008).}

\footnote{This is different to the finding of Pericoli et al. (2013) who find a positive significant effect. The difference to their study is that we exclude irrelevant country pairs from the sample. Including such pairs depends, of course, on the context of the study.}
of the source countries total equity holdings and the trade variable in terms of source country GDP.

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 we describe the theoretical model and examine the extent to which the empirical findings are in line with the theoretical predictions.
Table 2:  *Dependent variable: share of equity in the bilateral portfolio. Panel regression, 2001-2012.*

<table>
<thead>
<tr>
<th></th>
<th>Log-odds transformation</th>
<th>Tobit</th>
<th>Papke, Wooldridge (2008)</th>
<th>Trade per GDP (Tobit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilateral Trade</td>
<td>-0.682***</td>
<td>-1.426***</td>
<td>-1.203*</td>
<td>-1.466***</td>
</tr>
<tr>
<td></td>
<td>(0.133)</td>
<td>(0.243)</td>
<td>(0.692)</td>
<td>(0.238)</td>
</tr>
<tr>
<td></td>
<td>-0.606***</td>
<td>-1.288***</td>
<td>-1.249*</td>
<td>-1.447***</td>
</tr>
<tr>
<td></td>
<td>(0.128)</td>
<td>(0.231)</td>
<td>(0.682)</td>
<td>(0.226)</td>
</tr>
<tr>
<td>Third-country equity share</td>
<td>0.683***</td>
<td>0.507***</td>
<td>0.450***</td>
<td>0.510***</td>
</tr>
<tr>
<td></td>
<td>(0.042)</td>
<td>(0.028)</td>
<td>(0.068)</td>
<td>(0.028)</td>
</tr>
<tr>
<td>Domestic equity share</td>
<td>0.091***</td>
<td>-0.001</td>
<td>-0.000</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
<td></td>
<td>(0.001)</td>
<td></td>
</tr>
<tr>
<td>Partner Debt Safety</td>
<td>0.051***</td>
<td>0.005***</td>
<td>0.006***</td>
<td>0.005***</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.001)</td>
<td>(0.021)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.859***</td>
<td>0.835***</td>
<td>0.784***</td>
<td>0.196***</td>
</tr>
<tr>
<td></td>
<td>(0.434)</td>
<td>(0.032)</td>
<td>(0.030)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-4.282***</td>
<td>0.255***</td>
<td>0.196***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.550)</td>
<td>(0.059)</td>
<td>(0.057)</td>
<td></td>
</tr>
<tr>
<td>Time dummies</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Fixed effects</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>N</td>
<td>3060</td>
<td>3111</td>
<td>3111</td>
<td>3109</td>
</tr>
<tr>
<td># Country Pairs</td>
<td>340</td>
<td>344</td>
<td>344</td>
<td>344</td>
</tr>
</tbody>
</table>

Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% confidence level, respectively. In the case where the variables are transformed with a log-odds transformation observations are excluded were the variable takes the value 0 or 1. In the case of including controls or normalizing the trade variable by GDP two observations are excluded because of missing values.
Table 3:  \textit{Dependent variable: source country holdings of host country issued equity or debt (respectively). Panel regression, 2001-2012.}

<table>
<thead>
<tr>
<th></th>
<th>All variables in in level (log transformed), OLS</th>
<th>All variables normalized (Log-odds transformation)</th>
<th>All variables normalized, (Tobit)</th>
<th>All variables normalized, Trade per GDP (all log transformed)</th>
<th>All variables normalized, Trade per GDP (Tobit)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equity</td>
<td>Debt</td>
<td>Equity</td>
<td>Debt</td>
<td>Equity</td>
</tr>
<tr>
<td><strong>Bilateral Trade</strong></td>
<td>0.788***</td>
<td>1.112***</td>
<td>0.079</td>
<td>0.650***</td>
<td>0.091</td>
</tr>
<tr>
<td></td>
<td>(0.085)</td>
<td>(0.0712)</td>
<td>(0.097)</td>
<td>(0.083)</td>
<td>(0.081)</td>
</tr>
<tr>
<td></td>
<td>13.526***</td>
<td>11.324***</td>
<td>-3.167***</td>
<td>-0.947</td>
<td>0.173***</td>
</tr>
<tr>
<td></td>
<td>(0.756)</td>
<td>(0.629)</td>
<td>(0.316)</td>
<td>(0.272)</td>
<td>(0.011)</td>
</tr>
<tr>
<td><strong>Time dummies</strong></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>Country Pair Fixed effects</strong></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>Country Dummies</strong></td>
<td>x</td>
<td>x</td>
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<td>N</td>
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<td>3109</td>
</tr>
<tr>
<td></td>
<td># Country Pairs</td>
<td>342</td>
<td>343</td>
<td>344</td>
<td>344</td>
</tr>
</tbody>
</table>

Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% confidence level, respectively. In the case where variables are transformed with a log transformation observations are excluded where the variable takes the value 0. In the case where the variables are transformed with a log-odds transformation observations are excluded where the dependent variable (or the independent variable in the case of shares) takes the value 0 or 1. In the case of including controls or normalizing the trade variable by GDP observations are excluded because of missing values.
3 Trade and Portfolio Choice in a Two-Country Two-Good Model

We 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, we abstract from production but consider an endowment economy. The benchmark model is a two-country two-goods model borrowed from Devereux and Sutherland (2010). 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 tradable 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.

\[^{19}\] Devereux and Sutherland (2010) study the model in the context of external valuation channels. In the model described here we assume a different maturity for the long-term bonds.
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, we 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.\(^{20}\)

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). We focus on describing the Home economy and, unless otherwise stated, the same relations hold equivalently for the Foreign economy.

### Household’s consumption

The utility function of the representative agent is described by the standard constant relative risk aversion representation\(^{21}\)

\[
U_0 = E_0 \sum_{t=0}^{\infty} \beta^t \left[ \frac{C_t^{1-\rho}}{1-\rho} \right]. \tag{3}
\]

\(^{20}\)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.

\(^{21}\)In the case of \(\rho = 1\) the utility function converges to \(U_0 = E_0 \sum_{t=0}^{\infty} \beta^t \ln C_t\).
where $\rho$ is the relative risk aversion parameter. In this specification the inter-temporal elasticity of substitution is given by $1/\rho$.

The Home consumption good is assumed to be a bundle

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

where $\omega_t$ denotes the preference parameter for Home goods. $\theta$ 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

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

The associated Home consumer price index (CPI) is

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

**Output processes**

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

$$Y_t = Y_{K,t} + Y_{L,t}. \quad (7)$$

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).

The income processes follow

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

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

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

A global preference shock shifts the home bias in consumption

$$
\omega_t = \omega D_t \quad \omega_t^* = \omega^*(-D_t)
$$

where

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

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

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

$$
R_{E,t+1} = \frac{Y_{kt+1}P_{H,t+1} + Z_{E,t+1}}{Z_{E,t}} \quad R_{E^*,t+1} = \frac{Y_{k,t+1}^*P_{F,t+1} + Z_{E^*,t+1}}{Z_{E^*,t}}
$$

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

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

$$
R_{B,t+1} = \frac{P_{H,t+1} + Z_{B,t+1}}{Z_{B,t}} \quad R_{B^*,t+1} = \frac{P_{F,t+1} + Z_{B^*,t+1}}{Z_{B^*,t}}.
$$
where $R, R^*$ and $Z, Z^*$ denote gross returns and prices of real bonds (in terms of the Home consumption good).\footnote{The maturity of the real bond does not change the basic mechanism of the model. We do some sensitivity analysis where 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

$$\text{NFA}_{t} = B_{F,t} + s_{E^*,t}Z_{E^*,t} - s_{E,t}Z_{E,t} - B_{H,t}$$

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

$$B_{H,t} = -B_{H,t}^* s_{E,t} + s_{E^*,t}^* = 1,$$

and for Foreign issued assets

$$B_{F,t} = -B_{F,t}^* s_{E^*,t} + s_{E,t}^* = 1.$$  

**Budget constraint and financial asset holdings**

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

$$\text{NFA}_{t} = \text{NFA}_{t-1}r_{B,t} + Y_t * P_{H,t} - C_t +$$
$$+ \alpha_{E,t-1}(r_{E,t} - r_{B,t}) + \alpha_{E^*,t-1}(r_{E^*,t} - r_{B,t}) + \alpha_{B^*,t-1}(r_{B^*,t} - r_{B,t})$$

(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

\[ Y_t = C_{H,t} + C^*_{H,t}, \quad (18) \]

\[ Y^*_t = C^*_{F,t} + C_{F,t}. \quad (19) \]

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

\[ Q_t = \frac{P^*_t}{P_t}, \quad TOT_t = \frac{P_{F,t}}{P_{H,t}}. \quad (20) \]

**Consumption Euler equations**

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

\[ C^{-\rho}_t = \beta E_t[C^{-\rho}_{t+1}R_{E,t+1}], \quad C^{-\rho}_t = \beta E_t[C^{-\rho}_{t+1}R_{E^*,t+1}], \quad (21) \]

\[ C^{-\rho}_t = \beta E_t[C^{-\rho}_{t+1}R_{B,t+1}], \quad C^{-\rho}_t = \beta E_t[C^{-\rho}_{t+1}R_{B^*,t+1}], \quad (22) \]

\[ \frac{C^*_{t}^{-\rho}}{Q_t} = \beta E_t\left[\frac{C^*_{t+1}^{-\rho}}{Q_{t+1}}R_{E,t+1}\right], \quad \frac{C^*_{t}^{-\rho}}{Q_t} = \beta E_t\left[\frac{C^*_{t+1}^{-\rho}}{Q_{t+1}}R_{E^*,t+1}\right], \quad (23) \]

\[ \frac{C^*_{t}^{-\rho}}{Q_t} = \beta E_t\left[\frac{C^*_{t+1}^{-\rho}}{Q_{t+1}}R_{B,t+1}\right], \quad \frac{C^*_{t}^{-\rho}}{Q_t} = \beta E_t\left[\frac{C^*_{t+1}^{-\rho}}{Q_{t+1}}R_{B^*,t+1}\right]. \quad (24) \]
3.1 Equilibrium and Solution approach

We define a competitive equilibrium 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 we make 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 us to solve for portfolio demand.

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

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

(25)

where a hat denotes log-linearized variables and $\hat{R}_{x_{k,l}}$ 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 $\pi$ is given by

$$\bar{\pi} = \frac{\hat{\alpha}}{\beta Y}$$

(26)

$$\hat{\alpha} = [RR_2\Sigma DD'RR_1' - DD_1RR_2\Sigma RR_2']^{-1} RR_2\Sigma DD',$$

(27)

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

$$\hat{R}_{x_{k,l}} = RR_1\xi_{t-1} + RR_2\xi_{t-1}$$

$$\hat{C}_t - \hat{C}_t^* - \frac{1}{\rho}\hat{Q}_t = DD_1\xi_{t-1} + DD_2\xi_{t-1}.$$
The portfolio demand function (27) is iteratively computed given the solution to the policy functions obtained with the approach of Sims (2002).  

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, we find that increasing bilateral trade intensity is related to a decreasing share of equity in the bilateral portfolio. We also find that this result is driven by strongly rising holdings of foreign debt. Note that in the empirical part we took the perspective of a source country that holds equity and debt securities issued by one particular host country. For the model predictions, we will most of the time take the perspective of the Home economy versus the Foreign country. We 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 we will study a calibrated model version. 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. We 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.

---

23 An alternative approach for solving the model would be global solution methods. Rabitsch et al. (2014) 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. We infer that the DS algorithm also yields a sufficiently good approximation for the solution to the model studied here.
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 we will consider other values between $\rho = 1$ and $\rho = 5$.

There is little empirical evidence on the variance of the global demand shock. In the benchmark model we set the variance of the demand shock 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, we 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.

We calibrate the correlation between labour and capital income to $-0.214$ in order to match the average share of equity in a bilateral portfolio in the data. 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. We study two different cases: In the first case we set it equal to $\theta = 1.5$ (cf. inter alia Backus et al. 1992). For the second case we use the value obtained by Heathcote and Perri (2002) and set it equal to $\theta = 0.9$.

The comparative statics look at variation in the steady state trade intensity $1 - \omega$. In the benchmark calibration we therefore set the steady state home bias in consumption to $\omega = 0.70$ and look at variations within $\omega \in [0.68, 0.72]$. This calibration matches the median value of exports plus imports over GDP (cf. Table 1). In all calibrations Home and Foreign have the same steady state home bias in consumption $\omega = \omega^\prime$.

### 4.2 How does a change in the trade intensity affect the share of equity in the bilateral portfolio?

In the following exercise we study the comparative statics of a change in the steady state home bias in consumption $\omega$ in both countries. We study a stepwise reduction of the parameter by 0.01. One step is equivalent to a 1 percentage point increase in the trade intensity of Home versus Foreign, as
measured by exports plus imports divided by Home GDP (note that steady state GDP in the model is normalized to 1). Table 4 reports the results. It shows how a increasing trade intensity \((1-\omega)\) 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.\(^{24}\)

The calibrated model predicts that a one step decrease in the home bias in consumption leads to roughly a 0.4 percentage point decrease in the share of equity 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 we will discuss the main mechanism driving the results. It should be noted that the empirical results are larger in magnitude than the model predictions, mainly because in the data we find an even stronger increase of foreign debt holdings in response to increasing trade. Later, we will therefore also discuss the role of the elasticity of substitution, the relative risk aversion and the relative size of the shocks for the magnitude of the results.

<table>
<thead>
<tr>
<th>Trade intensity ((1-\omega))</th>
<th>Equity share in cross-border portfolio</th>
<th>Domestic holdings of foreign issued equity</th>
<th>Domestic holdings of foreign issued bonds</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.28</td>
<td>0.3595</td>
<td>0.1298</td>
<td>0.2313</td>
</tr>
<tr>
<td>0.29</td>
<td>0.3557 ((-0.0038))</td>
<td>0.1294 ((-0.00037))</td>
<td>0.2344 (0.0032)</td>
</tr>
<tr>
<td>0.30</td>
<td>0.3520 ((-0.0037))</td>
<td>0.1290 ((-0.00039))</td>
<td>0.2375 (0.0031)</td>
</tr>
<tr>
<td>0.31</td>
<td>0.3484 ((-0.0036))</td>
<td>0.1286 ((-0.00041))</td>
<td>0.2405 (0.0030)</td>
</tr>
<tr>
<td>0.32</td>
<td>0.3450 ((-0.0033))</td>
<td>0.1282 ((-0.00043))</td>
<td>0.2434 (0.0029)</td>
</tr>
</tbody>
</table>

Table 4: The effect of a change in goods trade intensity on domestic holdings of foreign equity and foreign bonds as well as on the share of equity in the cross-border portfolio. (Elasticity of substitution \(\theta = 1.5\)).

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.

\(^{24}\)Note that in the whole analysis, we normalize steady state equity and bond holdings by the steady state asset price. The steady state asset price is equal to \(\beta/(1 - \beta)\), both for equity and for real bonds.
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 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 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. In this case the market value of Home equity is relatively higher compared to Foreign equity. We then have, that with higher trade intensity Home equity is a better hedge against Foreign supply shocks compared to Foreign equity. As an implication, holdings of

\footnote{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.}
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. We should note 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 (Table 4) we have that the effect is strongly positive.

In the sensitivity analysis below we will study a larger range of values of (1) the trade intensity, (2) the relative risk aversion, (3) the elasticity of substitution and (4) the relative size of the demand shock. In a nutshell, holdings of foreign bonds are typically increasing with trade intensity. There is, however, a limited range of parameters 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 we also want to consider the special case of a low elasticity $\theta = 0.9$ (which is obtained by 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 quite robust for a number of parameter combinations (cf. the sensitivity analysis below). For illustrative purposes we change the relative risk aversion to a higher value of $\rho = 3$ and increase 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 Table 5.

Again, the pattern is in line with the empirical findings. 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 hold-
ings of foreign equity is slightly smaller. We can conclude that, under this calibration, the model predictions are in comparison with the benchmark case quantitatively better matching the magnitude of the empirical results. 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).

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<table>
<thead>
<tr>
<th>Goods trade intensity (1-ω)</th>
<th>Equity share in cross-border portfolio</th>
<th>Domestic holdings of foreign issued equity</th>
<th>Domestic holdings of foreign issued bonds</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.28</td>
<td>0.3857</td>
<td>0.1319</td>
<td>0.2100</td>
</tr>
<tr>
<td>0.29</td>
<td>0.3786 (-0.0071)</td>
<td>0.1316 (-0.00025)</td>
<td>0.2160 (0.0060)</td>
</tr>
<tr>
<td>0.30</td>
<td>0.3717 (-0.0069)</td>
<td>0.1313 (-0.00026)</td>
<td>0.2220 (0.0060)</td>
</tr>
<tr>
<td>0.31</td>
<td>0.3650 (-0.0067)</td>
<td>0.1311 (-0.00027)</td>
<td>0.2280 (0.0060)</td>
</tr>
<tr>
<td>0.32</td>
<td>0.3586 (-0.0064)</td>
<td>0.1308 (-0.00029)</td>
<td>0.2340 (0.0059)</td>
</tr>
</tbody>
</table>

Table 5: The effect of a change in goods trade intensity on domestic holdings of foreign equity and foreign bonds as well as on the share of equity in the cross-border portfolio. (Elasticity of substitution \( \theta = 0.9 \), \( \rho = 3 \), high variance of global demand shock).

### 4.3 The role of incomplete financial markets

In the model we have 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 we will look at 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 than 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 we obtain full diversification in equities 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 $\sigma$. 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). 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 $\tilde{\theta} \equiv \frac{\rho + 2\omega}{2\rho\omega} - 1$, 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 $\theta = \tilde{\theta} \equiv \frac{\rho + 2\omega}{2\rho\omega} - 1$, 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.

Note that neither full equity home bias nor full equity diversification are supported by the data (cf. Table 1). 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, 26With perfect correlation the equilibrium would not be uniquely determined.
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 we conduct a
number of sensitivity checks. We still focus on the two cases of elasticity of
substitution of $\theta = 1.5$ and elasticity of substitution of $\theta = 0.9$ but we report
graphically a wider range of parameter values for the steady state Home
bias in consumption $\varphi$ and the relative risk aversion $\rho$. Additionally, we also
report results for a low variance of the demand shock of $0.01^2$. The results
are plotted in Figures 1-4 in Appendix C. There it is showed 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, we uncover a cross-border financial diversification motive re-
lated to goods and services trade. We 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 bilat-
eral trade. We also find that the driving force behind this pattern is holdings
of foreign debt. 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 we study in a model with a Home and
a Foreign country, how the variation in the trade intensity between the two
countries changes the composition of equity and debt in the cross-border
portfolio. We employ a relatively standard two-country two-goods model,
very similar to the model studied in Devereux and Sutherland (2010). 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, we look at variations in the home bias in consumption. The quantitative 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 we 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 we abstract from production but consider an endowment economy. 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 a 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 frictionlessly across two countries. They focus on explaining the equity home bias and how it changes with trade. For reasonable parameter values, their model yields a negative holding 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).
References


Julliard, C. (2003). The international diversification puzzle is not worse than you think. *International Finance, EconWPA.*


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 Description of the Empirical Variables

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

Total portfolio equity holdings: Total portfolio equity holdings held by source country residents as reported for 2001-2012. Source: IMF Coordinated Portfolio Investment Survey.

Third-country portfolio equity holdings: Total portfolio equity holdings minus bilateral portfolio equity holdings.

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

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

Total portfolio long-term debt holdings: Total portfolio equity holdings held by source country residents as reported for 2001-2012. Source: Coordinated Portfolio Investment Survey.
**Third-country portfolio long-term debt holdings:** Total portfolio long-term debt holdings minus bilateral portfolio long-term debt holdings.

**Domestic portfolio debt holdings:** Debt market capitalization (Source: BIS) minus aggregate of foreign resident held domestic debt (Source: IMF CPIS).

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

**Domestic equity share:** Domestic portfolio equity holdings divided by sum of domestic portfolio equity holdings and domestic portfolio debt holdings.

**Total trade:** Sum of imports plus exports between source country and Rest of the World (5-years backward looking moving average) 2001-2012. Source: International Monetary Fund, Direction of Trade Statistics.

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

Appendix B: Definition of Equilibrium

An equilibrium is a set of quantities $C_t, C^*_t, C_{H,t}, C^*_{H,t}, C_{F,t}, Y_t, Y_{K,t}$, $Y_{L,t}, Y^*_t, Y^*_{K,t}, Y^*_{L,t}$, 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 $D_t, \epsilon_{K,t}, \epsilon_{L,t}, \epsilon^*_{K,t}, \epsilon^*_{L,t}$ and steady-state asset holdings $\alpha_E, \alpha^*_E, \alpha_B, \alpha^*_B$ 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 $\rho$ in the case of $\theta = 1.5$

Figure 1: Sensitivity analysis with $\theta = 1.5$ and benchmark variance for the demand shock.

Figure 2: Sensitivity analysis with $\theta = 1.5$ and low variance for the demand shock.
Changing relative risk aversion $\rho$ in the case of $\theta = 0.9$

Figure 3: Sensitivity analysis with $\theta = 0.9$ and benchmark variance for the demand shock.

Figure 4: Sensitivity analysis with $\theta = 0.9$ and low variance for the demand shock.