The Puzzles on International Comovement: The Role of International Trade and Non-competitive Banking*

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Abstract

This paper finds a solution to some of the discrepancies between the data and what standard international RBC models with complete markets predict. Specifically, the results solve the "consumption - output" or "quantity" anomaly identified by Backus, Kehoe and Kydland (1992) and are consistent with the cross-country co-movement of investment and employment observed in the data. Importantly, it does so while still reproducing the countercyclicality of net exports and some stylized facts for the US banking sector.

A standard two-country RBC model is extended through the introduction of a "trade in goods channel" to the international transmission of productivity shocks, a non-competitive banking industry and endogenously countercyclical markups in the market for loans.

Cross-country consumption correlations significantly lower than those obtained by previous work are derived from three elements: The imperfect risk sharing implied by incomplete financial markets, a terms of trade effect and non weakly separable preferences

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1 Introduction

A major subject in the International Economics literature is the existence of discrepancies between the data and what standard models with complete markets predict regarding international co-movements of macroeconomic aggregates. These discrepancies were first identified by Backus, Kehoe and Kydland (1992 and 1994) for the United States and the OECD countries. They have been proved robust to various changes to parameter values and model structures and have therefore, been labeled "anomalies".

This paper focuses on two discrepancies. First, in the data, correlations of output across countries are larger than analogous correlations for consumption. With only a few exceptions previous work[1] obtains consumption cross-country correlations that significantly exceed output correlations. This "inconsistency" has been labeled the "consumption / output anomaly" or the "quantity" anomaly. Second, in the data investment and employment co-move across countries, while most models predict negative values for their cross-country correlation.

Based on empirical evidence characterizing the US banking sector and the production for capital, in this paper we build a model that is able to explain these anomalies through the introduction of two elements into an otherwise standard two-country dynamic general equilibrium model. First, we expand the standard model by allowing for international trade in goods, which provides a "trade channel" to the international transmission of productivity shocks. Second, we model financial market frictions. It is worth noting here that this is a truly general equilibrium model of the world economy where all prices, including the interest rate, are endogenous.

In this two-good model, each country exogenously specializes in the production of one of them, and imports the other. As in Stockman and Tesar

[1] See Appendix D for a table summarizing the literature's results.

(1998) and Heathcote and Perri (2002), trade in goods provides a channel to the international transmission of the effects of productivity shocks. When one of the countries is hit by a positive shock, the other faces an increased demand for the good it produces, which is an imperfect substitute for the shocked country's good, and some of the benefits spill over to the rest of the world[2].

Regarding the countries' capital accounts, in models with perfectly functioning credit markets, and no exogenous restrictions to capital mobility, capital would flow from the rest of the world into the country where productivity is relatively higher. This gives rise to the negative cross-country correlations of factors of production and to the very low cross-country output correlations generally obtained in theoretical models.

Conversely, in this economy we allow for financial imperfections. Entrepreneurs operate an increasing returns to scale technology for capital production, they need outside financing to build the capital stock, and these funds are obtained from an oligopolistic banking sector. To avoid game theoretic issues, no particular oligopoly model is solved here. Oligopolistic banks are modeled in a reduced form, which is general enough to provide the main mechanisms at work in the model.

This "global" oligopolistic banking sector gets deposits from households and lends to entrepreneurs in both countries. Banks set an interest rate on loans which exceeds the opportunity cost of funds. Consistent with empirical evidence on returns to scale in the investment sector and on the behavior of banking sector markups, increasing returns to the capital production process allow for the elasticity of the demand for credit to be positively related to investment and for markups that are both endogenous and countercyclical enough to match the data on cross-country correlations.

[2]Stockman and Tesar (1998) show how multiple goods can generate cross-country output correlations that are more consistent with the data.

Endogenously countercyclical markups for this non-competitive banking industry allow for a decreased flow of foreign savings into the economy that has benefited from a positive shock.

With a falling market power and a lower markup, the cost of credit falls in the economy that has benefited from a positive productivity shock, with respect to standard models that lack this friction. This impacts capital production, employment and the marginal utility of consumption in a way such that the rate of return on deposits ends up being countercyclical. Therefore, banks start using local deposits, which are now cheaper for them, to finance both domestic and foreign loans.

This modifies the direction of the international flows of capital with respect to standard models. It prevents capital from flowing from the rest of the world into the relatively more productive economy, and helps to get cross-country co-movement for investment, employment and output. Endogenously countercyclical markups drive the main mechanism working in this model. As previous work has shown, trade in goods is not enough to account for the positive correlation of macroeconomic aggregates across countries.

Financial markets are incomplete in this setup. Households have access to only one financial asset for consumption smoothing purposes. Imperfect risk sharing, together with non weakly separable preferences and a terms of trade effect given by the existence of two different goods allow for a significantly reduced consumption correlation across countries.

Previous work has used restrictions to international capital flows to get increased cross-country correlations of output and factors of production. For example, Heathcote and Perri (2002) model an economy where risk-sharing is completely prohibited; Kollman (1996) and Baxter and Crucini (1995) study economies where risk sharing is restricted by allowing agents to trade in only one risk-free financial asset; Kehoe and Perri (2002) study enforcement con-

straints that limit countries to keep the autarky level of utility below that of financially integrated economies; and Kollman (1996) introduces adjustment costs to investment. Imperfectly competitive product markets have also been used as a mechanism for the international transmission of productivity shocks (Ubide (1999), Cook (2002) and Head (2002)).

In general, the literature has been relatively unsuccessful at explaining the puzzles. Previous work has been able to only reduce the magnitude in which the cross-country correlation of consumption exceeds that of income. Regarding the international comovements of investment and employment, the most successful papers have reproduced at most one of them. Canova and Ubide (1998), Ubide (1999), Cook (2002) and Kehoe and Perri (2002) solve the anomalies. However, Canova and Ubide (1998) need disturbances to both market and household technologies. Ubide (1999) uses exogenous markup and government spending shocks to be able to reproduce the data. To obtain markups that are elastic enough to cause international comovement, Cook (2002) needs sequential entry and a first-mover advantage to incumbents in the market for differentiated final goods. Last, Kehoe and Perri (2002) cannot account for the countercyclicality of net exports, which is another key stylized fact for the US and OECD economies.

The "quantity anomaly" is solved here: the obtained cross-country consumption correlation is very close to that in the data and hence, lower than that for output. Also, positive cross-country correlations of output, investment and employment are obtained for the model with both a "trade channel" and endogenously countercyclical banking sector markups. These results are obtained while reproducing other stylized facts of the US and OECD economies, namely, the countercyclicality of net exports, the real interest rate and markups for the banking industry, and the positive cross-country correlation of bank spreads.

The results are robust to several checks performed on the structure of

the model. First, conclusions hold for a model where non-competitive banks can get only domestic deposits, while still lending to both countries. Second, endogenously countercyclical markups can be obtained with constant returns in the production for capital, and either deviating from the Cobb-Douglas assumption for goods production or modelling an endogenous number of banks. Third, the qualitative results stay unchanged for a model with Cobb-Douglas preferences.

Last, an important novelty of the paper is to produce a financial friction coming from the supply side of the loans market. Investment is financed by price setting banks with market power, that make cheaper loans available in good times. This implies a financial accelerator that, to my knowledge, has not been previously modeled.

Following this introduction, the structure of the paper is as follows. The data's stylized facts are shown in Section 2. Section 3 presents a review of the previous work addressing the "anomalies". The model is presented in Section 4. The intuition about how the key force driving the model's results is analyzed in Section 5. Section 6 contains the calibration and some preliminary results. Section 7 concludes. Appendix A illustrates how the market for loans works in this model. Appendix B discusses two alternative ways to obtain endogenously countercyclical markups for the banking industry. A slightly different model with a CES production function for goods is presented in Appendix C. It is shown there how endogenously countercyclical banking markups can also be obtained just by deviating from the Cobb-Douglas specification and the isoelastic demand for credit that it implies. A chart with a detailed review of the literature can be found in Appendix D. The last appendix is a stylized summary of the most important changes in regulation in the US banking sector.

2 The Data

In Table 1 we report cross-country correlations between the OECD countries and the US main macroeconomic aggregates, calculated using OECD Quarterly National Accounts and OECD Main Economic Indicators (MEI) data for the 1960-2002 period[3].

Two observations are worth making. First, output, investment, employment and consumption are all positively correlated across countries. Second, consumption correlations are lower than output correlations.

Table 1: The Data on International Comovements

ρ(C,C^*)	0.3311
ρ((C+G),$(C^* + G^*)$)	0.1918
ρ(Y,Y^*)	0.4496
ρ(I,I^*)	0.4151
ρ(L,L^*)	0.2167

Source: OECD Quarterly National Accounts and OECD MEI data available in Fabrizio Perri's webpage.
Notes: Correlations between the United States and Europe for logged and Hodrick-Prescott filtered data. The sample period is 1960:I - 2002:II.

Worthy of note is the fact that, as discussed in Heathcote and Perri (2003)[4], over time, business cycles in the US have become less correlated

[3]Data available in Fabrizio Perri's webpage. European data refer to the following 15 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and United Kingdom. Data for employment between 1972.1 and 1983.4 is only for the following subgroup: Austria, Finland, France, Germany, Italy, Norway, Spain, Sweden and United Kingdom. Data for employment between 1962.1 and 1971.4 is only for the following subgroup: Finland, Germany, Italy, Sweden and United Kingdom.

[4]Heathcote and Perri (2003) can account for this by a combination of changes in the nature of real shocks and an increase in US financial integration. The estimated process for TFP shocks changes very little. Increased risk-sharing tends to reduce the international

with those of the other OECD countries. Correlations calculated for the 1970-1990 period by Backus, Kehoe and Kydland (1992) are 0.51 for private consumption, 0.66 for output, 0.53 for investment and 0.33 for employment.

Figure 1 shows the positive co-movements referred to above.

Table 2 shows the cross-country correlations between the macroeconomic aggregates for the US and some European economies in particular. As shown there, the "consumption/output" anomaly is still a feature of the correlations with individual countries.

There are also credit markets data that this paper can match by modelling a non-competitive banking sector.

Bank spreads, defined as the difference between the interest rates on loans and deposits, are countercyclical in the US. In Europe, the same is true for Germany and the UK (see Table 3 for the data and spread specifications). Therefore, the degree of market power in the banking industry falls as the economy becomes more productive.

This can also be seen by looking at the number of banking institutions and branches. They are both procyclical. The correlation of the number of commercial banks branches to GDP is positive and equal to 0.13. That of the number of banking institutions to GDP equals 0.24. The evolution of the number of banking institutions and branches is plotted in Figure 2[5].

These correlations were calculated also separately for the 1967-1996 and 1997-2000 periods[6]. It can be seen in Table 3 that banking institutions and branches are both procyclical in these two periods. Moreover, the value

comovement of investment through permitting intertemporal specialization in production. More integration also leads to decreased cross-country consumption correlations because of lower substitutability between home and foreign goods, a stronger home-bias in consumption and higher willingness to substitute consumption intertemporally.

[5]The model will not rely on this procyclicality though. The number of banks is exogenous in the theoretical model.

[6]In the US interstate branching was completely unrestricted after 1997.

Table 2: The Data on International Comovements

Country	ρ(**C**,C^{US})	ρ(**Y**,Y^{US})	ρ(**I**,I^{US})	ρ(**L**,L^{US})	ρ(**G**,G^{US})
Australia	-0.13	0.6	0.21	-0.17	0.46
Austria	0.45	0.54	0.57	0.58	0.31
Canada	0.46	0.81	0	0.5	0.08
France	0.42	0.46	0.22	0.36	-0.18
Germany	0.64	0.85	0.66	0.6	0.4
Italy	0.04	0.49	0.39	0.11	0.23
Japan	0.49	0.66	0.59	0.48	0.06
Switzerland	0.48	0.48	0.38	0.43	-0.01
UK	0.42	0.64	0.46	0.68	-0.1

Source: Baxter (1995).

Quarterly data	ρ(**C**,C^{US})	ρ(**Y**,Y^{US})	ρ(**I**,I^{US})
France	0.0593	0.2171	-0.0001
Germany	0.2678	0.4184	0.3416

Annual data	ρ(**C**,C^{US})	ρ(**Y**,Y^{US})	ρ(**I**,I^{US})	ρ(**L**,L^{US})
France	0.432	0.4901	0.4861	
Germany		-0.7449	-0.768	
Italy	0.2756	0.4911	0.352	0.2743
UK	0.8333	0.913	0.9553	0.7656

Source: Own calculations.

Data are on the correlations between the United States and Europe for logged and Hodrick-Prescott filtered data.

Quarterly data: Sample period for correlations with France: 1978:I - 2002:III.

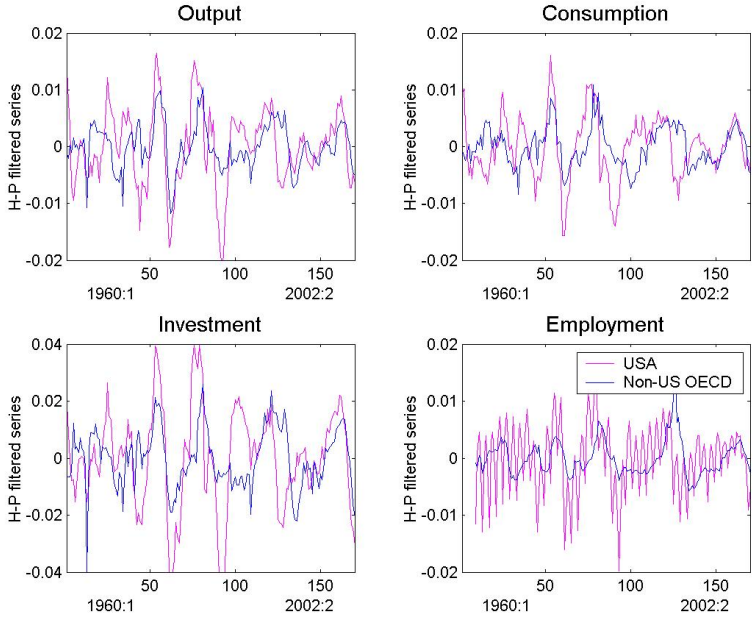
Sample period for correlations with Germany: 1999:I - 2002:III.

Annual data: 1980-1995.

Sources: Quarterly data: OECD National Accounts for USA data, INSEE Main Economic Indicators for France, Federal Statistical Office for Germany.

Annual data: United Nations Common Database.

Figure 1: International Comovements



of the correlation increased after the deregulation of interstate banking and branching was imposed (See Appendix E for a review of the changes in banking regulation in the US).

In our simulation results, banks' markups are negatively correlated with GDP, which implies a falling market power in the boom. However, market power falls not through falling concentration in the banking sector, i.e., the number of banks is fixed in the theoretical economy.

Another useful indicator to test how the degree of concentration in the banking sector changes over the cycle is the Hirschman-Herfindahl index (HHI) of market concentration[7]. Using the FDIC's Summary of Deposits

[7]It is calculated as the sum of the firms' squared market shares. It equals 1 in a monopoly and 0 in perfect competition. Thus, an increase in HHI implies an increase in

annual data on individual banks, we calculate the HHI for total deposits in the US for the 1994-2002 period. The correlation between this index and detrended output is negative, what indicates that concentration in the market for deposits falls as output grows[8].

Thus, for the US economy there is substantial evidence that market concentration and market power in the banking industry are inversely related to GDP.

As of real interest rates, there is evidence that they are countercyclical in both the United States and the United Kingdom. Prescott et al (1983), Plosser (1987), Fama and French (1989), King and Watson (1996) and Seppala (2000) also provide evidence on the countercyclicality of real returns.

The last issue that we want to study is the cross-country correlation of banks spreads. This statistic was calculated for alternative measures of spreads in the European banking sector and for particular OECD countries (Germany and the United Kingdom). As shown on Table 3, there is also evidence on the comovement of bank markups across countries.

Standard international real business cycle models with only one good and complete financial markets fail to reproduce the cross-country correlations facts. They predict negative cross-country correlations for investment and employment; a very low cross-country correlation for output, driven mainly by the correlation of the exogenous process assumed for total factor productivity; and a perfect (or close to perfect) correlation for consumption levels. That is, predicted consumption correlations are always higher than output ones, what has been labelled the "quantity anomaly".

This paper is able to match the positive correlations in the data, the ranking between consumption and output correlations, and the countercyclicality

market concentration.

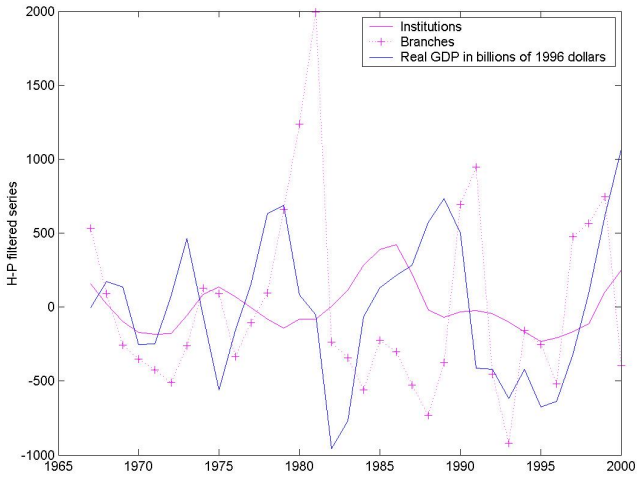
[8]I plan to calculate the HHI correlation with output for the market for loans in the near future.

Table 3: Banking Sector Stylized Facts

Spread Correlation with Output	
USA	
Spread = (Bank prime − certificate of deposits)	-0.41
Spread = (Bank prime − 3 month Treasury Bill rate)	-0.21
European Countries	
Germany	-0.29
United Kingdom	-0.13
USA: Market Power / Concentration and Output	
ρ**(number of branches, GDP)**	
1967 − 2000	0.13
1967 − 1996	0.15
1997 − 2000	0.22
σ^2(number of branches)(relative to σ^2(Y))	2.14
ρ**(number of banking institutions, GDP)**	
1967 − 2000	0.24
1967 − 1996	0.12
1997 − 2000	0.98
σ^2(number of institutions)(relative to σ^2(Y))	0.32
ρ(HHI for deposits, GDP)	-0.14
Interest Rates	
USA: $\rho(r, GDP)^a$	-0.27
United Kingdom: $\rho(r, GDP)^b$	-0.17
Cross-Country Correlation of Spreads	
With European spread (for up to 3 months deposits and loans rates)	0.4441
With European spread (for up to 1 year deposits and loans rates)	0.1228
With Germany	-0.147
With UK	0.1646

Source: Board of Governors of the Federal Reserve and FDIC for US data and International Financial Statistics for European data.
US data on interest rates is quarterly for 1967.I to 2003.I.
European data on interest rates is quarterly for 1996.I to 2003.I.
Data on deposits used to calculate the HHI index is annual data for 1994-2002.
Data on number of institutions and branches is annual for 1966-2000.
a It is difficult to estimate expected inflation to get real interest rate series. I take this correlation from King and Watson (1996).
b Based on Seppala (2000) for the correlation between the one-year real interest rate and the cyclical component of real GDP per capita in the UK.

Figure 2: USA Banking Institutions and Branches



of net exports. Our results also match the countercyclicality of real interest rates and of bank spreads that characterize the US economy, and the positive comovement of bank spreads across countries.

3 Literature Review

Numerous papers have tried to explain these discrepancies between the cross-country correlations in the data and what benchmark models with complete markets predict. They have done this through very different modelling alternatives, including credit market imperfections, imperfect competition in input markets, household production, government spending entering preferences, belief shocks, etc.

This paper is most closely related to two different strands of this literature. First, the work using credit market frictions to explain the puzzles.

Second, the literature on imperfect competition in goods markets as a source of international propagation of shocks.

The most influential papers within the first strand are Baxter and Crucini (1995), Kollman (1996), Heathcote and Perri (2002) and Kehoe and Perri (2002).

Baxter and Crucini (1995) use a two-country, single-good model of an economy where only non-contingent bonds can be traded. Their model predicts high output correlations and low consumption correlations. However, they find that incomplete markets modify the predictions of the standard RBC model only when productivity in each country follows a random walk without international spillovers and with correlated innovations. This is not exactly consistent with empirical estimations of the process followed by total factor productivity in the US and OECD economies. Moreover, they cannot neither solve the quantity anomaly nor reproduce the comovement of factors of production.

Kollman (1996) develops a single good model with adjustment costs to investment. Market incompleteness is given by the fact that only debt contracts (risk-free bonds) can be traded in asset markets. As a result, agents are less able to offset the effects of idiosyncratic shocks, and consumption across countries is less correlated than under complete markets. However, he gets negative investment and employment cross-country correlations.

Heathcote and Perri (2002) build a two-country, two-good model, but one of financial autarky where risk sharing is completely prohibited. Autarky helps them get cross-country consumption, output, investment and employment correlations similar to those in the data. They still cannot solve the quantity anomaly though.

Kehoe and Perri (2002) endogeneize market incompleteness. They solve some of the anomalies between theoretical predictions and the data through the introduction of imperfectly enforceable international loans in a two-

country, one-good model. The credit market imperfection comes from the requirement that each country prefer the allocation it receives when participating in international financial markets relative to the autarky one. This friction helps to account for the discrepancies more than does exogenously restricting available trade in assets. One of the key mechanisms that work to get an increased output correlation is given by the severe restrictions that the enforcement constraints impose on risk-sharing and international investment flows. As regards consumption, the correlation across countries is reduced because risk-sharing is not feasible if the enforcement constraints are to be met. The restrictions that these constraints impose on financial capital mobility do not arise from arbitrage arguments in a decentralized economy[9]. The strength of this paper lies on the endogeneity of financial markets incompleteness. Risk sharing is not exogenously restricted as in most of the models, including mine.

This paper is also embedded within the literature on imperfectly competitive markets as a mechanism for the international transmission of productivity shocks. Rottemberg and Woodford (1991, 1992 and 1995) use countercyclical markups as a propagation mechanism, but they don't specifically address the international RBC puzzles. Head (2002) explains comovements with procyclical product inventions. In a small open economy model, Schmitt-Grohe (1998) models countercyclical markups to explain the transmission of US interest rate and trade shocks to the Canadian economy. Ubide (1999) introduces government spending entering households' preferences, imperfect

[9]Kehoe and Perri (2002) show how to decentralize this economy. Private agents act competitively in an economy with capital income taxes and take as given the government's default decisions on foreign debt. With both such instruments-debt default and capital income taxes-the constrained efficient allocations can be decentralized. When the capital income tax is set appropriately, it both aligns the intertemporal marginal rates of substitution of the private agents with those of the planner and makes private agents internalize the external effect generated by investment (Kehoe and Perri (2002)).

competition in the goods markets, indivisible labor and complete markets in an international business cycle model. He models technology, markups and government spending exogenous shocks. He concludes that markup fluctuations alone are not able to reproduce the main stylized facts[10], and that government spending shocks are needed to match the data. Among the several specifications he estimates, the best results are gotten for a model with exogenous government spending and markup shocks. He doesn't get positive comovements for all variables in a variable markups model driven just by technology shocks. Ubide argues in his paper that imperfect competition is key in models of international business cycles and that it should be endogenized. This paper will endogenously model imperfect competition in the financial sector, something to my knowledge not previously done in the context of the International RBC literature.

Specially relevant is Cook (2002), with its imperfectly competitive dynamic general equilibrium model. He models procyclical sequential market entry for final goods producers in a market characterized by Cournot competition with free entry. This acts as an international transmission mechanism for productivity shocks because, with trade in differentiated goods, a productivity increase in one economy leads to additional business formation in the other country through demand spillovers. Business formation brings countercyclical markups, what leads to an expansion in employment, investment and production in both economies.

Sequential entry and a first-mover advantage to incumbents are needed to obtain markups that are elastic enough to cause international comovement. An alternative framework with simultaneous entry does not work. With simultaneous entry, an increase in aggregate demand makes more firms able to cover the fixed costs and, as a result, new firms enter the market, markups

[10]They reproduce cross-country correlations, but predict countercyclical consumption and productivity.

fall, and sales for each firm in the market fall, what makes more difficult for subsequent entrants to cover fixed costs. Conversely, with sequential entry, the entry of a marginal firm into a previously less competitive market does not reduce the size of sales for subsequent entrants into less competitive markets. As a result, entry and markups respond more elastically to changes in output.

Cook (2002) abstracts from firms' financing issues and credit market imperfections.

Table 4 presents the results of the papers reviewed here. Boxes around the numbers indicate that either the "consumption / output" anomaly is solved, positive cross-country correlations are obtained for investment and/or employment or the countercyclicality of net exports is reproduced.

An extended table summarizes the literature's main results in the last appendix. I include simulation results for both the papers reviewed here and some others that try to solve the anomalies, although with models not directly related to mine. The goal there is to show the ample work on these puzzles and the relatively lack of success in finding a solution to them.

A strength of our model is that the restriction to international financial capital mobility arises from the endogenous behavior of real interest rates and its implications for savings allocation between local and foreign assets in a decentralized economy. In other words, capital (bank savings) mobility is dampened because of interest rates behavior and savers arbitrage. The model improves over previous papers by being able to solve the anomalies while still reproducing the countercyclicality of net exports, and to address banking sector stylized facts and to reproduce the countercyclicality of real interest rates.

Table 4: The Literature Results

	ρ(C,C*)	ρ(Y,Y*)	ρ(I,I*)	ρ(L,L*)	ρ(TB/Y,Y)
Data	**0.3311**	**0.4496**	**0.4151**	**0.2167**	**-0.37**
Backus et al model	0.88	-0.21	-0.94	-0.94	0.01
Baxter and Crucini (1995)1a	0.95	0.04	0.02	-0.7	0.65[7]
Baxter and Crucini 1b	0.92	0.06	0.12	-0.67	0.65[7]
Baxter and Crucini 2a	0.89	-0.41	-0.92	-0.91	-0.18[7]
Baxter and Crucini 2b	-0.28	0.54	-0.5	-0.56	-0.28[7]
Kollman (1996)3	0.38	0.1	-0.12	-0.12	-0.07
Ubide(1999)	0.73	0.26	-0.15	0.32	-0.55[7]
Ubide (1999) with exogenous G and markup shocks	0.82	0.91	0.85	0.91	-0.22[7]
Heathcote and Perri (2002)	0.85	0.24	0.35	0.14	0
Cook (2002)	0.284	0.521	0.188	0.884	-
Head (2002)4	0.81	0.485	0.343	0.293	-0.187
Head (2002)5	0.853	0.486	0.451	0.302	0.085
Kehoe and Perri (2002)	0.29	0.25	0.33	0.23	0.27
Alesandria and Choi(2004)6	0.2	0.43	0.39	0.64	-0.43
This paper - GHH U	0.4241	0.4814	0.3788	0.2977	-0.3342
Cobb-Douglas U	0.8469	0.8505	0.8854	0.8499	-0.0007

1a- Baxter and Crucini (1995): Complete markets Backus et al parameterization of TFP process.

1b- Baxter and Crucini (1995): Only noncontingent bonds Backus et al parameterization of TFP.

2a- Baxter and Crucini (1995): Complete markets Unit root in productivity without spillovers.

2b- Baxter and Crucini (1995): Only noncontingent bonds Unit root in productivity without spillovers.

3- Kollman (1996): Only risk-free debt contracts. Adjustment costs to investment.

4- Head (2002): Purely country-specific shocks and increasing returns to scale, which operate through changes in the world-wide variety of intermediate domestic and foreign goods that produce a final good in each country. An increase in one country's variety of producer goods raises TFP for both economies (trade in varieties-induced link).

5- Head (2002): Constant returns to variety and strongly correlated technology shocks, Corr(e1, e2) = 0.7.

6- Alessandria and Choi (2004) model a complete markets economy with trade in differentiated intermediate goods and fixed costs to exports. Firms are subject to idiosyncratic technology shocks.

7- Net exports in this case.

4 The Model

The model is an extension of a standard two country model, expanded by the introduction of international trade in two imperfectly substitutable goods, and a credit market friction given by entrepreneurs financing capital production with loans granted by an oligopolistic banking sector.

There is a representative household, a representative firm and a representative entrepreneur in each country. A "global" oligopolistic banking sector takes deposits and lends to both economies.

The setup for the home country is presented in this section. Analogous optimization problems apply to all agents in the foreign country[11].

4.1 The Households

Households choose consumption of domestic and imported goods, labor and bank deposits to maximize expected utility given by:

$$\max_{C_t, L_t, D^i_{t+1}} E_0[\sum_{t=0}^{\infty} \beta^t U(C_t, L_t)] \tag{1}$$

Preferences are of the GHH type:

$$U(C, L) = \frac{(C - L^{\omega})^{1-\sigma}}{(1-\sigma)} \tag{2}$$

with (1-σ)<1, and where $\sigma < 1$ and 1/(1-σ) denotes the elasticity of substitution between domestic and foreign consumption goods.

C represents the domestic consumption aggregator over goods produced in the home country (good 1, x_1) and in the foreign country (good 2, x_2). It is given by:

$$C = [\varepsilon x_1^{\rho} + (1-\varepsilon) x_2^{\rho}]^{1/\rho} \tag{3}$$

[11]Stars are used to denote foreign country's variables.

The foreign aggregator C^* is represented by an analogous expression where ε is replaced by (1-ε).

The two-good model provides a "trade channel" for the international transmission of shocks. Each country exogenously specializes in the production of one of the goods; the pattern of production specialization is not endogenized through neither comparative advantage nor Heckscher-Ohlin theories [12].

These aggregators take a CES form, so that the elasticity of substitution between domestic and foreign goods is not restricted to be unitary, which is consistent with the data. Also, perfect substitutability and a linear aggregator would imply that agents would consume only the good that is relatively cheaper. There would be no demand spillovers that increase cross-country output correlations, and that would prevent the model from reproducing consumption patterns of both local and imported goods.

The specification for preferences implies no wealth effects for labor supply. Preferences that feature wealth effects should help to get increased cross-country output correlations. With complete markets, a positive productivity shock in the home country implies that its residents have to share the positive wealth effect with the rest of the world. Thus, with lower gains with respect to the incomplete markets setup, they will increase labor supply and hence, output. With market incompleteness, the wealth effect for home residents is positive, making them reduce the number of hours they work, which helps to get a higher correlation with the foreign output. Simulation results for the case of Cobb-Douglas preferences with wealth effects of labor supply are shown in Section 6.

The household's budget constraint in the home country is given by:

[12] This exogenous specialization simplifying assumption is standard in the literature.

$$x_{1,t} + T_t x_{2,t} + \sum_{i=1}^{N} D_{t+1}^i = (1 + r_t) \sum_{i=1}^{N} D_t^i + w_t L_t + \pi_t^f + \pi_t^e + \frac{1}{2} \sum_{i=1}^{N} \pi_t^b \quad (4)$$

where T_t are terms of trade or, equivalently, the relative price of the foreign good in terms of the domestic good (the numeraire), D^i is domestic household's deposits in each of the N oligopolistic global banks[13]. Domestic households own the domestic goods producing firms and entrepreneurs, and earn dividends on them. As of banks, it is assumed here that households in each country own one half of the global banks. This fraction is assumed constant at business cycle frequencies. Firms, entrepreneurs and banks profits are all rebated to the household in a lump-sum fashion.

The interest rate on deposits earned by domestic households is denoted by r. Interest rates are endogenous in this two-country, truly general equilibrium model.

The household is subject to a borrowing constraint that prevents it from engaging in Ponzi schemes:

$$\lim_{j \to \infty} E_t q_{t+j+1} D_{t+j+1}^i \geq 0 \quad (5)$$

where the superscript i denotes each of the N banks in this economy and where:

$$q_t = r_1 r_2 ..... r_t \quad (6)$$

4.2 The Final Good Sector

Competitive firms in the economy produce a final consumption-investment good, operating a constant returns to scale technology. They demand labor

[13]It is worth noting that households in this model are not allowed to invest in risk-free assets. The returns on deposits are affected by both the real interest rate and the terms of trade, which are endogenous and unknown at the time the household makes its saving choices.

and hire capital to maximize profits. Labor is country-specific and it earns a wage rate w_t. Capital is rented at a cost r_t^K from entrepreneurs who produce the economy's capital stock. The representative firm's problem[14] is given by:

$$\max_{L_t, K_t} \pi_t^f = Y_t - w_t L_t - r_t^K K_t \tag{7}$$

subject to a Cobb-Douglas production technology:

$$Y_t = F(K_t, L_t) = A_t K_t^{\alpha} L_t^{1-\alpha} \tag{8}$$

where the exogenous process followed by total factor productivity (A_t) is calibrated following Backus et al. (1992).

$$log(A_{t+1}) = \Lambda log(A_t) + \varepsilon_{t+1} \tag{9}$$

where

$$A_t \equiv (A_t, A_t^*) \tag{10}$$

is part of the state vector of the model. Λ is a matrix of coefficients and $\varepsilon_t = (\varepsilon_t, \varepsilon_t^*)$. The off-diagonal elements of Λ_t define the spillovers from one country to the other. The elements of ε_t are serially independent, multivariate, normal random variables with contemporaneous covariance matrix V. TFP processes are related across countries through the off-diagonal elements of both Λ and V.

4.3 The Investment Sector

Entrepreneurs produce the economy's capital stock. They finance capital production with loans obtained from oligopolistic banks at a rate R, and rent capital to producers of final goods at a rate r^K.

[14] An implicit assumption here is that agents cannot own physical capital in the foreign country. This shouldn't be an arguable assumption when interpreting K as "production plants".

Based on evidence by Antweiler and Trefler (2000)[15], Harrison (2003)[16] and Maioli (2003)[17], I model an investment process characterized by increasing returns.

The representative entrepreneur's maximization problem is therefore given by:

$$\max_{d^E_{t+1}, i_t} \Pi^E = E_0[\sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \pi^E_t] \tag{11}$$

$$\pi^E_t = r^K_t k_t - i_t + d^E_{t+1} - (1 + R_t) d^E_t \tag{12}$$

$$d^E_{t+1} \geq \Omega i_t \tag{13}$$

$$k_{t+1} = z_t i_t + (1 - \delta) k_t \tag{14}$$

$$z_t = \eta + I^{\theta}_t \tag{15}$$

Entrepreneurs use the same discount factor as the household. k and i stand for capital and investment for each entrepreneur, respectively. λ denotes the marginal utility of consumption for the household, d^E stands for the loans amount. The parameter Ω denotes the fraction of investment that needs to be externally financed. Given that the interest rate on loans is strictly positive and bigger than the discount rate for the entrepreneur, the borrowing constraint in (13) binds in equilibrium.

In equilibrium:

$$i_t = I_t \tag{16}$$

[15]They find evidence of constant returns to scale for sectors like apparel, food, fishing and agricultural goods,textiles and electricity, and of increasing returns to scale for other sectors like petroleum and coal products, pharmaceuticals, electric and electronic machinery, iron and steel basic industries, instruments and non-electrical machinery.

[16]Harrison (2003) finds that returns to scale are increasing in the investment sector. For consumption, her study indicates decreasing to constant returns, with evidence of a positive external effect.

[17]Maioli (2003) estimates returns to scale for 22 French industries and finds that they are generally higher for sectors like minerals, gas, metals and electric and mechanical products than for typical consumption goods.

$$k_t = K_t \tag{17}$$

This specification does not imply increasing returns to the capital production process for entrepreneurs. This production process features an externality not internalized by entrepreneurs when they take their production decisions. Therefore, increasing returns apply only at the aggregate level[18].

The constant term η in the z function is included for the following two reasons. First, it allows for the degree of increasing returns to be an increasing and concave function of the aggregate level of investment. As a result, when the economy is hit by a positive productivity shock, the degree of increasing returns increases too and makes the elasticity of the demand for credit more procyclical. This would not hold in a model where $\eta = 0$ and returns to scale are everywhere given by $(1+\theta)$. Second, it gives more degrees of freedom for the calibration, while still matching the degree of increasing returns in the data.

What is key here is that this implies that the elasticity of the demand for loans is increasing in the equilibrium amount of credit, and the markup or interest rate spread charged by the banking sector is countercyclical. It can be seen by looking at the equation for ε_R that ε_R would be procyclical in a model with constant returns, i.e. with η and θ being zero.

4.4 The Banking Sector

There are N "global" or world oligopolistic banks with branches in each of the countries, that take deposits from both domestic and foreign households and lend to both entrepreneurs. As in Cetorelli and Peretto (2000), they

[18] z is a function of the aggregate level of investment I, not the individual investment by each entrepreneur in the economy. Moreover, this specification for the Z function implies that the degree of increasing returns to scale is $\frac{\theta I^{\theta}}{(\eta+I^{\theta})}$. This is an increasing and concave function in the aggregate investment level of the economy; it starts at 0 and it is bounded from above by θ

face a downward sloping demand for funds and affect the price of loans when taking their credit supply decisions.

Banks have market power in the market for loans, but behave competitively when taking deposits from households in the economy, they have no oligopsonistic power.

To avoid game theoretic issues, oligopolistic banks are characterized in a reduced form, and no particular oligopolistic structure is modeled here. Still, the specification is general enough to account for a banking sector markup that is both endogenous and countercyclical.

Each of the N banks' optimization problem is given by[19]:

$$\max_{l_t^i, l_t^{i*}} \pi_t^b = R_t(l_t^i) l_t^i + R_t^*(l_t^{i*}) l_t^{i*} - r_t D_{t+1}^i - r_t^* D_{t+1}^{i*} \tag{18}$$

$$\sum_{i=1}^{N} l_t^i = d_{t+1}^E \tag{19}$$

$$\sum_{i=1}^{N} l_t^{i*} = d_{t+1}^{E*} \tag{20}$$

l^i (l^{i*}) denotes the loans to the domestic (foreign) country by bank i. d^E (d^{E*}) is the total volume of loans for the whole domestic (foreign) economy.

Banks make their loan decisions and set an interest rate on loans R. Entrepreneurs face it and set the rental rate on capital r^K.

As already discussed, an increase in total factor productivity, which increases the firm's demand for capital and hence, the entrepreneur's demand for credit[20], raises the price elasticity of the demand for credit, lowering the markup and the cost of credit. As a result, the equilibrium level of capital increases by more than in standard models. This, in turn, implies a counter-

[19] i superscripts are used to denote each of the individual banks.

[20] It is key to note that the cost of credit falls due to the degree of non-competitiveness falling when the economy becomes more productive, and to a higher loans amount being available then.

cyclical return on deposits. A diagram of how the market for loans adjusts after a positive productivity shock is presented in Appendix A.

4.5 Timing

Within any period, the timing of events is the following:

1. The aggregate productivity shock is realized;
2. banks determine the interest rate on loans in each economy;
3. entrepreneurs get loans and produce capital; households take labor supply decisions;
4. firms calculate their labor and capital demands. Labor and capital markets clear in both economies and the country-specific wages and rentals rates to capital are determined;
5. output is obtained and sold;
6. dividends from banks, entrepreneurs and firms are distributed to local and foreign households. Households receive the dividends and take consumption and savings decisions. As a result, the goods and the capital markets clear. The terms of trade and the price of the consumption aggregator are determined then.

4.6 Model's Solution

The FOCs for the representative household's optimization problem are given by:

$$\beta^t (C_t - L_t^{\omega})^{-\sigma} [\varepsilon x_{1,t}^{\rho} + (1-\varepsilon) x_{2,t}^{\rho}]^{1/\rho - 1} \varepsilon x_{1,t}^{\rho-1} = \lambda_t \tag{21}$$

$$\beta^t(C_t - L_t^{\omega})^{-\sigma}[\varepsilon x_{1,t}^{\rho} + (1-\varepsilon)x_{2,t}^{\rho}]^{1/\rho-1}(1-\varepsilon)x_{2,t}^{\rho-1} = \lambda_t T_t \tag{22}$$

where λ_t is the shadow value of wealth for the household. These are the marginal utility of consumption of the local and the foreign good, respectively.

The intratemporal condition for the allocation of consumption between domestic and foreign goods is obtained by dividing (21) into (22).

$$\frac{\varepsilon}{(1-\varepsilon)}(\frac{x_{1,t}}{x_{2,t}})^{\rho-1} = \frac{1}{T_t} \tag{23}$$

The Euler equations for consumption, which govern the optimal allocation of total consumption over time in each country are:

$$\frac{(C_t - L_t^{\omega})^{-\sigma}}{p_t^C} = \beta E_t \frac{(C_{t+1} - L_{t+1}^{\omega})^{-\sigma}}{p_{t+1}^C}(1 + r_{t+1}) \tag{24}$$

$$\frac{(C_t^* - L_t^{*\omega})^{-\sigma}}{p_t^{*C}} = \beta E_t \frac{(C_{t+1}^* - L_{t+1}^{*\omega})^{-\sigma}}{p_{t+1}^{C*}}(1 + r_{t+1}^*) \tag{25}$$

where:

$$p_t^C = (\varepsilon + (1-\varepsilon)T_t^{1-\Gamma})^{1/(1-\Gamma)} \tag{26}$$

$$p_t^{C*} = ((1-\varepsilon) + \varepsilon T_t^{1-\Gamma})^{1/(1-\Gamma)} \tag{27}$$

$$\Gamma = \frac{1}{1-\rho} \tag{28}$$

By p_t^C and p_t^{C*} we denote the price of the consumption aggregator in terms of domestic goods (the numeraire) in the home and foreign country respectively. They are a price index built as a weighted average of the price of the numeraire and the terms of trade (T_t).

Equation (29) determines household labor-leisure choices, and it shows that no wealth effects affect labor supply.

$$\omega L_t^{\omega-1} = \frac{w_t}{p_t^C} \tag{29}$$

The firm's problem gives the standard inverse demand functions for labor and capital:

$$w_t = A_t(1-\alpha)K_t^{\alpha}L_t^{-\alpha} \tag{30}$$

$$r_t^K = A_t\alpha K_t^{\alpha-1}L_t^{1-\alpha} \tag{31}$$

The following expression is derived from the first order conditions for the entrepreneur's problem.

$$\frac{(1-\Omega)}{z_t} = \beta E_t \frac{\lambda_{t+1}}{\lambda_t}[r_{t+1}^K + \frac{(1-\Omega)(1-\delta)}{z_{t+1}} - \frac{(1+R_{t+1})\Omega}{z_t} + \beta\frac{\lambda_{t+1}}{\lambda_t}\frac{(1+R_{t+2})\Omega(1-\delta)}{z_{t+1}}] \tag{32}$$

As mentioned before, entrepreneurs do not internalize their effect on z.

The bank's optimization problem results in the pricing function for loans:

$$R_t = \frac{r_t}{(1-\frac{\varepsilon_R}{N})} \tag{33}$$

where ε_R is the reciprocal of the elasticity of the demand for loans by entrepreneurs, and $(1-\varepsilon_R/N)$ is the reciprocal of the gross markup.

When the economy becomes more productive, the demand for loans increases and ε_R falls, such that the markup falls. Bank spreads behave countercyclically in this model. Thus, the banking industry becomes more competitive in the booms, which is consistent with the US banking sector stylized facts presented before. This implies a fall in the return on deposits in a way that will become clear later. This prevents capital from flowing from the rest of the world into relatively more productive economies, what helps to get positive cross-country comovements of investment, employment and output.

4.7 Market Clearing

The market clearing conditions are defined by equations (34)-(36) below. World output of each good is devoted to consumption and investment, so that the market clearing conditions in the goods markets are:

$$x_{1,t} + x^*_{1,t} + I_t = A_t F(K_t, L_t) \tag{34}$$

$$x_{2,t} + x^*_{2,t} + I^*_t = A^*_t F(K^*_t, L^*_t) \tag{35}$$

The market clearing condition for the deposits/loans market is:

$$D_{t+1} + T_t D^*_{t+1} = d^E_{t+1} + T_t d^{E*}_{t+1} \tag{36}$$

In each country households' labor supply has to equal the firm's labor demand. Similarly, capital markets have to clear and capital demand by the firm has to equal the capital supply implied by the entrepreneur's Euler equation.

4.8 The Equilibrium

The recursive equilibrium in this economy is defined by value functions for the home and foreign households $V(A,A^*,D,D^*)$ and $V(A,A^*,D,D^*)$; value functions for the home and foreign entrepreneurs $V(d^E_t,d^{E*}_t,K_t,K^*_t)$ and $V(d^E_t,d^{E*}_t,K_t,K^*_t)$; decision rules on consumption, labor supply and savings for the home and foreign households; decision rules on labor and capital demand for the home and foreign firms; decision rules on investment for the home and foreign entrepreneurs; decision rules on the supply of loans for each of the banks; and prices $(p^C_t,p^{C*}_t,T_t,w_t,w^*_t,r^K_t,r^{K*}_t,r_t,r^*_t,R_t,R^*_t)$ that satisfy the following conditions:

- The home and foreign households' FOCs;

- the home and foreign firms' FOCs;

- the home and foreign entrepreneurs' FOCs;

- the banks' pricing equations;

- the world resource constraints for both goods;

- the market clearing conditions for the labor, capital and loans/deposits markets; and

- the no-Ponzi constraint on deposits.

5 The Non-Stochastic Steady State

The intuition about how the key mechanism in the model works can be made clear by solving analytically for some of the variables in the non-stochastic steady state of the model. As it will be shown with the numerical results, the main force that allows to get positive cross-country correlations for employment, investment and output is an endogenously countercyclical markup for the oligopolistic banking industry.

An expression for the steady state price elasticity of the demand for credit is derived in this section, and it is shown to be directly related to the level of investment demand. Therefore, when the economy is hit by a positive productivity shock, both investment and the demand for credit to finance it increase. The elasticity of that demand also increases, and implies a lower unitary markup for the oligopolistic banks that provide investment financing, due to falling market power for them.

In the steady state the reciprocal of the elasticity of the demand for credit is:

$$\varepsilon_R = \frac{\partial(1+R)}{\partial d^E}\frac{d^E}{1+R} \tag{37}$$

$$= \frac{\frac{\alpha(\omega+\alpha)-(\omega+\alpha-1)}{(\omega+\alpha-1)}\eta + ((1+\theta)\frac{\alpha(\omega+\alpha)-(\omega+\alpha-1)}{(\omega+\alpha-1)}+\theta)I^{\theta}}{\frac{(1-\Omega)}{\beta r^K}-z} \tag{38}$$

(39)

It can be shown that $\frac{d\varepsilon_R}{dI}$ <0 for the model calibrated to the US economy. Denoting:

$$\nu = \frac{\alpha(\omega+\alpha)-(\omega+\alpha-1)}{(\omega+\alpha-1)} < 0 \quad (40)$$

$$\vartheta = (1+\theta)\nu+\theta < 0 \quad (41)$$

$$\mu = \frac{-(1-\Omega)\nu\eta}{\beta^2 r^K K\delta} + I^{\theta-1}\left(\frac{-(1-\Omega)\nu(1+\theta)}{\beta^2 r^K z} - \theta\right) > 0 \quad (42)$$

$$\frac{d(\varepsilon_R)}{dI} = \theta I^{\theta-1}\vartheta\left(\frac{(1-\Omega)}{\beta r^K} - z\right) - (\nu\eta + I^\theta\vartheta)\mu < 0 \quad (43)$$

The standard model is nested in this one. It corresponds to $\eta = \theta = 0$ and $\Omega = 1$, so that the elasticity of demand is constant and equal to $\varepsilon_R = \frac{(1-\alpha)(\omega+\alpha)-1}{(\omega+\alpha-1)}$.

Here banks' markups are constant over the cycle. Results for this case show that the key feature in this model that allows to solve the quantity anomaly and to reproduce the co-movements of employment and investment, is not the oligopolistic structure of banking per se, but the endogenously countercyclical markups.

When the economy becomes more productive and the demand for loans increases, the markup falls and the banking industry becomes more competitive. This is consistent with the US banking sector stylized facts presented in Section 2.

With a falling markup, the cost of credit falls with respect to standard models that lack this friction. Moreover, with highly autocorrelated technology shocks, the degree of oligopolistic power is most probably lower in the future than currently. Agents know this and the fact that the cost of investing will be lower in the future. Consequently, the ratio $\frac{C_{t+1}}{C_t}$ falls and the ratio $\frac{U'(C_{t+1})}{U'(C_t)}$ increases with respect to standard models. This together

with the fact that in this model there is a wedge between the interest rate on deposits and the marginal productivity of capital imply a countercyclical rate of return on deposits.

The non weak separability of preferences also plays a role here. With a decreasing market power, the quantity of capital increases over time relative to standard models without this friction. The marginal productivity of labor increases and leisure falls over time, again relative to standard models. The marginal utility of consumption increases over time and works to get a countercyclical return on households' savings (r).

Given that r represents the opportunity cost of funds for banks, a countercyclical r together with a countercyclical markup imply a strongly countercyclical cost of credit. A fall in r makes banks use local deposits, which are now cheaper for them, to finance both domestic and foreign loans. This modifies the direction of the international flows of capital with respect to standard models. It prevents capital from flowing from the rest of the world into the relatively more productive economy, and helps to get cross-country comovement for investment, employment and output.

Remark: Prescott et al (1983), Plosser (1987), Fama and French (1989), King and Watson (1996) and Seppala (2000) provide evidence on the countercyclicality of real returns.

6 Numerical Solution

6.1 Calibration

The model is calibrated to match some of the post-war stylized facts of the USA - OECD economies. The time period is a quarter. The parameter values are shown in Table 5.

The parameter β, the discount factor for households, is chosen to be the reciprocal of the gross interest rate in steady state. and ω and ω^* are

Table 5: Calibration

Utility function and budget constraint	**Consumption aggregator**
$\beta = 0.99$	$\varepsilon = 0.85$
$\omega = 2.2$	ρ = -1/9
$\sigma = 2$	
Goods production function	
$\alpha = 0.36$	
Production function for capital	
$N = 2$	
$\Omega = 0.3$	$\theta = 0.3$
$\eta = 0.1$	
TFP Process (Backus et al)	
$\lambda_{11} = \lambda_{22} = 0.906$	
$\lambda_{12} = \lambda_{21} = 0.088$	
$\sigma^2(\varepsilon_t) = \sigma^2(\varepsilon_t^*) = (0.0085)^2$	$\rho(\varepsilon, \varepsilon^*) = 0.25$

A * denotes foreign country's parameters.

calibrated to match the price elasticities of labor supply in the US and OECD countries.

In the consumption aggregators, ε is chosen to match the share of imported goods in total consumption. The parameter ρ governs the elasticity of substitution between local and foreign goods in consumption. It is chosen to match a 0.9 elasticity as in Heathcote and Perri (2002).

In the production function, α is chosen to match the constant output share of capital (labor) remuneration to 0.36 (0.64).

The parameters governing the capital production process Ω, η and θ , are chosen to match a 1/4 investment share of output in the deterministic steady state. Also, the values for θ and η are consistent with the evidence for slight increasing returns found by Harrison (2003).

We calibrate the process followed by total factor productivity using the regression results presented in Backus, Kehoe and Kydland (1992) and used by most of the studies focusing on the anomalies.

6.2 Results

The model has no closed form solution and has to be solved using a numerical algorithm. The symmetry of the steady state, the linearity of the problem and the assumption that the shocks to the economy are not significantly big make log-linearization around a symmetric steady state a valid method[21].

The solution to this incomplete markets model does not feature a unit root as in Baxter and Crucini (1995) and Kollman (1996). The endogeneity of the rates of return on deposits and the non-competitive structure of the banking industry together allow us to get a mean-reverting series for asset holdings. Therefore, stationarity is obtained without the need to appeal to an endogenous discount factor for households, adjustments costs to deposits or an equation modeling a debt elastic interest rate.

6.3 GHH Preferences

Results for the benchmark model with GHH preferences are presented in this section. Some key features of the way in which the general equilibrium works arise from the simulations.

A positive technology shock to the home country increases its marginal productivities of both labor and capital. Therefore, both factors of production increase on impact. Because of the specific shape assumed for preferences, labor increases even with the positive wealth effect of the shock implied by market incompleteness. As a result, home output increases too.

The behavior of terms of trade and consumption prices after the shock depends on the calibration of the model. From the supply side, goods produced in the foreign country (which is relatively less productive) become more expensive. From the demand side, the home country is now wealthier and it increases the demand for both types of goods, increasing it relatively

[21]The model was solved numerically using the log-linearization codes available in Professors Stephanie Schmitt-Grohe's and Martin Uribe's web pages.

more for home goods[22], what makes the latter more expensive. As a result, terms of trade and the prices for both the home and foreign consumption aggregators may increase or decrease on impact, depending on the relative strengths of these two forces.

Simulation results are presented in Table 6. The second column shows results for the model with both the "trade channel" and oligopolistic banking. Correlations for employment and investment are both positive and close to the data. Consumption and output also co-move. The consumption correlation is lower than for output, what solves the "quantity anomaly".

The results also replicate the countercyclicality of net exports, which is another stylized fact of international real business cycles. There are two opposite forces affecting the capital account after a positive TFP shock to one of the countries. On the one hand, foreign assets held by domestic households[23] increase due to the interest rate effect. A lower interest rate in the relatively more productive economy makes banks use this economy's deposits to finance foreign investment. On the other hand, foreigners' holdings of domestic assets increase due to the productivity effect. The numerical results indicate that the second effect is more powerful, what makes the capital account procyclical (and the current account, countercyclical).

Our results also match the countercyclicality of real interest rates and banks' markups, and the positive cross-country correlation of the latter.

There is one dimension in which the model does not perform well. The standard deviation of the terms of trade is too high with respect to the data.

A relevant exercise is to show how results change for two alternative scenarios. First, for a two-good model with perfectly competitive banks and no frictions in the capital production process. Second, for an oligopolistic banking economy but with only one good, that is, for a case with no "trade

[22]This is because of the way in which the consumption aggregator is calibrated, with a higher share of domestic goods for any level of consumption.

[23]The fraction of local deposits financing foreign loans.

Table 6: Simulation Results with GHH Preferences

	Data	2 goods olig. banks	2 goods comp. banks	1 good olig. banks
ρ(C,C*)	0.3311	0.4241	-0.149	0.9199
ρ(L,L*)	0.2167	0.2977	0.0197	0.7053
ρ(I,I*)	0.4151	0.3788	-0.0297	-0.1863
ρ(Y,Y*)	0.4496	0.4814	-0.4166	0.7061
ρ(spread,spread*)	0.1228 / 0.4441	0.4998	-	-0.7482
ρ(NX/Y,Y)	-0.37	-0.3342	-0.0401	0.9135
ρ(NX*/Y*,Y*)	-0.25	0.4337	0.2605	-0.8909
ρ(C,Y)	0.8734	0.441	0.5392	0.9793
ρ(C*,Y*)	0.8092	0.4459	0.3396	0.9819
ρ(L,Y)	0.5494	0.4753	0.644	1
ρ(L*,Y*)	0.6957	0.2952	0.467	1
ρ(I,Y)	0.9245	0.4372	0.0791	-0.3308
ρ(I*,Y*)	0.8896	0.3792	-0.0892	0.2865
$\rho(r, Y)^a$	-0.27	-0.0118	0.0203	-0.0014
ρ(r*,Y*)	-	0.0006	0.0017	-0.0175
ρ(spread,Y)	-0.21 -0.41	-0.4917	-	0.8121
ρ(spread*,Y*)	-0.13 -0.29	-0.4762	-	-0.8049
σ(C)/σ(Y)	0.8	5.83	0.2041	0.0099
σ(L)/σ(Y)	0.88	2.67	0.1385	0.01
σ(I)/σ(Y)	2.61	6.39	0.69	0.4799
σ(NX)/σ(Y)	1.65	3.84	12.0374	0.123
σ(T)/σ(Y)	2.88	42.99	0.7197	-

Source: Idem Table 1.

C: consumption, Y: output, I: investment, L: employment, NX: net exports, r: real interest rate on deposits.

a: It is difficult to estimate expected inflation to get real interest rates series. I take this correlation from King and Watson (1996).

channel". Results for these experiments are shown on the third and fourth columns of Table 6, respectively. The purpose is to highlight the importance of both the trade in goods channel and credit market frictions working together for explaining the anomalies.

In the first alternative scenario, for the perfectly competitive banking model, cross-country correlations are still negative, even with the trade channel working there. I interpret these results as suggestive of non-perfect competition in the banking sector being crucial to explain the anomalies.

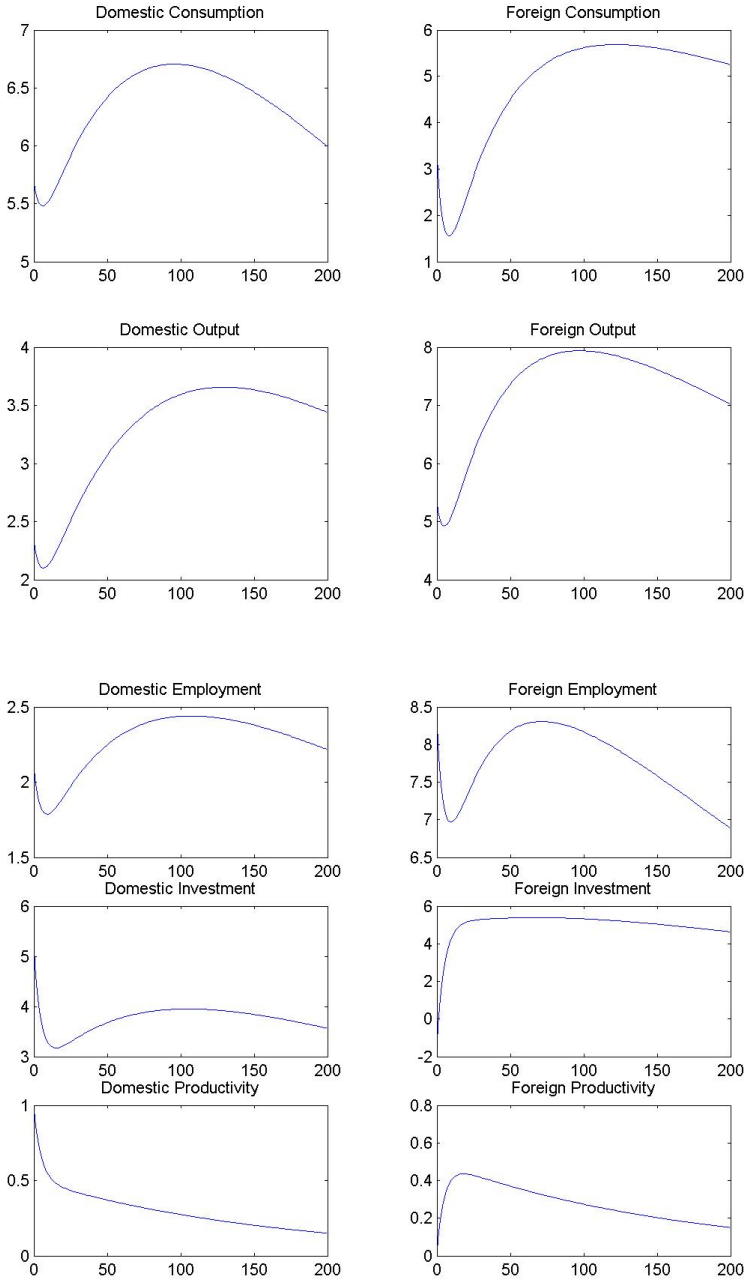
Results for the second scenario show that trade in goods is important in explaining the puzzles. Even with countercyclical real interest rates and bank spreads, with no trade, the cross-country correlation of investment is still negative, and the quantity anomaly cannot be solved. As expected, the cross-country output correlation is much lower without the "trade channel". Cross-country consumption correlations are still too high with respect to output ones. The terms of trade effect is not working to reduce consumption correlations in this case. Last, bank spreads are negatively correlated across countries.

Impulse response functions to a one standard deviation shock to the home country's total factor productivity are shown in Figure 3 for consumption, employment, investment, output and productivity. Foreign productivity is not shocked.

Home total factor productivity experiences a 1 percentage increase on impact. Foreign productivity also increases, given that there are significant international spillovers according to the Backus, Kehoe and Kydland (1992) specification for the process followed by productivity.

Investment in both countries lies above the steady state level for most of the time. It falls on impact in the foreign country. Employment jumps in both economies. Interestingly, it does so by a higher percentage in the foreign country. With no wealth effects on labor supply, this can be explained with

Figure 3: Impulse Response Functions



an initial change in the terms of trade that increases the real wage in the foreign country relatively more than domestically. **CHECK THIS!!**. As a result, both output and consumption increase in the two economies.

6.4 Cobb-Douglas Preferences

In this section we present a robustness check of the benchmark model. We now specify Cobb-Douglas household preferences of the following form:

$$U(C, L) = \frac{(C^{\mu}(1-L)^{1-\mu})^{1-\sigma}}{(1-\sigma)} \tag{44}$$

where the parameter μ pins down the share of consumption and it is calibrated to 0.38. Results for this alternative framework are presented in Table 7.

Results regarding the anomalies stay the same. Positive co-movements for investment and employment are still obtained and the cross-country correlation of consumption roughly equals that for output. Quantitatively, moments are farther from the data in this case.

With incomplete markets, an increase in the home country's total factor productivity implies a positive wealth effect to both economies, but the magnitude of the effect is higher in the domestic economy. With wealth effects affecting labor supply, this implies a fall in labor hours with respect to the GHH case. As a result, local labor, capital and output correlations with their foreign counterparts are increased with respect to the benchmark model with GHH preferences.

7 Concluding Remarks

This paper is able to explain the discrepancies in the International RBC literature identified by Backus, Kehoe and Kydland (1992), through the in-

Table 7: Simulation Results with Cobb-Douglas Preferences

	Data	Benchmark model
ρ(C,C*)	0.3311	0.8469
ρ(L,L*)	0.2167	0.8499
ρ(I,I*)	0.4151	0.8854
ρ(Y,Y*)	0.4496	0.8505
ρ(spread,spread*)	0.1228 / 0.4441	0.8145
ρ(NX/Y,Y)	-0.37	-0.0007
ρ(NX*/Y*,Y*)	-0.25	0.0527
ρ(C,Y)	0.8734	0.8526
ρ(C*,Y*)	0.8092	0.8254
ρ(L,Y)	0.5494	0.9636
ρ(L*,Y*)	0.6957	0.8655
ρ(I,Y)	0.9245	0.8631
ρ(I*,Y*)	0.8896	0.9195
ρ(r,Y)	-0.27	0.877
ρ(r*,Y*)	-	0.8988
ρ(spread,Y)	0.512195122	-0.851
ρ(spread*,Y*)	0.448275862	-0.8127
σ(C)/σ(Y)	0.8	1.6718
σ(L)/σ(Y)	0.88	1.658
σ(I)/σ(Y)	2.61	1.9471
σ(NX)/σ(Y)	1.65	5.00E+10
σ(T)/σ(Y)	2.88	1.9385

Source: Idem Table 6.

troduction of trade in goods and credit market frictions into an otherwise standard two-country model.

Trade in goods provides a channel for the positive transmission of shocks across countries. When one of the countries becomes relatively more productive, it increases its own demand for foreign goods and the benefits of higher productivity spill over to the rest of the world.

Entrepreneurs operate an increasing returns to scale technology to produce capital. They need loans to finance production, and these are provided by non-competitive "global" banks that make cheaper loans available in good times. An endogenously countercyclical markup in the credit market helps to increase the cross-country correlations of factors of production and hence, of output with respect to standard models.

A novelty of the paper is to model a financial friction coming from the supply side of the loans market, which to my knowledge has not been previously studied.

Positive co-movements of consumption, output, investment and employment that closely match the data are obtained, and the "quantity" or "consumption - output" anomaly is solved. Simulations for a one-good model and for a setup with perfectly competitive banking are indicative of the importance of the trade in goods channel and oligopolistic banking together to explain the international comovement in the data.

This is obtained at the same time the model reproduces other stylized facts identified here for the US banking sector, namely, the countercyclicality of net exports, real interest rates and banks' markups, and the positive cross-country correlation of bank spreads.

Two main directions for further research arise from this paper. First, it provides a framework appropriate for the study of the impact of banking sector and interest rate regulations on the supply of credit and on the economy's business cycle. Second, it is also worth exploring the implications of

asymmetries across countries, specially in the structure of the banking sector and in the regulations governing it.

To conclude, our results are interpreted as evidence of the model's strength and accuracy. Therefore, the main structure of this model can be used to study issues not directly related to the ones we focus on here. Specifically, the model can be readily applied to answer more policy oriented research questions related, for example, to current account issues and optimal exchange rate regimes.

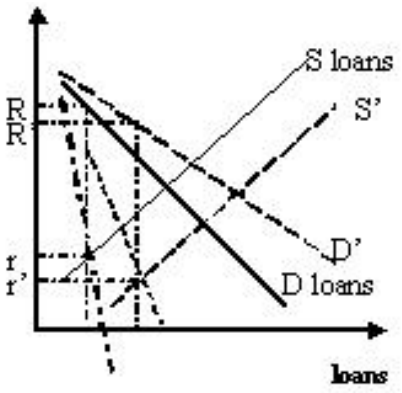
A The Market for Loans

This appendix presents a graphical analysis of the key mechanisms working in the model.

After a positive productivity shock, both the demand and the supply of loans increase. The demand shifts due to a higher marginal productivity of capital. The supply of loans is given by the banks' marginal cost of funds, which is the rate of return they pay on deposits. Therefore, the supply increases because of a positive wealth effect for households who increase their savings. Also, demand becomes more elastic in this model.

The market adjusts to a new equilibrium with a lower cost of credit, a lower opportunity cost for the banking sector and a lower markup.

Figure 4: The Market for Loans



In the standard model with perfectly competitive banks, there is no wedge between the interest rates on deposits and loans. Both the opportunity cost of funds for banks (r) and the cost of credit (R) increase after the economy is hit by a positive shock to the marginal productivity of capital.

B Alternative Modeling Ideas

Based on evidence by Harrison (2003), an increasing returns capital production process[24] is the way chosen in the main body of the paper to obtain a countercyclical markup for the banking sector.

This appendix presents alternative ways to get that the perceived elasticity for each bank falls with GDP, even with no special frictions to the capital production process.

First, the number of banks in the economy can be made endogenous. With fixed costs of production, entry will occur in the banking sector until the point at which profits for the marginal entrant equal zero. Thus, a zero-profit condition and a pricing equation for each bank together determine the equilibrium quantity of banks.

$$\pi^B_{i,t} = R_t(l^i_t)l^i_t + R^*_t(l^{i*}_t)l^{i*}_t - r_t D_{t+1} - r^*_t D^*_{t+1} - \phi = 0 \quad (45)$$

$$R_t = \frac{r_t}{(1 - \frac{\varepsilon_R}{N})} \quad (46)$$

where ϕ denotes a fixed cost of operation for each bank.

An increase in the number of banks lowers profits for each of the banks by lowering the interest rate on loans and the demand for credit for each bank. Therefore, an opportunity for additional entry arises in the boom of the cycle, when the demand for loans increases. This would predict a procyclical number of banks, which is consistent with the empirical evidence for the US economy presented in the data section.

In this model, ε_R is constant, but ε_R/N is still countercyclical.

A second way to get countercyclical markups is through a model in which the number of banks is still exogenously given, and where goods are produced using a CES production function of the following form:

[24] which implies a non-isoelastic demand for credit

$$Y_t = (aK_t^{\theta} + bL_t^{\theta})^{1/\theta} \tag{47}$$

where $\theta < 1$ and $1/(1-\theta)$ is the elasticity of substitution between capital and labor. The next appendix presents this alternative formulation and numerical simulation results for the benchmark model, a model with trade in goods and competitive banking, and a 1 good model with oligopolistic banking.

C The Model with CES Goods Production

An alternative formulation for this model economy has a representative firm that builds the capital stock and operates a constant elasticity of substitution technology[25] for goods production. The firm borrows from oligopolistic banks at the rate R to finance its investment projects.

It uses a production function of the following type:

$$Y_t = A_t(aK_t^{\theta} + bL_t^{\theta})^{1/\theta} \tag{48}$$

where $\theta < 1$ and $1/(1-\theta)$ is the elasticity of substitution between capital and labor.

The capital accumulation process is particular in the sense that investment takes no time to build the capital stock and there is full depreciation. Therefore,

$$I_t = K_t \tag{49}$$

Also, as a shortcut and for simplicity, I assume here that loans equal a given fraction of investment and that they are paid back in the same period, such that the price of investment is $(1 + R)$. Therefore:

$$d_t^f \geq \Omega I_t \tag{50}$$

where d^f stands for the loans amount. This constraint will always bind in equilibrium given that the cost of external financing for the firm is higher than that of using its own sales income.

[25]CES production technologies imply variable factor shares. However, in the numerical simulations I calibrate the parameters a and b such that in steady state the labor (capital) share is 0.64 (0.36). With log-linearization as the numerical method used to solve the model, results are local and, as a result, shares in the transition don't differ significantly from those assumed in the more standard Cobb-Douglas problems with constant factor shares.

The firm's problem is then static: it maximizes instantaneous profits in every period subject to (48)-(50).

$$\max_{L_t, I_t, d_t^f} \pi^f = Y_t - w_t L_t - (1 + R_t) d_t^f - (1 - \Omega) I_t \tag{51}$$

which can be reduced to:

$$\max_{L_t, d_t^f} \pi^f = Y_t - w_t L_t - (1 + \Omega R_t) d_t^f \tag{52}$$

s.t. equation (48).

The household's and the banks' optimization problems are the same as in the benchmark economy.

The firm's inverse demands for labor and capital are now given by:

$$w_t = A_t b (a K_t^\theta + b L_t^\theta)^{1/\theta - 1} L_t^{\theta - 1} \tag{53}$$

$$(1 + \Omega R_t) = A_t a (a K_t^\theta + b L_t^\theta)^{1/\theta - 1} K_t^{\theta - 1} \tag{54}$$

It can be easily shown that the reciprocal of the price elasticity of the demand for credit is now:

$$\varepsilon_{R,t} = (1 - \theta) + (\theta - 1) \frac{K_t}{Y_t} \eta_t \tag{55}$$

where η stands for the marginal productivity of capital.

Also, the elasticity of the demand for credit is procyclical in this case too. To see this, I calculate the derivative of ε_R with respect to the investment level, and show that it is negative for $\theta > 0$.

$$\frac{d\varepsilon_R}{dI} = (\theta - 1)(\frac{\eta}{Y} + \frac{K}{Y} \frac{d\eta}{K} - \frac{K}{Y^2} \eta^2) \tag{56}$$

$$\frac{d\varepsilon_R}{dI} = (\theta - 1) \frac{\theta a b K^{\theta - 1} L^\theta}{(a K^\theta + b L^\theta)^2} < 0 \tag{57}$$

Thus, banks' markups are still countercyclical, with no capital production frictions and with the number of banks in the economy being exogenously fixed.

C.1 Calibration

We choose a and b to match a 0.64 labor share and a 0.36 capital share in the steady state.

We calibrate θ to be equal to 0.3. This implies an elasticity of substitution between capital and labor of around 1.5.

The calibration for the rest of the parameters follows that in the benchmark model.

Table 8: Calibration - CES Goods Production

Utility Function and Budget Constraint	**Consumption Aggregator**
$\beta = 0.99$	$\varepsilon = 0.85$
$\omega = 2.2$	$\rho = \rho^* =$ -1/9
$\omega^* = 2.2$	
$\sigma = \sigma^* = 2$	
Goods Production Function	
$a = 0.36$	$b = 0.64$
$\theta = 0.3$	
Production Function for Capital N = N* = 2	$\Omega = 0.3$
TFP Process (Backus et al) $\lambda 11 = \lambda 22 = 0.906$	$\lambda 12 = \lambda 21 = 0.088$
Std(ε) = Std(ε^*) = 0.0085	Corr(ε,ε^*)= 0.25

Simulation results are shown in Table 9 for the model with both trade in goods and oligopolistic banking, and for alternative formulations where either one of these two forces does not operate.

The qualitative results are the same as in the benchmark model. Positive cross-country co-movements of all macroeconomic aggregates is obtained and the quantity anomaly is solved when both effects work in the model.

Importantly, my simulations match the countercyclicality of real interest rates and the trade balance observed in the data. Also, bank markups comove here as in the data.

Regarding the volatility of terms of trade, the benchmark model with CES production still delivers a standard deviation that falls short of the value in the data, but the wedge is smaller than that obtained by previous work.

As expected, results for a 1-good economy show lower output comovement and higher consumption comovement. Again, we interpret this as indicative of the importance of trade in goods to solve the quantity anomaly.

With competitive banking, both consumption and employment are negatively correlated across countries. Also, the interest rate on deposits is now procyclical.

Again, we interpret these results as evidence of the importance of both trade in goods and endogenous and countercyclical banking sector markups for finding a solution to the Backus et al. anomalies.

Table 9: Simulation Results: CES Goods Production

	Data	**2 goods oligop. banking**	**2 goods comp. banking**	**1-good oligop. banking**
ρ(C,C*)	0.3311	0.2637	-0.6319	0.7574
ρ(L,L*)	0.2167	0.7051	-0.3259	0.1739
ρ(I,I*)	0.4151	0.9707	0.1574	0.2624
ρ(Y,Y*)	0.4496	0.8747	0.0555	0.2491
ρ(spread, spread*)	0.1228 / 0.4441	0.9972	-	0.1172
ρ(NX/Y,Y)	-0.37	-0.1783	-0.3168	0.1788
ρ(NX*/Y*,Y*)	-0.25	-0.3057	-0.9147	0.3714
ρ(C,Y)	0.8734	0.8316	0.9145	-0.6409
ρ(C*,Y*)	0.8092	0.8871	0.9831	-0.4022
ρ(L,Y)	0.5494	0.9845	0.9966	0.9992
ρ(L*,Y*)	0.6957	0.9681	0.9433	0.9992
ρ(I,Y)	0.9245	0.9849	0.998	1
ρ(I*,Y*)	0.8896	0.9742	0.998	1
ρ(r,Y)	-0.27	-0.2627	0.7195	0.7845
ρ(r*,Y*)	-	-0.2535	-0.5853	0.7876
ρ(spread,Y)	0.512195122	0.649	-	0.4323
ρ(spread*,Y*)	0.448275862	0.6228	-	0.0844
σ(C)/σ(Y)	0.8	0.3881	3.0087	0.4133
σ(L)/σ(Y)	0.88	0.4692	2.7481	0.1446
σ(I)/σ(Y)	2.61	3.0887	0.6538	5.0283
σ(NX)/σ(Y)	1.65	0.4692	0.6192	0.0994
σ(T)/σ(Y)	2.88	1.1582	3.4743	-

D Summary of the Literature Results

The following table summarizes the literature results and compares them to the results in this paper.

Table 10: The Literature Results

	ρ(C,C*)	ρ(Y,Y*)	ρ(I,I*)	ρ(L,L*)	ρ(TB/Y,Y)
Data	**0.3311**	**0.4496**	**0.4151**	**0.2167**	**-0.37**
Benchmark Backus et al	0.88	-0.21	-0.94	-0.94	0.01
BKK with transport costs	0.89	-0.05	-0.48	-0.48	0.23
BKK - no risk sharing)	0.56	0.08	-0.31	-0.31	-
1-Tesar (1993)	0.44 - 0.97	0.48 - 0.7	-	-	-
2a-Baxter and Crucini (1995)	0.95	0.04	0.02	-0.7	0.65^{20}
2b-Baxter and Crucini (1995)	0.92	0.06	0.12	-0.67	0.65^{20}
3a-Baxter and Crucini (1995)	0.89	-0.41	-0.92	-0.91	-0.18^{20}
3b-Baxter and Crucini (1995)	-0.28	0.54	-0.5	-0.56	-0.28^{20}
4- Boileau (1996)	0.5	0.52	-0.48	0.6	-
5- Kollman (1996)	0.38	0.1	-0.12	-0.12	-0.07
6- Kollman (1996)	0.51	0.18	-	-	-
7- Kollman (1996)	0.28	0.14	-	-	-
8- Roche (1996)	0.78	-0.07	-	-	-0.34

Table 11: Table Continued

Table (cont.)	**Cross-country C corr**	**Cross-country Y corr**	**Cross-country I corr**	**Cross-country L corr**	**Corr of TB/Y with Y**
9- Canova and Ubide (1998)	0.72	0.78	0.27	0.8	-0.32[20]
10- Guo et al. (1998)	0.44	0.98	-	-	-0.009
11- Stockman and Tesar (1998)	0.25	0.52	-	-	-0.48[20]
12a- Ubide (1999)	0.73	0.26	-0.15	0.32	-0.55[20]
12b- Ubide (1999) - G shocks and imp. comp.	0.82	0.91	0.85	0.91	-0.22[20]
13- Lubik (2000) - TFP shocks	0.42 - 0.79	0.61 - 0.77	0.89 - 0.99	-	-0.14 - 0.01
13- Lubik (2000) - TFP and money shocks	0.33 - 0.71	0.51 - 0.66	0.78 - 0.96	-	-0.15 - -0.01
14- Heathcote and Perri (2002)	0.85	0.24	0.35	0.14	0
15- Cook (2002)	0.284	0.521	0.188	0.884	-
16- Hairault (2002)	0.71	0.29	0.08	0.25	-0.49[20]
17a- Head (2002)	0.81	0.485	0.343	0.293	-0.187
17b- Head (2002)	0.853	0.486	0.451	0.302	0.085
18- Kehoe and Perri(2002)	0.29	0.25	0.33	0.23	0.27
19- Alesandria and Choi(2004)	0.2	0.43	0.39	0.64	-0.43
This paper - GHH U	0.4241	0.4814	0.3788	0.2977	-0.3342
Cobb-Douglas U	0.8469	0.8505	0.8854	0.8499	-0.0007

Notes:

1- Tesar (1993): A model with complete financial markets and stochastic fluctuations in the output of non-traded goods. She concentrates on the high correlation between savings and investment, the low cross-country correlation between consumption growth rates and the home bias in investment portfolios.

2a- Baxter and Crucini (1995): Complete markets - Backus et al parameterization of TFP process. **2b- Baxter and Crucini (1995):** Only noncontingent bonds - Backus et al parameterization of TFP process.

3a- Baxter and Crucini (1995): Complete markets - Unit root in productivity without spillovers. **3b- Baxter and Crucini (1995):** Only noncontingent bonds - Unit root in productivity without spillovers.

4- Boileau (1996): A two-country, single-traded good RBC model with endogenous growth and a non-market (and non-traded) sector. Financial markets are complete and international externalities in production are modeled. A positive productivity shock to the home country induces mobile factors of production to reallocate across sectors and countries. The sectoral reallocation from household production to market production in each country compensates for the international reallocation. Employment is positively correlated across countries as a result. The shocks to non-market production reduce the cross-country correlation of consumption.

5- Kollman (1996): Only risk-free debt contracts can be traded in asset markets. Adjustment costs to investment. The main purpose is to show how this helps reduce cross-country consumption correlations.

6- Same as in 5 with fixed hours.

7- Same as in 5 with high risk aversion.

8- Roche (1996): A one-good economy, countries produce a non-specialized traded good and households derive utility from public goods. Shocks to both productivity and government spending. The latter act as additive exogenous preference shocks. Households deriving utility from exogenous government purchases has important implications for the countercyclicality of the trade balance.

9- Canova and Ubide (1998): A model with a non-traded sector and financial claims traded internationally. Disturbances to both market and household technologies. With the non-market sector using capital, after positive shocks, reallocations of capital from the non-traded to the traded sector makes the cross-country correlation of market investment less negative. Autocorrelated shocks with international spillovers. Cross-sector, cross-country spillovers as well as inter-sector, intra-country spillovers are set to zero.

10- Guo and Sturzenegger (1998): An increasing returns to scale economy with no contingent claims markets and shocks to both productivity and "beliefs". The latter affect the consumption Euler equation.

11- Stockman and Tesar (1998): A two-sector model with traded (each country specializes in the production of one good) and nontraded goods. There is also trade in financial assets. Shocks to technologies and tastes with particular features for taste shocks. Taste shocks are needed to explain the anomalies, productivity shocks are not enough. I report here their results for Case 6 (taste shocks to home-produced goods, correlated across goods), their best results.

12- Ubide (1999): A model with government spending entering preferences. Imperfect competition in the goods markets (modeled exogenously), competitive behavior in the factors market, indivisible labor, and complete asset markets. He models technology, markups and government spending exogenous shocks. Markup fluctuations alone are not able to reproduce the main stylized facts ; government spending shocks are needed. They follow other studies (Ravn (1997) and Rottemberg and Woodford (1995) for the calibration of the process followed by government spending and markups. They don't estimate a VAR for productivity, government spending and markups. Among the several specifications he estimates, the best results are gotten for a model with government spending and markup shocks. He doesn't get positive comov

13- Lubik (2000): A two-sector (tradeables and non-tradeables), multiple-good, monetary business cycle model with price stickiness in the non-traded sector. On the one hand, positive technology shocks in one country lower the terms of trade and stimulate production abroad. On the other, price stickiness causes the terms of trade (of the country that has undergone a monetary expansion) to improve, and this leads to a contraction of foreign economic activity. The model features incomplete asset markets and adjustment costs to investment.

ements for all relevant aggregates in a variable markups model driven by technology shocks. **14- Heathcote and Perri (2002):** A two-good model with two countries in financial autarky.

15- Cook (2002): A model with risk-free debt, imperfect competition and procyclical sequential market entry for Cournot final goods producers. With trade in differentiated goods, a productivity increase in one economy leads to additional business formation in the other country through demand spillovers. Business formation brings countercyclical markups, what leads to an expansion in employment, investment and production in both economies.

16- Hairault (2002): After the economies are shocked, expected returns to labor market search change and induce movements in search and recruiting activities. Given the cross-country correlation of technology shocks, domestic and foreign firms start searching labor at the same time. Employment increases in both countries and this helps to partially curtail the capital outflows from the country not benefiting from the shock.

17a- Head (2002): Purely country-specific shocks and increasing returns to scale, which operate through changes in the world-wide variety of intermediate domestic and foreign goods that produce a final consumption - investment good in each country. An increase in one country's variety of producer goods raises TFP for both economies simultaneously. What works here is a "trade in varieties-induced link". **17b- Head (2002):** Constant returns to variety and strongly correlated technology shocks, Corr(ε_1,ε_2) = 0.7.

18- Kehoe and Perri (2002): They endogeneize market incompleteness through imperfectly enforceable international loans in a one-good model. The credit market imperfection comes from the requirement that each country prefer the allocation it receives when participating in international financial markets relative to the autarky one.

19- Alessandria and Choi (2004): They develop a model with complete asset markets, firm heterogeneity, and fixed entry and continuation costs in export markets. Monopolistically competitive firms each producing a differentiated intermediate good are subject to idiosyncratic technology shocks. In each country final goods are produced in a competitive market using domestic and imported intermediate goods. An increase in home TFP lowers the fraction of domestic firms that stop to export due to the fact that with lower production costs, they are better willing to pay the fixed costs of shipping goods abroad. Foreign producers of intermediates, who face a higher demand, start entering export markets ad deferring exit. So, an increase in domestic productivity triggers an increase in capital accumulation in the domestic economy and an increase in the absorption of foreign varieties. Foreign production increases as a result. Home consumption increases initially, while foreign consumption falls on impact. That allows for a reduced cross-country correlation of consumption.

20- Net exports in this case.

E Banking Regulation in the United States

In this appendix we review the main developments in banking sector regulations, in particular those regarding the creation of banking institutions and branches.

1927: The **McFadden Act** regulated intrastate branching and allowed national banks to branch to the extent permitted by state laws. It specifically prohibited intrastate branching by allowing a national bank to branch only within the city in which it was situated.

1956: The **Douglas Amendment to the Bank Holding Company Act of 1956** controlled whether and under what circumstances out-of-state bank holding companies could own and operate banks within their borders.

1980: The **Depository Institutions Deregulation and Monetary Control Act of 1980** eliminated deposit interest rate ceilings and increased the limit of deposit insurance.

1994: The **Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994** repealed the Douglas Amendment. On September 29, 1995, it allowed full nationwide banking across the country, regardless of state law.

It also allowed for affliate banks within bank holding companies to effectively act as branches for each other, accepting deposits, collecting payments and providing other customer services.

It allowed national banks to operate branches across state lines after June 1, 1997. This law permits branching through acquisition only, which means that a bank must acquire another bank and merge the two structures in order to operate branches across state lines.

However, the **Riegle-Neal Act** specified that state law continues to control intrastate branching for both national and state banks.

"de novo" branching: US states have the power to authorize branching

across state lines. This allows a bank to simply open a branch in another state instead of having to acquire an entire bank.

1999: The **Gramm-Leach-Bliley Act of 1999** substantially expanded powers for qualifying bank holding companies by repealing existing restrictions on affiliations with insurance companies and securities firms.

It created the financial holding company and allowed this new entity to offer banking, securities and insurance products under on corporate roof. In general this Act has provisions intended to increase competition and efficiency in the industry (Ennis, 2001).

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