Can Uninsurable Idiosyncratic Shocks Lead to Global Imbalances?*

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Abstract

One of the features of the world economy since the early 1980s has been the persistent accumulation of current account imbalances. This paper demonstrates that simultaneous changes in the volatility of uninsurable idiosyncratic risk across countries can explain the occurrence of such imbalances. I construct an international real business cycle model in which heterogeneous agents are not able to fully insure against aggregate and idiosyncratic shocks to labor earnings. First, I show that changes in idiosyncratic volatility can lead to much larger external imbalances than changes in aggregate volatility of the same magnitude. Second, I employ the Luxembourg Income Study dataset to measure changes in idiosyncratic risk for selected countries over the period 1980-2000, and use the results to calibrate the model. Under this approach, the model can quantitatively explain between 30 and 40 percent of the change in the U.S. net foreign asset position and comes close to explaining the change in Japan's net foreign asset position. The results are robust to different parameter values and model specifications.

Keywords: Business cycle volatility, idiosyncratic volatility, precautionary saving, global imbalances, net foreign asset position, current account, heterogeneous agent models

JEL Classification: F32, F34, F41,

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1. Introduction

One of the features of the world economy since the early 1980s, has been the persistent accumulation of current account imbalances. These imbalances are a global phenomenon, caused by both developed and developing countries. The deficit side is represented by Australia, Brazil, Canada, Mexico, the U.K. and the U.S., whereas the surplus side includes Germany, Japan, Switzerland, and more recently, the East Asian countries. Figure 1 shows the dynamics of net foreign asset positions,[1] expressed as a fraction of the U.S. GDP[2], for 4 regions of the world: East Asia,[3] Europe,[4] Japan and the U.S.

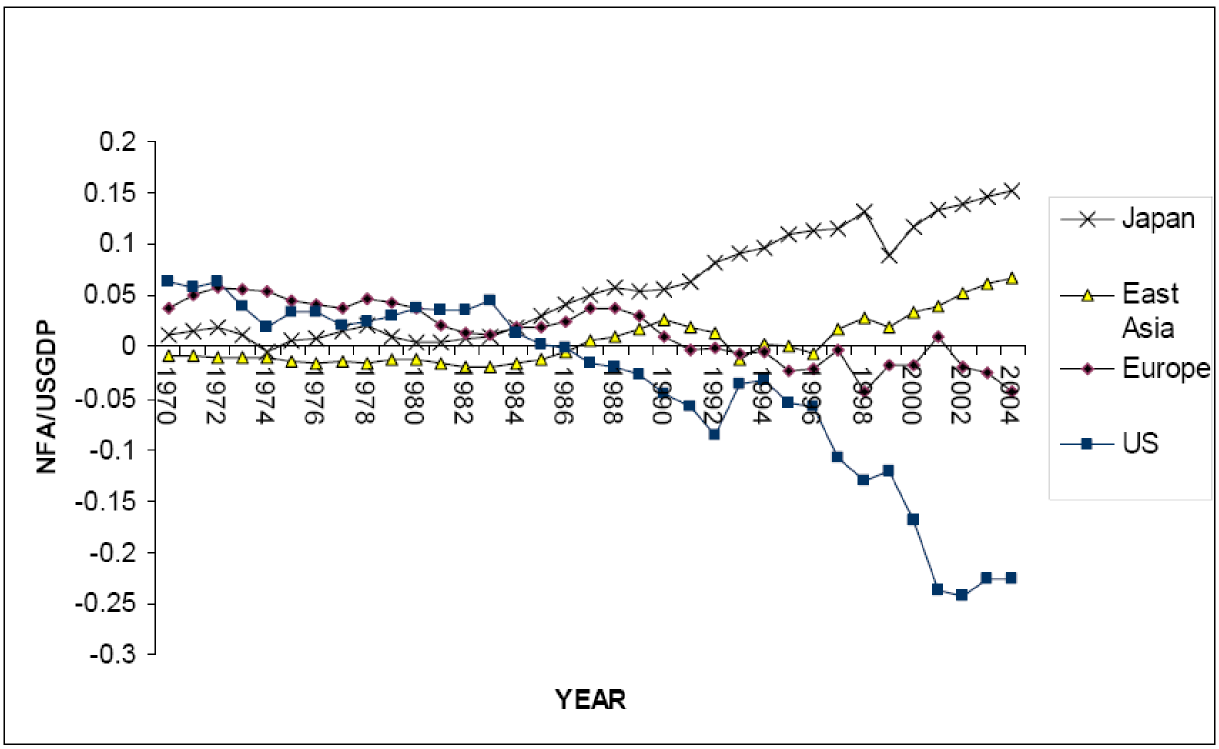

Figure 1 Dynamics of Net Foreign Asset Positions for Selected Regions of the World.

Several observations emerge from this figure. First, the U.S. is currently the biggest borrower

[1]Source: Lane and Milesi-Ferretti (2007) and own calculations

[2]Sampling period is from 1970-2004.

[3]East Asian countries in the sample are: Hong Kong, Indonesia, Korea, Malaysia, Philippines, Singapore, and Taiwan.

[4]European countries in the sample are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

in the global financial markets with a negative net foreign asset (NFA) position of 22.6 % of its GDP in 2004. Second, the accumulation of a negative position by the U.S. happened in two waves: the first one started around 1983 and the second one around 1996. Third, Japan started accumulating a positive net foreign asset position around the same time when the U.S. started accumulating foreign debt. Fourth, Europe has been slowly shifting from a positive position into a negative position, but at a much slower pace than the rest of the regions considered here. Finally, the East Asian countries, while having a deficit for half of the sample period, started a persistent accumulation of positive net foreign assets around 1997.

This paper provides a new explanation for this accumulation of NFA imbalances: I build an international business cycle model in which the volatility of uninsurable shocks to individual labor earnings has the potential to affect the creation of global imbalances. The intuition behind the result is the following: suppose that the volatility of uninsurable idiosyncratic shocks increases in one country relatively to the rest of the world. Such a change in volatility causes agents in this country to build a buffer of precautionary savings to address the increased uncertainty. As a result, aggregate savings rise in the country that experiences the increase in volatility, and the country accumulates a positive external position. To generalize, countries that become relatively riskier in terms of individual uncertainty accumulate positive net foreign asset positions, and countries that become relatively safer accumulate negative ones. The goal of this paper is to quantify the variation in external imbalances that can be accounted for by the variation in the volatility of idiosyncratic shocks. To the best of my knowledge, this is the first paper to explore this link.

I extend the representative agent framework of Backus, Kehoe and Kydland (1992) to introduce heterogeneous agents into the model. In particular, agents are subject to different labor productivity shocks. In order to take explicitly into consideration the volatility of shocks, I compute a second order approximation of the model and compare the stochastic steady state in which countries have the identical levels of aggregate and idiosyncratic volatilities with the stochastic steady state in which one of the countries experiences a large decrease in both volatilities. I show that the decrease in the idiosyncratic volatility can generate much larger external positions than the decrease in the aggregate volatility of the same magnitude.

In order to assess quantitatively the extent to which the change in idiosyncratic volatilities can explain the net foreign asset positions observed in the data, I do the following. First, I select the countries[5] responsible for the creation of global imbalances, and I measure their changes in aggregate and idiosyncratic income volatility between two periods: 1970-1983 and 1983-2004. I use World Development Indicators (WDI) and International Financial Statistics (IFS) datasets to calculate changes in aggregate volatility, and the Luxembourg Income Study (LIS)[6] micro dataset to calculate changes in idiosyncratic volatility. I then use the results to calibrate the model, and compare the stochastic steady state in which all countries have equal volatilities with the steady state in which countries have volatilities calibrated according to the changes found in the data. The model can quantitatively explain between 30 and 40 percent of the change in the U.S. net foreign asset position and comes close to explaining the change in Japan's net foreign asset position. The model also matches qualitatively the changes in the net foreign asset positions for Australia, Japan, Mexico, Taiwan and the U.S.

The global imbalances have attracted much attention from researchers. Two opposing points of view arose from numerous studies. Obstfeld and Rogoff (2004), and Blanchard, Giavazzi and Sa (2005) claim that sudden adjustment of the U.S. current account would lead to a massive depreciation of the dollar, and possibly to a global economic crisis. However, a more conservative view is put forward by Fogli and Perri (2006), Bernanke (2005), Mendoza, Quadrini and Rios-Rull (2006), Caballero, Farhi and Gorinchas (2006), and Antras and Caballero (2007), who view global imbalances as the innocuous outcome of the economic forces that prevail in today's world. For example, Mendoza, Quadrini and Rios-Rull (2006) consider a multi-country dynamic general equilibrium model with cross-country heterogeneity of financial markets. They show that global imbalances are the gradual result of financial integration of countries with different financial institutions. Caballero, Farhi and Gorinchas (2006) show that the global imbalances could be the harmless outcome of the difference in growth potentials and abilities to produce financial assets among different regions of the world. Antras and Caballero (2007) show that capital can flow from the emerging economies to the industrial ones if the former have less developed financial markets. Bernanke (2005) relates the accumulation of external imbalances

[5]Selected countries are: Australia, Brazil, Canada, Germany, Hong Kong, Japan, Mexico, Switzerland, Taiwan and United States. Due to various reasons, I dropped from the sample Brazil, Hong Kong and Switzerland, more on this in the Data section.

[6]LIS dataset collects cross-sectional income micro-data (household/individual level) from a large number of countries (more than 30 countries) and in different points in time.

with the emergence of the so called 'global saving glut' which is the recent increase in the global supply of saving. Large part of the increase comes from the East Asian countries due to the change in their roles from being net borrowers to net lenders after the financial crisis in 1997. In particular, most of the East Asian countries have seen a reversal from current account deficits to surpluses within the past ten years, and those that were in the surplus before 1997 have kept their positive position since then.[7].

Closest to my work is the paper by Fogli and Perri (2006), in which the authors associate the accumulation of external imbalances with the period of "Great Moderation" in the U.S., which is the decrease in the U.S. business cycle volatility during the last 20 years. Stock and Watson (2005) identify 1983-1984 as the beginning of a period during which the business cycle volatility declined in the G7 countries. Interestingly, 1983 is also the year when the U.S. net foreign assets position started to deteriorate (Figures 1 and 2). Fogli and Perri (2006) link these two empirical facts, in a two-country model in which they show that the reduction in aggregate volatility can account for about 20% of the U.S. external imbalance. The intuition for their result is very similar to this study: the reduction in aggregate volatility in the U.S. makes the U.S. relatively safer place, while the rest of the world riskier. Hence, agents in the rest of the world increase the buffer of precautionary savings flowing in the U.S, and causing the U.S. to run negative net foreign asset position. Fogli and Perri (2006) assume that idiosyncratic risk in each country is perfectly insured among their residents. In this study, instead, I relax this assumption and investigate the effects of uninsurable idiosyncratic risk on global imbalances. The volatility of idiosyncratic shocks is one order of magnitude larger than that of typical aggregate shocks. Therefore the ability of idiosyncratic shocks to explain global imbalances is potentially larger than that of aggregate shocks. I find that idiosyncratic volatility has become higher in all countries, but the relative increase in volatility in Japan is larger than the increase in the U.S., a fact which implies, that the U.S. has become a relatively safer investment environment and that Japan has become relatively riskier. As a result, the U.S. has become the largest borrower and Japan the largest lender on the global financial markets.

The rest of the paper is organized as follows. Section II presents the model. Section III

[7] Those countries are Hong Kong, Indonesia, Korea, Malaysia, Philippines and Thailand. Singapore and Taiwan have been in surplus for most of the sample period.

discusses the properties of the model. Section IV describes the data. The results are discussed in section V. Section VI reports various robustness checks. Section VII concludes.

2. Model

Environment. The model is an extension of Backus, Kehoe and Kydland (1992) to a multi-country world that includes, in each country, two types of agents distinguished by their labor income realizations. The world consists of n countries. Countries use labor and capital to produce one homogenous good. They differ along the following dimensions. First, the size of the countries is different. Second, the production process in each country is subject to country specific technology shocks. Third, agents are subject to individual labor earnings shocks (idiosyncratic shocks) specific to each country.

Households. Each country is populated with two equal sized infinitely-lived households indexed by $i = 1, 2$[8]. Households consume, save, and divide time between work and leisure. I assume that households are endowed with $\overline{L}$ units of time, which can be used either for leisure or work. The per-period utility function for agent i, in country j, at time t determines agents' preferences over consumption c_{ijt} and leisure $\overline{L} - l_{ijt}$, where l_{ijt} is the time spent at work, τ determines the leisure weight in the utility function and $\theta > 0$ determines risk aversion. Each household maximizes a lifetime utility function given by:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \frac{[c_{ijt}(\overline{L} - l_{ijt})^{\tau}]^{1-\theta}}{1-\theta}, \tag{1}$$

subject to budget constraint:

$$c_{ijt} + s_{ijt} = w_{jt}\epsilon_{ijt}l_{ijt} + R_{t-1}s_{ijt-1} - .5\phi(s_{ijt} - \overline{S}_j)^2 + T_{ijt} \tag{2}$$

where $\beta > 0$ is the discount factor, $w_{jt}\epsilon_{ijt}l_{ijt}$ is the labor income, with w_{jt} to be a common

[8] Having two agents is the simplest way to introduce heterogeneity into the model and is employed for example in Heaton and Lucas (1996). However, individual shocks in this economy may have potential aggregate effects in particular on the interest rate; which is not the case with continuum of agents, where by the law of large numbers individual shocks do not have aggregate effects. Den Haan (1996) compares properties of two-agent model with a continuum of agents' model and finds no large differences for most parameter values.

wage rate in country j, ϵ_{ijt} idiosyncratic labor income shock. As in Heaton and Lucas (1996), I assume that one agent's individual shock is perfectly negatively correlated with the other agent's individual shock. I set ϵ_{ijt} equal to $1+z_{jt}$ for one of the agents and $1-z_{jt}$ for the other one, where z_{jt} is a stochastic individual income process that takes the following autoregressive form:

$$z_{jt} = \rho_z z_{jt-1} + \sqrt{1-\rho_z^2} e_{jt}^z, \tag{3}$$

where ρ_z is an autocorrelation parameter and $e_{jt}^z \sim N(0, \sigma_{zj}^2)$. s_{ijt} are households' assets that pay a gross interest rate R_t. I assume that in order to adjust their asset portfolios, households have to pay fees to the domestic financial intermediary. I assume that fees are a quadratic function of households' assets holdings:[9] $.5\phi(s_{ijt} - \overline{S}_j)^2$. This specification pins down steady state positions of assets. I assume that financial intermediary rebates the revenues from these fees back to the households in a lump sum fashion and households take them as given. I use T_{ijt} to denote the rebates, which are equal to $.5\phi(s_{ijt} - \overline{S}_j)^2$ in equilibrium. First order conditions for consumption and labor are as follows:

$$c_{ijt}^{-\theta}\left(\overline{L} - l_{ijt}\right)^{\tau(1-\theta)}\left[1 + \phi\left(s_{ijt} - \overline{S}_j\right)\right] = \beta E_t\left(R_t c_{ijt+1}^{-\theta}\left[\overline{L} - l_{ijt+1}\right]^{\tau(1-\theta)}\right) \tag{4}$$

$$w_{jt}\epsilon_{ijt} = \frac{\tau c_{ijt}}{\overline{L} - l_{ijt}}. \tag{5}$$

Production. There is no mobility of labor between countries. I use capital letters to denote aggregate quantities within each country, for example, K_{jt} denotes aggregate capital in country j at time t and define the aggregate quantities as averages of the individual quantities. In each country there is an aggregate production function given by:

$$Y_{jt} = \exp(A_{jt}) K_{jt-1}^{\alpha} L_{jt}^{1-\alpha}, \tag{6}$$

where K_{jt} and L_{jt} are aggregate capital and labor used in the production, α is the capital share, A_{jt} is the country specific total factor productivity (TFP) shock. The exogenous process for

[9] The constant $\overline{S}_j$ is calibrated to be equal to the steady state capital, K_j in each country.

TFP is modeled as AR(1) process and is specified as follows:

$$A_{jt} = \rho_a A_{jt-1} + \sqrt{1-\rho_a^2} e_{jt}^a, \tag{7}$$

where ρ_a is the autocorrelation parameter and $e_{jt}^a \sim N(0, \sigma_{aj}^2)$. In equilibrium, prices are set to their marginal products:

$$w_{jt} = (1-\alpha) \exp(A_{jt}) K_{jt-1}^{\alpha} L_{jt}^{-\alpha} = \frac{(1-\alpha) Y_{jt}}{L_{jt}}, \tag{8}$$

$$R_{t-1} - 1 + \delta = \alpha \exp(A_{jt}) K_{jt-1}^{\alpha-1} L_{jt}^{1-\alpha} = \frac{\alpha Y_{jt}}{K_{jt-1}}, \tag{9}$$

where δ is the depreciation rate of the capital. The stock of capital in each country evolves according to (10):

$$K_{jt} = I_{jt} + (1-\delta) K_{jt-1}, \tag{10}$$

where I_{jt} is aggregate investment.

Aggregation. Defining net foreign asset position as: $NFA_{jt} = S_{jt} - K_{jt}$ and aggregating across household budget constraints yields standard definition for current account as the sum of net investment income and trade balance:

$$CA_{jt} = NFA_{jt} - NFA_{jt-1} = r_{t-1} NFA_{jt-1} + Y_{jt} - C_{jt} - I_{jt}, \tag{11}$$

where r_{t-1} is net interest rate. Details on the derivation are in the appendix A.

Financial markets. International financial markets are incomplete and only risk-free bonds are traded across the countries. I assume that there is a centralized institution in each country that collects all the assets from the agents. These institutions meet on the global financial market and borrow/lend to each other in terms of the risk-free bonds. The "shortfall" between aggregate assets and aggregate capital used in the domestic production is borrowed, while the "excess" is lent. International financial markets clear, so that countries' bonds are in zero net supply:

$$\sum_{j=1}^{n} \omega_j (S_{jt} - K_{jt}) = 0, \tag{12}$$

where ω_j are countries' weights.

3. Model properties

In this section I briefly discuss the solution method and present results for a 3-country version of the model with a simple calibration to illustrate model's properties.

3.1. Solution method

First, I solve for the deterministic steady state of the model. Appendix A includes all derivation details as well as steady state values for both aggregate and individual variables. Second, I solve second order approximation of the model around this deterministic steady state.[10] Third, I compute unconditional first moments of endogenous variables implied by the solution. The variances of the shocks affect these moments (see for example Schmitt-Grohe and Uribe (2004)), and they are not equal to deterministic steady state values, as would be the case with first order approximation. Hence it is a long run equilibrium of the model in which agents take into account the likelihood of future shocks, in other words it is a stochastic steady state of the model implied by the shocks. Thus different levels of aggregate and idiosyncratic volatilities deliver different stochastic steady state values for countries' net foreign asset positions. So, in order to compare how change in volatility levels affects the countries' change in external positions, I compute the difference between stochastic steady state values for net foreign asset positions, implied by different volatility levels. If I were to apply first order approximation to solve the model then unconditional first moments of endogenous variables coincide with the deterministic steady state values, which would be the same for different volatility levels.

[10] I use Dynare software.

3.2. Basic calibration

Table 1 summarizes the calibrated parameters used in the exercise.

Name	**Symbol**	**Value**
Capital Share	α	.33
Discount Factor	β	.97
Consumption/leisure substitution	τ	1
Time endowment	$\overline{L}$	2.06
Depreciation rate	δ	.1
Scale parameter for portfolio adjustment costs	ϕ	.01
Risk Aversion	θ	5
Persistence of aggregate shocks	ρ_a	.9
Persistence of individual shocks	ρ_z	.9

Table 1: Values for parameters

The time period is one year. I set the capital share $\alpha = 0.33$ and the depreciation rate $\delta = .1$ as in King and Rebelo (1999) and discount factor $\beta = .97$. These values deliver steady state value of investment to output ratio of .25 and consumption to output ratio of .75 as in Backus, Kehoe and Kydland (1992) and steady state value for interest rate of 3%. I set $\tau = 1$ and the total endowment of time $\overline{L} = 2.06$: these two values imply the time spent on market activities is around 47 percent of the available time. This number is in line with the evidence that on average household spends 1/3 of total time on market activities and assumption that households do not receive any utility from sleeping. I set scale parameter for portfolio adjustment costs $\phi = .01$. This number is sufficiently small to generate well-defined stationary distribution of countries net foreign asset positions. Persistence parameters ρ_a and ρ_z are set to 0.9: as in Iacoviello and Pavan (2008). Finally risk aversion parameter is set to $\theta = 5$ as in Fogli and Perri (2006). In the robustness section I perform a sensitivity analysis on the key parameters.

I use standard deviations of the aggregate/idiosyncratic shocks, as a measure of the aggregate/idiosyncratic volatilities. In this exercise, I assume for simplicity that the world consists of three regions, labeled A, B and C. Initially, all regions have the same levels of aggregate volatility $\sigma_a = .01$ and idiosyncratic volatility $\sigma_z = .1$.[11] When the volatilities are the same in

[11] The numbers chosen are smaller than the ones observed in the data. However, I maintain the difference in the scale between aggregate and idiosyncratic standard deviations. Data shows that the individual standard

all the countries the model delivers stochastic steady state values for net foreign positions equal to zero.

3.3. Basic experiments

I conduct the following three experiments. First, I increase aggregate volatility in one region (say A) and keep the rest of the regions unchanged. Second, I increase idiosyncratic volatility in the same region A and keep the rest of regions unchanged. Third, I increase aggregate and idiosyncratic volatilities simultaneously. In Table 2 I present aggregate volatilities σ_a, idiosyncratic volatilities σ_z and corresponding stochastic steady state values for net foreign asset positions as a percentage of the world output, NFA.

Region	**Experiment I**			**Experiment II**			**Experiment III**		
	$\boldsymbol{\sigma}_a$	$\boldsymbol{\sigma}_z$	NFA	$\boldsymbol{\sigma}_a$	$\boldsymbol{\sigma}_z$	NFA	$\boldsymbol{\sigma}_a$	$\boldsymbol{\sigma}_z$	NFA
A	.015	.1	.04	.01	.15	2.14	.015	.15	2.190
B	.010	.1	-.02	.01	.10	-1.07	.010	.10	-1.095
C	.010	.1	-.02	.01	.10	-1.07	.010	.10	-1.095

Table 2: Results from basic experiments

In Experiment I, aggregate volatility in region A increases by 50% from .01 to .015. This increase makes region A relatively riskier place than regions B and C. Agents in A increase the buffer of precautionary savings that flow into regions B and C. As a result region A accumulates positive net foreign asset position of .04% of the world output and regions B and C negative positions of .02%[12]. In Experiment II, idiosyncratic volatility in region A increases by 50% from .1 to .15. Similar argument follows. Region A becomes relatively riskier causing the accumulation of precautionary savings in A. The model delivers positive net foreign asset position for region A in the amount of 2.14% of the world output, while B and C accumulate negative positions equal to 1.07%. In Experiment III, I allow simultaneous increase in aggregate and idiosyncratic volatilities in region A by 50%. The results are very similar to the second experiment. Region A accumulates positive asset position in the amount of 2.19%

deviation of individual shocks is at least 10 times larger than of aggregate shocks (more on this in the data section).

[12]In these experiments I use equal country weights: $\omega_1 = 1/3$, $\omega_2 = 1/3$, $\omega_3 = 1/3$.

and B and C negative positions of 1.095%. Hence, qualitatively same percentage changes in aggregate and idiosyncratic volatilities deliver the same results, although quantitatively results are very different. Changes in idiosyncratic volatility generate much larger external imbalances than those generated by changes in aggregate volatility. The model delivers net foreign asset position in region A of 2.14% of the world output with the 50% drop in idiosyncratic volatility and only .04% with the 50% drop in aggregate volatility. This result suggests that volatility of idiosyncratic shocks can be a possible channel to generate sizable external imbalances with much larger magnitude than aggregate shocks alone.

Next I will construct a multi-country version of the model with the data based on careful calibration of aggregate and idiosyncratic volatilities to be discussed below.

4. Data

In this section, I discuss the selection rule to choose the countries that are responsible for the creation of global imbalances. I also discuss the data I use to calibrate aggregate and idiosyncratic volatilities for the selected countries, and document some empirical facts regarding these volatilities.

4.1. Country selection

Lane and Milesi-Ferretti (2007) construct a dataset containing information on external assets and liabilities for 145 countries for the period 1970-2004. I use this dataset to select the countries for the model and apply the following criteria. First, I compute average of *absolute* values of the world net foreign positions over the period 1970-2004, NFA_W.[13] Second, I compute average of *absolute* values of each country's net foreign position, NFA_i.[14] A country i goes into the sample if NFA_i satisfies the condition:

$$NFA_i \geq pNFA_W, \tag{13}$$

[13] Due to statistical discrepancy the sum of total assets and total liabilities at every given year is not equal to 0 in this dataset.

[14] For some countries, data is not available for the whole period: 1970-2004, so I compute average over the years for which data is available.

where p is a number between 0 and 1. Condition (13) allows me to select the most active countries on the global financial market in terms of the sizes. I set parameter p to .025, and as a result 10 countries enter the sample: Australia, Brazil, Canada, Germany, Hong Kong, Japan, Mexico, Switzerland, Taiwan, and United States.[15] Table 1A in the Appendix gives more details on the different values of p and the corresponding list of countries that met the criteria. Figure 2 shows the dynamics of net foreign asset positions for countries from the sample.[16]

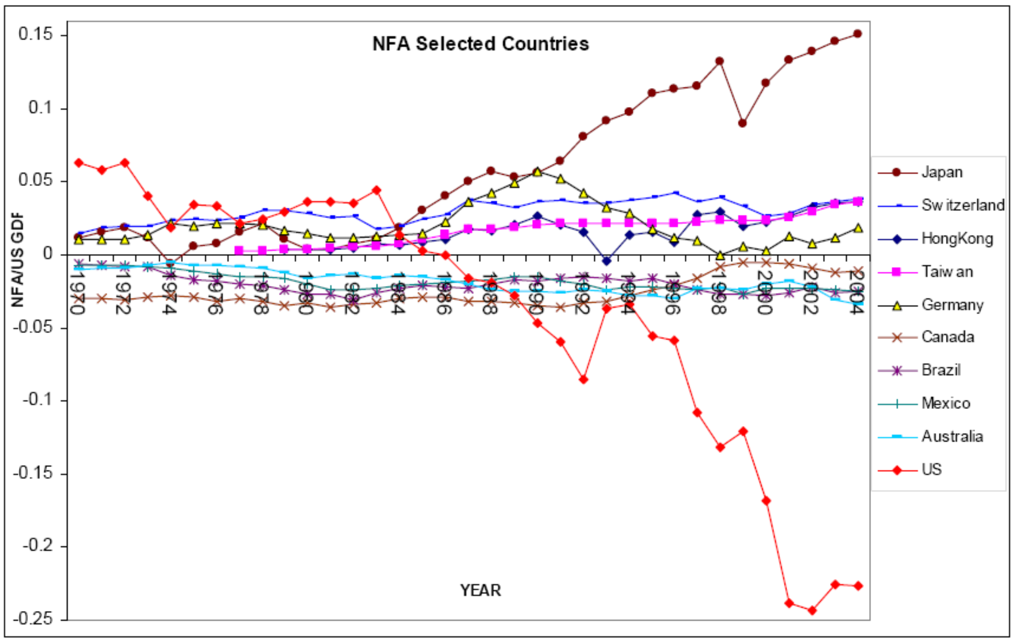

Figure 2 Dynamics of Net Foreign Asset Position for Selected Countries.

As the Figure shows the U.S. is the largest country on the deficit side, while Japan on the surplus side. The rest of the countries are located in between of the two. In the next subsection I will discuss the change in aggregate volatility for selected countries.

4.2. Aggregate volatility

All the data are from the World Development Indicators (WDI) dataset published by the World Bank and International Financial Statistics (IFS) dataset, published by the IMF, except for

[15] I choose p so no oil-exporting countries are in the sample.

[16] China does not meet this criterion.

Taiwan for the period 1960-2005.[17] Figure 3 plots log real GDP detrended with Baxter-King filter (BK).[18]

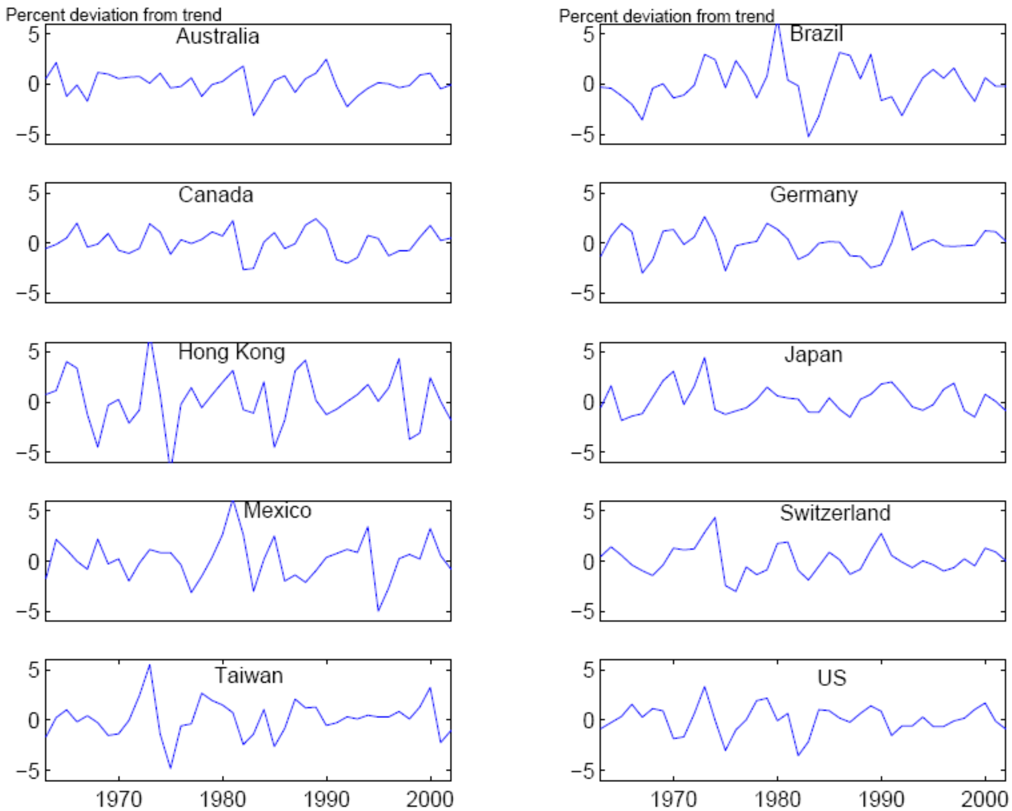

Figure 3 Business cycles in selected countries: Baxter-King filtering

We can see from Figure 3 that business cycle volatility moderated after mid-1980s in Japan, Mexico, Switzerland, Taiwan and the U.S.[19] However, for the rest of the countries in the sample it is difficult to make any conclusion from this figure. So I compute standard deviations for the selected countries over two periods: 1960-1983, and 1984-2005. Table 3 reports the results.

The data shows that the volatility of economic activity measured by real GDP has been

[17] Data for Australia, Brazil, Hong Kong, Japan, Mexico, Switzerland and the U.S. are annual real GDP from WDI. Data for Canada and Germany are from IFS, I constructed annual real GDP series for Germany and Canada using nominal values and dividing them by the appropriate deflators. Both WDI and IFS do not contain any data for Taiwan. Data for Taiwan are from Directorate General of Budget, Accounting and Statistics, National Statistics, Republic of China.

[18] BK filter is a type of a bandpass filter and I set parameters equal to 2 and 8 isolating the frequencies shorter than 2 year and longer than 8. For Germany I replaced 1991 value with Germany specific full sample median value, as in Stock and Watson (2005)

[19] I also detrended the data taking first differences and HP filter, they show very similar patterns to BK filtering.

Country	Percent Standard Deviation 1960-1983	1984-2005	Level Change	Ratio	Percent change relative to the US
Australia	1.22	1.06	-0.16	.87	71
Brazil	2.41	1.85	-0.56	.77	52
Canada	1.30	1.25	-0.05	.96	90
Germany	1.54	1.24	-0.30	.80	59
Hong Kong	2.90	2.51	-0.39	.87	71
Japan	1.59	1.13	-0.46	.71	40
Mexico	2.15	2.06	-0.09	.96	89
Switzerland	1.82	0.97	-0.85	.53	5.4
Taiwan	2.14	1.39	-0.75	.65	28
US	1.72	0.87	-0.85	.51	0.0

Table 3: Changes in Aggregate volatility for Selected Countries: BK filter

moderated in all the countries in the sample[20]. However, the decrease in business cycle volatility is very different across the countries. I assess the size of the decrease in the aggregate volatility using the following measures. First, I compute the change in levels, which is the difference between the standard deviations from two periods. Second, I compute the ratio of standard deviations from two periods. Third, I compute the percentage change in the volatility in a given country relatively to the change in the volatility in the U.S[21]. I will employ the same approach to compare idiosyncratic volatilities. All the countries experienced the relative decrease in the aggregate volatility smaller than the decrease in the U.S. aggregate volatility. Taiwan, Switzerland and the U.S. experienced the largest decreases in the aggregate volatilities. The level of aggregate volatility in the post period is the largest in Hong Kong (2.51), and Mexico (2.06) has the second large. The U.S. has the smallest level of volatility (.87) in the post moderation period.

4.3. Idiosyncratic volatility

Aggregate income volatility measures a country specific uncertainty. All agents in a given country face the same level of aggregate uncertainty. On top of that, agents could also face some level of individual income uncertainty within the country. The literature defines idiosyncratic

[20] These findings are consistent with Fogli and Perri (2006) for the G3 countries and Stock and Watson (2005) for the G7 countries.

[21] For example Australia: $(1.06/1.32)/(.84/1.86) = 1.7781$, so the percentage change relative to the U.S. change is equal $177.8 - 100 = 77.8\%$.

volatility in several ways. One of them, introduced by Moffitt and Gottschalk (1994), and used in Moffitt and Gottschalk (2002), Gottschalk and Moffitt (2008) and Zhang (2008), among others, computes cross-sectional variance of some measure of individual income (wage, earnings, household income etc.) then utilizes parametric models to decompose this variance into permanent and transitory components.[22] This transitory component is used to measure idiosyncratic volatility of income. An alternative approach employed by Cameron and Tracy (1998), Dynan, Elmendorf, and Sichel (2008) and Shin and Solon (2008) is to use simple statistics to measure individual income volatility.[23] For example, Shin and Solon (2008) define earnings volatility as the standard deviation of age-adjusted change in log earnings. However, in order to apply any of these approaches, the required data is micro-level longitudinal data and, to the best of my knowledge publicly available panel datasets starting from 1983 are only available for the U.S. and Germany, and pseudo panel data for Taiwan[24]. Due to these data limitations, I use a residual income inequality to define individual income volatility. Specifically, I define the standard deviation of age-and-education adjusted log of total household disposable income as a measurement of idiosyncratic volatility. This is the same number defined as the residual variance from the first-stage regression in Moffitt and Gottschalk (2008).

The data come from the Luxembourg Income Study dataset (LIS). This dataset collects micro-data (household/individual level) from different surveys in order to make possible comparative research across a large set of countries and in different points in time. The dataset includes over 30 countries including both industrial and emerging economies. The dataset is harmonized and standardized to make the consistent comparison of income inequalities in different countries using one uniform setting. As pointed out by Gottschalk and Smeeding (1997) the latter is one of the greatest advantages of LIS dataset. The dataset includes only 7 out of 10 selected countries: Australia, Canada, Germany, Mexico, Switzerland, Taiwan and United States. Unfortunately, the dataset does not have data on Brazil, Hong Kong and Japan. I drop Brazil and Hong Kong from my sample. However, Japan is the second largest participant in

[22] Katz and Autor (1999) is an excellent survey of this literature.

[23] The model specifications very often are sensitive to the chosen dataset, for example Baker and Solon (2003) using Canadian Longitudinal income tax data rejects the restrictions imposed in Moffitt and Gottschalk (1995) specification.

[24] Pseudo panel could do the trick as well, Cameron and Tracy (1998), and Hertz (2006) use CPS data to estimate earnings/income volatility.

the international financial markets according to the data (see Figures 1 and 2), hence I keep it in the sample and use the information from the rest of the countries in the sample to assess the idiosyncratic volatility for Japan. Details are in the next subsection.

In order to compute idiosyncratic volatilities I follow Zhang (2008) which is an extension of Moffitt and Gottschalk (2008). In addition to the U.S. she estimates permanent and transitory components of household income inequality for Germany and the UK. Let y_{ijt} denote household disposable income available to a household i in a country j in a period t[25]. I rescale y_{ijt} according to the number of members in the household applying general official U.S. Equivalence Weight scale. Then for each country and each available year, I regress $log(y_{ijt})$ on head's characteristics: age, age squared, education, number of children, marital status and gender and compute standard deviation of residuals for each regression.[26] For some countries LIS created a recoding of original education variable into four broad categories. Whenever available, I use suggested recoding, otherwise, I created dummies for the original categories. Some studies include additional demographic parameters. For example Cameron and Tracy (1998) use dummies for industry and replace age, and age squared with quartic in age. Krueger and Perri (2006) also include experience, interaction terms between experience and education, dummies for managerial/professional occupation, and region of residence.

One of the shortcomings of the LIS dataset is that points in time, for which surveys are available, are different from country to country. In the model, I compare states of the world in 1980 to 2000. For each country, I chose the closest available survey to 1980 and 2000 based on the date and availability of all demographic parameters used in the regressions.[27]

Since disaggregated data for Japan are almost impossible to obtain I make some conjectures about standard deviation of household disposable income without having the data at hand. Note

[25] I use household disposable income instead of individual income due to the following: First, individual data are not available for all countries in particular for Switzerland 2000 and 2002. Second, for Mexico only net wages are available at the individual level while only gross wages are available for the other countries.

[26] The OLS specification is very similar to Zhang (2008) first stage regression with a few differences. First, I include head's sex dummy. Second, while she is using number of years of education, LIS data set has only categorical variable education.

[27] All the countries were chosen based on the closest date, except for Germany, I chose 1984 over 1981, since in 1981 education was given in the years of education and not in categories. However, I estimated the standard deviation of residuals for 1981 with number of years of education and this value .3725 is very close to 1984 value .3704.

that standard deviation of the lognormal distribution can be computed from Gini coefficient (see for example Klasen (2006)) using the following expression:

$$\sigma = \sqrt{2}[\Phi^{-1}(\frac{G+1}{2})], \quad (14)$$

where σ is standard deviation of the distribution, G is the Gini coefficient and Φ^{-1} is the inverse of a cumulative distribution function of a standard normal distribution. Gini coefficients are available for most of the countries including Japan. In order to infer about the idiosyncratic volatility in Japan, I will make two assumptions. First, I assume that household disposable income for Japan is log normally distributed. Second, I assume that the fraction in the total variance of the household disposable income in Japan explained by fixed effects (age and education) is equal to the average value of fractions in the total variances explained by the fixed effects in the rest of industrial countries in my sample. In the benchmark model I use Gini published in Ministry of Health and Welfare (1999) and OECD (2006) and computed from Income Redistribution Survey (IRS) using household disposable income as a unit of analysis.[28] 1984 and 1999 are the chosen years for the analysis, the values for volatilities are reported in table 4.[29]

Country	**Standard Deviation**				**Level Change**	**Percent Change**	**Percent change relative to the US**
	year 1		**year 2**				
Australia	**1981**	.4838	**2001**	.4859	.0021	0.45	-6.90
Canada	**1981**	.4817	**2000**	.4899	.0082	1.70	-5.73
Germany	**1984**	.3704	**2000**	.4040	.0336	9.07	1.10
Japan	**1984**	.5198	**1999**	.5936	.0738	14.2	5.85
Mexico	**1984**	.6887	**2000**	.7397	.0510	7.37	-0.44
Switzerland	**1982**	.4371	**2000**	.3774	-.0597	-14.7	-20.0
Taiwan	**1981**	.3870	**2000**	.4220	.0350	9.37	1.07
US	**1979**	.5206	**2000**	.5617	.0411	7.90	0.00

Table 4: Changes in Idiosyncratic volatility for Selected Countries

In Table 4 I present standard deviations of residuals from each regression, years for which

[28] In the robustness analysis section I also use Gini from the Comprehensive Survey of the Living Conditions of People on Health and Welfare and published by OECD (2006).

[29] Another option would be to choose 1981, however this would result in the increase in volatility between two periods by 25%, this number is at odds of the estimates for other countries in the sample.

volatilities were computed, and different measures of the changes in those volatilities. I assess the size of the change in idiosyncratic volatility utilizing the same measures used for aggregate volatility. First, I compute the change in levels, which is the difference between the standard deviations from two periods. Second, I compute the ratio of standard deviations from two periods. Third, I compute the percentage change in the volatility in a given country relatively to the change in the volatility in the U.S. Figure 4 plots the change in idiosyncratic volatilities over two periods: if a country is above 45 degree line then idiosyncratic volatility of this country increased from 1980 to 2000. We can conclude from Figure 4, that all the countries in the sample but Switzerland experienced an increase in the idiosyncratic volatilities.

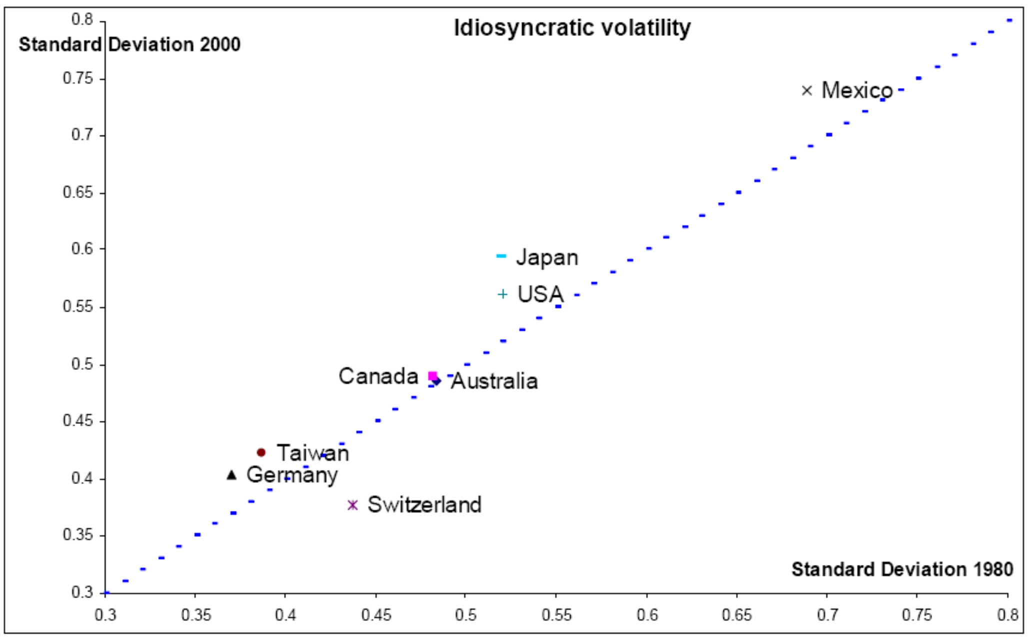

Figure 4 Changes in idiosyncratic volatilities for selected countries

In the next section I will bring the model to the data and evaluate quantitatively how much of external imbalances in the data it can account for.

5. Results

5.1. Benchmark model

As a benchmark case, I consider the world consisting of seven countries: Australia, Canada, Germany, Japan, Mexico, Taiwan and the U.S. I dropped Switzerland from the sample in the benchmark model due to two reasons. First, 1982 data does not contain education variable. Second, Switzerland is the only country in the sample that experienced fall in both aggregate and idiosyncratic volatilities, while running positive net foreign asset position. I believe this is the unique feature of the Swiss economy and consider Switzerland to be an outlier in my sample.[30]

In order to check if the model is capable to capture qualitatively and quantitatively the net foreign asset positions for the selected countries I conduct the following experiment, which I call "ratio experiment". In this experiment I take explicitly into account how changes in the volatilities in any given country have increased/decreased relatively to the change in the U.S. To do so, I compute for each country the ratio of idiosyncratic volatilities in 1980 and 2000, and then divide this ratio by the U.S. ratio. If the number is larger than 1, then the country has become relatively riskier than the U.S. Conversely, if it is smaller than 1, then it has become relatively safer. I calibrate countries' volatilities by multiplying these numbers by the U.S. volatilities from the pre moderation period.In table 5 I present the values for countries' volatilities, changes in countries' net foreign asset positions between 1980 and 2000 normalized by the U.S. GDP from the data, and changes in countries' net foreign asset positions computed from the model The latter is the difference between stochastic steady state values of net foreign asset positions corresponding to the volatilities in table 5 and values of net foreign asset positions in the symmetric stochastic steady state. In symmetric stochastic steady state all countries have the same level of aggregate and idiosyncratic volatility and accumulate zero net foreign asset positions. Put differently, I assume that initially countries have zero net foreign asset positions (no imbalances), then I change countries' volatilities according to the changes with respect to the U.S. and compute their net foreign asset positions. The last step is to

[30] As an additional robustness check I include Switzerland into the sample. Results are reported in the robustness section.

compare the imbalances generated by the model with the imbalances in the data.

Country	**Standard Deviation**		**Data NFA**	**Model NFA**
	Aggregate	**Idiosyncratic**	**Change**	**Change**
Australia	.030	.480	-0.46	-2.66
Canada	.032	.490	2.76	-3.92
Germany	.027	.530	-1.20	0.63
Japan	.024	.550	11.3	12.5
Mexico	.033	.520	-0.30	-0.65
Taiwan	.022	.530	1.97	0.09
US	.017	.520	-20.5	-6.04

Table 5: Ratio experiment, benchmark model

The discussion focuses mainly on the U.S. and Japan. The model delivers net foreign asset position for the U.S. equal to -6.04% of its output. This number accounts for about 30% of the change in the U.S. net foreign asset position. This exercise is also successful in matching the change in the net foreign asset position for Japan 12.5% in the model and 11.3% in the data. There is some mixed success in matching the changes in the net asset positions for the rest of the countries. The model matches qualitatively the changes (correct sign) for Australia, Mexico and Taiwan and quantitatively for Mexico but fails to match both qualitatively and quantitatively changes in positions for Canada and Germany. Explanation for such mixed success in matching positions for the rest of the countries could be due to the fact that model does not take into account how relatively safer/riskier countries became with each other. I use the U.S. economy, as a benchmark and the rest of the countries are modeled relatively to the U.S., and not with each other.

I also conduct another experiment, which I call "level experiment". I compute two stochastic steady state values for countries' net foreign asset positions. In the first one, I calibrate aggregate and idiosyncratic volatilities and weights for each country at a level before the great moderation. In the second one, I calibrate aggregate and idiosyncratic volatilities and country weights at a level after the great moderation. Table 3 reports values for aggregate volatilities, table 4 values for idiosyncratic volatilities. In Table 6 I present countries' net foreign asset positions normalized by the U.S. GDP in 1980 and in 2000 from the data, and corresponding stochastic steady values for net foreign asset positions computed by the model. In table 7 I present the results.

Country	Weights	
	1980	*2000*
Australia	.025	.027
Canada	.050	.049
Germany	.145	.122
Japan	.198	.184
Mexico	.052	.049
Taiwan	.013	.028
US	.517	.542

Table 6: Countries weights: before and after

Country	Data			Model		
	NFA *1980*	NFA *2000*	*Change*	NFA *1980*	NFA *2000*	*Change*
Australia	-1.55	-2.01	-0.46	-1.41	-4.46	-3.05
Canada	-3.29	-0.53	2.76	-3.11	-7.57	-4.46
Germany	1.47	0.27	-1.20	-41.3	-41.0	0.30
Japan	0.40	11.7	11.3	5.80	20.5	14.7
Mexico	-2.00	-2.30	-0.30	26.9	28.1	1.20
Taiwan	0.41	2.38	1.97	-3.21	-8.29	-5.08
US	3.70	-16.8	-20.5	16.3	12.8	-3.50

Table 7: Level experiment benchmark model

The model is successful in matching qualitatively (correct signs) the change in the net foreign asset positions for Australia, Japan, and the U.S but not for Canada, Germany, Mexico and Taiwan. However, the model is not successful quantitatively. It predicts that the U.S. net foreign asset position should deteriorate by 3.5% of its GDP. In the data when compared 1980 to 2000, the net foreign asset position for the U.S. deteriorated by 20% of its GDP. So the changes in aggregate and idiosyncratic volatilities account for 17%of the US actual net foreign asset position. The model is very close to match external positions for Japan: 14.7%, while 11.3% in the data. The model is not successful in explaining the levels of net foreign asset positions. For example: the U.S. had net foreign asset position of +3.7% in 1980 and -16.8% in 2000, while the model delivers +16.3% and +12.8% respectively.

One of the features of the model is that a country with the largest level of idiosyncratic volatility in the sample, in other words, the riskiest country, will tend to have positive net foreign asset position. Suppose some country, let me call it A, has the largest level of idiosyncratic volatility in both 1980 and 2000. The model predicts that this country runs positive net foreign asset positions in both periods. However, it is possible that another country let me call it B, while having the smaller values for idiosyncratic volatilities than A in both periods, experienced larger relative increase in idiosyncratic volatility than A in the second period[31]. Hence, country B becomes relatively riskier than country A, and country B is supposed to accumulate positive net foreign asset position. Unfortunately, the level experiment fails to recognize that.

In the next section I will do a series of robustness checks and sensitivity analysis for the key parameters and the model specifications.

6. Robustness

I showed that changes in aggregate and individual uncertainty may lead to the accumulation of precautionary savings in some countries. However, precautionary motive for savings is not driven only by the volatilities of the shocks, but also, by the persistence parameters ρ_a and ρ_z, and agents' preferences parameters, in particular by the risk aversion parameter θ. In this section I perform sensitivity analysis on those parameters. I also discuss how important the relative sizes of the countries are. I also extend the model to include Switzerland and report the results for eight countries version of the model. Changes in idiosyncratic volatility in Japan depend crucially on the choice of Gini coefficients. Hence, I recalculate the results of the model with the alternative values for Gini coefficients. Finally, I assume a different specification for the individual income process, and show how successful is the model in the alternative specification.

Persistence of individual income shocks. Idiosyncratic shocks are the driving channel for generation of external imbalances in this model and persistence of the shocks is one of the key parameters. The values estimated and used in the literature vary a lot. Storesletten, Telmer, and Yaron (2004) estimate the value of $\rho_z = .95$. Heaton and Lucas (1996) obtained much smaller estimate of $\rho_z = .53$. Iacoviello (2008) uses a more conservative value of $\rho_z = .75$. I recalculated net foreign asset positions for all above mentioned values of ρ_z. Table 8 reports the results.

There is an increasing monotonic relation between persistence of the idiosyncratic shocks and

[31] For example: country A has idiosyncratic volatility equal to .4 in 1980 and .5 in 2000, while country B has .2 in 1980 and .3 in 2000. So country A experiences an increase in volatility by 25%, while country B experiences an increase in volatility by 50%. Moreover, country B becomes relatively riskier than country A by 20% ((.3/.2)/(.5/.4)=1.20).

	$\rho_z = .53$			
	level experiment			**ratio experiment**
	before	*after*	*change*	*change*
Japan	2.4	8.6	6.2	5.3
US	6.9	5.3	-1.6	-2.8
	$\rho_z = .75$			
	level experiment			**ratio experiment**
	before	*after*	*change*	*change*
Japan	3.90	14.0	10.1	8.6
US	11.1	8.63	-2.47	-4.3
	$\rho_z = .95$			
	level experiment			**ratio experiment**
	before	*after*	*change*	*change*
Japan	5.90	20.8	14.9	12.7
US	16.5	12.9	-3.60	-6.12

Table 8: Sensitivity analysis, persistence of idiosyncratic income shocks

accumulation of net foreign asset positions. For low persistence $\rho_z = .53$ the U.S. accumulates only -1.6% for the level experiment and -2.8% for the ratio experiment. For high persistence $\rho_z = .95$ the U.S. accumulates net foreign asset positions of -3.6% and -6.12% for the level and ratio experiments respectively. Intuitively, when the shocks are more persistent it is more difficult for the agents to insure against them and agents need larger cushion of precautionary savings to reduce the increase in income uncertainty.

Persistence of aggregate income shocks. Though effects of changes in aggregate uncertainty are of one order smaller than changes in idiosyncratic uncertainty, I performed sensitivity analysis for different values of persistence parameter of aggregate shocks. I recalculate the model with perstistence parameters $\rho_a = .5$ and $\rho_a = .75$. Table 9 reports the results. The benchmark model results are robust to the changes in the persistence of the aggregate shocks.

Risk Aversion, θ. I recalculate the model with lower risk aversion $\theta = 2$ and higher $\theta = 8$. Economic intuition suggests that when agents become less risk averse $\theta = 2$, the incentives to undertake precautionary savings diminishes, resulting in the smaller imbalances. However, with larger risk aversion, $\theta = 8$, agents are more willing to increase their buffer of precautionary savings, which leads to larger imbalances. Results in Table 10 support this intuition. The model predicts (ratio experiment) the change in the U.S. net foreign asset position to be only -1.7% for smaller θ and -12.2% for larger θ.

	$\rho_a = .5$			
	level experiment			**ratio experiment**
	before	*after*	*change*	*change*
Japan	5.80	20.51	14.7	12.45
US	16.36	12.84	-3.52	-5.62
	$\rho_a = .75$			
	level experiment			**ratio experiment**
	before	*after*	*change*	*change*
Japan	5.80	20.52	14.72	12.49
US	16.35	12.80	-3.55	-5.81

Table 9: Sensitivity analysis, persistence of aggregate income shocks

	$\theta = 2$				$\theta = 8$			
	level experiment			**ratio experiment**	**level experiment**			**ratio experiment**
	before	*after*	*change*	*change*	*before*	*after*	*change*	*change*
Japan	1.6	5.8	4.2	3.5	11.7	41.3	29.6	25.3
US	4.6	3.6	-1.0	-1.7	32.9	25.7	-7.20	-12.2

Table 10: Sensitivity analysis, risk aversion

Scale parameter for portfolio adjustment costs, ϕ. I perform a sensitivity analysis on different values of ϕ: .005, .0025 and .001. Intuitively for smaller values of ϕ it is less costly for the agents to adjust their asset holdings, resulting in larger imbalances. Table 11 presents the results which supports this intuition.

For example if $\phi = .0025$ the model delivers -13.7% for the change in the U.S. net foreign asset position which accounts for 67 % of the actual change in the U.S. net foreign asset position. However, for Japan the model delivers 28.5% which is larger than in the data.

Switzerland. I extend my model to include Switzerland into my sample, and repeat the exercise for an eight countries' version. Results are reported in Table 12. The results are robust to the inclusion of Switzerland. The model predicts the deterioration of the US net foreign asset position of 2.30% and 7.4% for the level and ratio experiments respectively.

Gini. I recalibrate the model with the values for Gini computed using different survey: Comprehensive Survey of the Living Conditions of People on Health and Welfare (CSLCPHW) and published in OECD (2006). As in the benchmark calibration, I use 1984 and 1999 as years for pre moderation and post moderation periods and household disposable income as a measurement of income. Table 13 reports the results. For the U.S. the model (ratio experiment)

	$\phi = .005$			
	level experiment			**ratio experiment**
	before	*after*	*change*	*change*
Japan	8.60	30.4	21.8	18.6
US	24.2	18.9	-5.30	-9.00
	$\phi = .0025$			
	level experiment			**ratio experiment**
	before	*after*	*change*	*change*
Japan	13.2	46.6	33.4	28.5
US	37.2	29.0	-8.20	-13.7
	$\phi = .001$			
	level experiment			**ratio experiment**
	before	*after*	*change*	*change*
Japan	25.1	89.0	63.9	54.3
US	71.2	55.4	-15.8	-26.1

Table 11: Sensitivity analysis, portfolio adjustment costs

delivers change in net foreign asset position of -8.01% of its output, which explains 40% of the change in the data. However, the model delivers 15.5% for Japan, which is much larger than 11.3% found in the data.

Model specification. As pointed out in Heathcote, Storesletten and Violante (2008), the most accurate process to describe uninsurable idiosyncratic income shocks consist of highly persistent and transitory components. In the benchmark model, I modeled the process for the idiosyncratic shocks to comprise only of a persistent component. However, if the true specification of the income process consists of two components then the value of the persistent parameter used in the calibration might be incorrect. As an additional robustness check, I repeat benchmark model computations with the following specification of the idiosyncratic income shocks:

$$z_{ijt} = p_{ijt} + u_{ijt}, \tag{15}$$

$$p_{ijt} = \rho_p p_{ijt-1} + (\sqrt{1-\rho_{pj}^2})e_{ijt}^p, \tag{16}$$

where p_{ijt} is a persistent component, u_{ijt} is a transitory component, ρ_p is an autocorrelation parameter, $e_{ijt}^p \sim N(0, \sigma_{pj}^2)$ and $u_{ijt} \sim N(0, \sigma_{uj}^2)$. I assume that innovations to permanent component e_{ijt}^p and transitory component u_{ijt} are independent with each other. This specification implies that the total variance of idiosyncratic shocks can be decomposed into the sum of

Country	Data			Model			
				level experiment			ratio experiment
	before	*after*	*change*	*before*	*after*	*change*	*change*
Australia	-1.55	-2.01	-0.46	-1.51	-4.29	-2.80	-2.36
Canada	-3.29	-0.53	2.76	-2.95	-7.27	-4.32	-3.25
Germany	1.47	0.27	-1.20	-34.4	-40.0	-5.60	0.23
Japan	0.40	11.7	.11.3	5.46	21.1	15.6	16.4
Mexico	-2.00	-2.30	-0.30	24.9	27.9	3.00	-0.50
Switzerland	2.90	2.70	-0.20	-1.78	-4.32	-2.54	-3.14
Taiwan	0.41	2.38	1.97	-6.92	-8.10	-1.20	0.01
US	3.70	-16.8	-20.5	17.2	14.9	-2.30	-7.40

Table 12: Results 8 countries' version

Country	level experiment			ratio experiment
	before	*after*	*change*	*change*
Australia	-0.29	-3.04	-2.75	-2.76
Canada	-0.83	-5.02	-4.19	-4.09
Germany	-34.8	-34.7	0.10	0.19
Japan	-30.4	-22.1	8.30	15.5
Mexico	29.3	30.6	1.30	-0.82
Taiwan	-2.64	-6.85	-4.21	0.01
US	39.7	41.0	1.30	-8.01

Table 13: Robustness check, Alternative Gini for Japan

variances of innovations to persistent and transitory components:

$$Var(z_{ijt}) = Var(e^p_{ijt}) + Var(u_{ijt}) = \sigma^2_{pj} + \sigma^2_{uj}. \tag{17}$$

I assume that for each country half of the total variance of idiosyncratic shocks is coming from the persistent component and half from transitory one and I set $\rho_p = .95$. I present results in Table 14. Qualitatively results are very similar to the benchmark case for both level and ratio experiments. However, quantitatively effects are smaller. An interpretation can be as follows. I showed before that the higher is the persistence of the idiosyncratic shocks, the larger is the buffer stock of precautionary savings. In this case income process is comprised of highly persistent component and zero-persistent component, transitory part. But the variance of the persistent component is only half of the variance of the persistent component used in the benchmark model. So agents accumulate smaller buffers of precautionary savings as compared to the benchmark case.

Country	**level experiment**			**ratio experiment**
	before	*after*	*change*	*change*
Australia	-0.85	-2.70	-1.85	-1.58
Canada	-1.90	-4.57	-2.67	-2.34
Germany	-24.9	-24.7	0.20	0.44
Japan	3.50	12.4	8.90	7.60
Mexico	16.3	17.0	0.70	-0.33
Taiwan	-1.93	-5.00	-3.07	0.06
US	9.85	7.64	-2.21	-3.83

Table 14: Robustness check, alternative income process specification

7. Conclusion

To the best of my knowledge the present study is the first one to explore a link between idiosyncratic uncertainty and external imbalances. I showed that changes in the volatilities of uninsurable idiosyncratic shocks are a possible channel to generate sizable external imbalances in addition or as an alternative to changes in the volatility of aggregate shocks. I quantitatively assess this phenomenon this result in a multi-country model calibrated to industrial and emerging markets. With a plausible calibration, the model is able to account quantitatively between 30 and 40 percent of the U.S. net foreign asset position present in the data and comes close to explaining the change in Japan's net foreign asset position. The model is robust to the different parameter values and different model specifications.

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Appendices

.1. Appendix A

.1.1. Current Account

I multiply budget constraints for both households by .5, then add those constraints. This implies: $C_{jt} + S_{jt} = w_{jt}L_{jt} + R_{t-1}S_{jt-1}$,where $C_{jt} = \frac{c_{1jt}+c_{2jt}}{2}$, $S_{jt} = \frac{s_{1jt}+s_{2jt}}{2}$, $L_{jt} = \frac{l_{1jt}+l_{2jt}}{2}$[32]. From equations (8) and (9): $w_{jt}L_{jt} = (1-\alpha)Y_{jt}$ and $R_{t-1}K_{jt-1} = \alpha Y_{jt} + K_{jt-1}(1-\delta)$. Plugging those expressions into (13) and defining $NFA_{jt} = S_{jt} - K_{jt}$ and net interest rate $r_{t-1} = R_{t-1} - 1$, implies: $C_{jt} + K_{jt} + NFA_{jt} = (1-\alpha)Y_{jt} + (1 + r_{t-1})NFA_{jt-1} + \alpha Y_{jt} + K_{jt-1}(1-\delta)$. Finally, imposing the law of motion for capital (10) yields: $NFA_{jt} - NFA_{jt-1} = Y_{jt} - C_{jt} - I_{jt} + r_{t-1}NFA_{jt-1} = CA_{jt}$ which is equation (11) in the text.

.1.2. Deterministic steady state

In this section I solve for deterministic steady state for arbitrary country j. I start with Euler equation (4) for agent 1 in country j in deterministic steady state it boils down to: $[1 + \phi(s_{1j} - K_j)] = \beta R$ and similar for agent 2: $[1 + \phi(s_{2j} - K_j)] = \beta R$. These two conditions implies that deterministic steady state values for agents assets are equal $s_{1j} = s_{2j}$. Since aggregate saving are defined as $S_j = \frac{s_{1j}+s_{2j}}{2}$, which implies

$$s_{1j} = s_{2j} = S_j \tag{18}$$

Substituting for s_{1j}, yields $[1 + \phi(S_j - K_j)] = \beta R$, which must hold for any j implying that $S_j - K_j = S_i - K_i$ for any i and j.Plugging the last equality into market clearing condtion (12) implies that:

$$S_j = K_j. \tag{19}$$

Condition (19) holds for any j, pinning down deterministic steady state values for countries' net foreign asset positions:

$$NFA_j = 0. \tag{20}$$

[32] I assume that $z_{jt}(l_{1jt} - l_{2jt}) \approx 0$

Plugging (18) back into Euler equation (4) and using (19) implies familiar steady state value for gross interest rate:

$$R = 1/\beta. \tag{21}$$

Imposing (21) into equation (9) yields:

$$\frac{K_j}{Y_j} = \frac{\alpha}{1/\beta - 1 + \delta}. \tag{22}$$

Law of motion for capital (10) implies:

$$I_j = \delta K_j. \tag{23}$$

Applying (20), (22) and (23) into (11) implies:

$$\frac{C_j}{Y_j} = 1 - \frac{\alpha\delta}{1/\beta - 1 + \delta}. \tag{24}$$

Aggregating (5) across agents then dividing by (8) and imposing (24) yields steady state value for L_j:

$$L_j = \frac{(1-\alpha)\overline{L}}{\tau\left[1 - \frac{\alpha\delta}{1/\beta - 1 + \delta}\right] + 1 - \alpha}. \tag{25}$$

Using (23) in the production function (6) and solving for K_j gives:

$$K_j = (\alpha/(1/\beta - (1-\delta)))\hat{}\,(1/(1-\alpha))\overline{L}(1-\alpha)/(1-\alpha+\tau(1-\delta\alpha/(1/\beta-(1-\delta)))). \tag{26}$$

Using (25) and (26) into (6) to find Y_j:

$$Y_j = (K_j)^{\alpha}(L_j)^{1-\alpha}. \tag{27}$$

Using (25) and (27) into (8) to find w_j:

$$w_j = \frac{(1-\alpha)Y_j}{L_j} \tag{28}$$

Using (27) in (24) implies:

$$C_j = Y_j(1 - \frac{\alpha\delta}{1/\beta - 1 + \delta}). \quad (29)$$

Solving (5) for c_{ij} and plugging into budget constraints for both agents gives identical equations for l_{1j} and l_{2j} implying:

$$l_{1j} = l_{2j} = L_j. \quad (30)$$

Finally using (30) in the agents budget constraints yields:

$$c_{1j} = c_{2j} = C_j. \quad (31)$$

.2. Appendix B

Value of p	Country list
.15	None
.14	United States
.12	+ Japan
.04	+ Switzerland
.035	+ Hong Kong, Taiwan
.03	+ Australia, Brazil, Canada, Mexico
.025	+ Germany
.02	+ Spain, United Arab Emirates
.015	+ Indonesia, Italy, Saudi Arabia, UK
.01	+ Argentina, Finland, France, India, Kuwait, Netherlands, Singapore, Turkey

Table .1: Value of p and country list

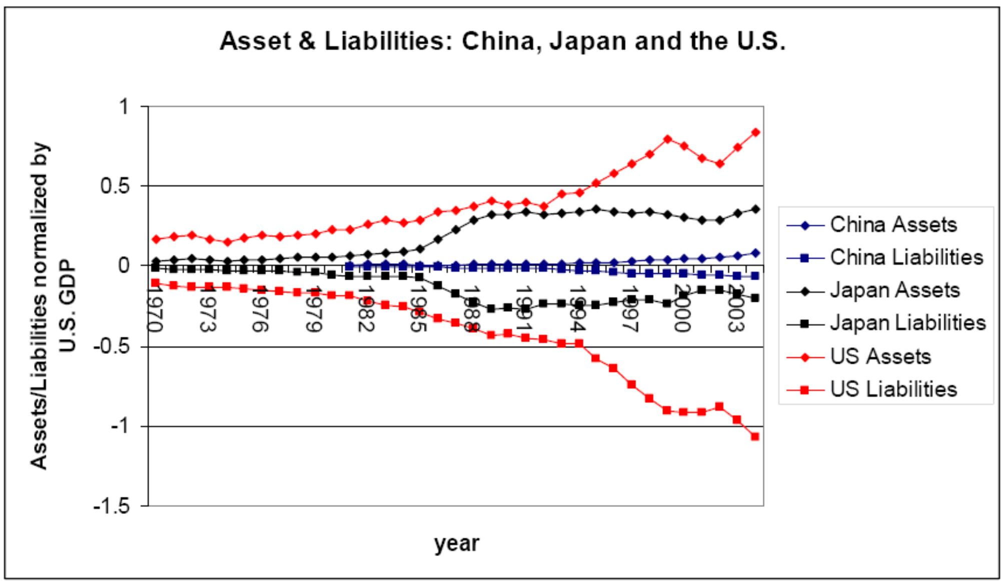

Figure .1: **Dynamics of Total Asset and Liabilities for China, Japan, and the U.S.**
Source: Lane and Milesi-Ferretti (2007) and own calculations