Is Our World More Integrated? The Feldstein Horioka Puzzle Revisited

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Presented to the Department of Economics
in partial fulfillment of requirements
for a Bachelor of Arts degree with Honors

Harvard College
Cambridge, Massachusetts
March 19, 2020

Abstract

This thesis revisits the relationship between a country's domestic saving and its investment, a link first explored by Feldstein and Horioka (1980). I show that the once strong relationship between domestic saving and investment waned over time and essentially disappeared in the years before the financial crisis, followed by some reemergence more recently. I find that the countries that opened themselves most to trade saw the greatest decline in the saving-investment relationship. I also present evidence from an instrumental variable strategy that suggests that saving-investment relationship is causal. All told, the evidence in this paper suggests a general decline in the saving-investment relationship indicative of the strong forces of globalization at play and the recent uptick relates to a pull-back of cross-border capital investment following the Great Recession.

Introduction

Does domestic saving flow to areas where capital is most productive capital or does it stay in its country of origin? Feldstein and Horioka (1980) (FH) posed this question, spurring an extensive literature on international capital mobility. For open economies, theory predicts that domestic saving adds to a world pool of saving that finds the investment with the highest rate of return regardless of boarders. Thus, theory predicts that saving and investment in a country should not closely track each other. Yet Feldstein and Horioka found a strong relationship between saving and investment in a cross section of countries and used these results to argue that there existed less-than-perfect capital mobility in industrialized countries. Since the paper was written, the finding of a relationship between a country's saving and its investment has remained robust to different estimation methods although the relationship is weaker for more recent

samples. Economists have also challenged the interpretation that saving-investment correlations are indicative of capital mobility.

The bulk of this work building on Feldstein and Horioka occurred in earlier decades, notably in the eighties and nineties. Thus, there is room for revisiting the issue, particularly given that it bears on important public policy questions concerning the determinants of capital formation, including the role of taxes. Further, understanding how the relationship has changed over time and where it stands now can yield insight into how the interconnectedness of the world has evolved over time.

Over the last 50 years, the world has experienced a substantial increase in financial and physical integration. Cross border flows of services, capital, and labor have increased by many measures.[1] Most goods from shoes to smart phones are produced in a global supply chain and capital flows across the world to build that supply chain. Technology manufacturers like Apple and Microsoft invest billions of dollars in physical capital in China to produce phones and computers that are sold in the United States. Nike and Adidas produce the majority of their shoes in China and Vietnam, having made large capital investments in those countries.[2] Following the NAFTA trade deal, Chevrolet shifted production of many of its iconic American cars to their Mexican plants.[3] In short, companies do much more international investment than before, which one would expect to contribute to the decoupling of domestic saving and investment.

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[1] Lawrence H. Summers (1999). "Reflections on Managing Global Integration." Journal of Economic Perspectives. Spring 1999.
[2] https://qz.com/1274044/nike-and-adidas-are-steadily-ditching-china-for-vietnam-to-make-their-sneakers/
[3] https://gmauthority.com/blog/2018/08/nafta-here-are-exactly-what-cars-trucks-gm-exports-from-mexico-to-the-u-s-and-canada/

In terms of regulation, capital controls and measures of financial regulation have generally decreased over the decades, possibly inducing the weakening of the relationship.[4] However, there have been large changes in the opposite direction in some countries in the wake of the 2007-08 global financial crisis. In particular, many governments have implemented policies that keep funds in their home country through caps on interest rates, cross-border capital regulation, and forcing state banks to keep more domestic treasury bills (Reinhart et. al 2011). Altogether, these considerations suggest that the relationship between domestic saving and investment has likely changed since the eighties and nineties when the major papers around the puzzle were published.

Revisiting the relationship between a country's saving and its investment, and, in particular, exploring causal mechanisms helps clarify whether governments should incentivize saving as a lever to affect investment, which can then increase economic growth. In general, increasing the stock of capital increases the production of goods and services. Capital goods like machines, transport equipment, factories, and other tools increase the productivity of workers and drive more output. But in order to increase the stock of capital, countries must finance capital formation either from internal sources, like national saving, or external sources like net capital inflows.[5]

To be clear, higher rates of saving can raise the incomes of citizens of a country even if the saving does not get invested domestically since the source country receives the yield on its international investment apart from any taxes collected by foreign governments. On the other hand, if capital stays in the source country, the source country will experience more job creation, and an expanded tax base. (Likewise, higher domestic investment if funded by foreigners can

[4] Chinn and Ito (2008).
[5] Cavallo and Pedemonte (2015).

still create job opportunities and increase output since foreign owners of capital have to pay taxes and their employees in the foreign country.)

This paper will explore whether domestic saving is absorbed into domestic investment for a given country. Relatedly, it explores whether domestic saving is an appropriate lever to change domestic investment through an instrumental variable approach. It will examine the change of the saving-investment relationship over time by considering two different estimation methods—first, a cross-sectional regression of average investment rates on average saving rates over a long period, and, second, a panel regression of investment rates on saving rates. FH performed the former estimation, arguing that averages smoothed out yearly variations in investment and saving rates and allowed them to approximate a long-run view of the relationship. But a cross sectional approach has a limited causal interpretation because both saving and investment are measured simultaneously and averaged over a long period, introducing the possibility for reverse causality.[6] A panel estimate—which tracks the saving-investment relationship for a particular country over time—better aligns with the "savings retention" interpretation, especially if combined with an instrumental variable strategy to obtain conditional correlations and perhaps suggest causation.

To preview my results, this paper charts a general decline of the saving-investment with both estimation methods. For the OECD countries originally studied in Feldstein Horioka (1980), I find a general decline in the relationship, eventually disappearing in the period before the financial crisis. In the years after the crisis, the relationship reappears and steps up. In regressions that estimate the saving-investment relationship for each country and its change between two

[6] From 15-year averaged investment and saving rates, it would be impossible to tell whether periods of periods of comparatively high saving rates preceded periods of comparatively high investment rates or the other way around. A panel data structure, instead tracks year to year changes in the relationship, which as I say above is more consistent with FH's interpretation.

periods (1970-1993 to 1993-2017), I find there is considerable variability in the size and change of the relationship. I then show that greater financial openness is associated with a greater decline in the relationship.

In a final exercise, I use military spending as an instrument for national saving and use an instrumental variable (IV) strategy to estimate the FH regression, building off the work of Frankel et. al (1987). The instrument is plausibly exogenous to the extent military spending changes as a result of geopolitical factors like wars and conflict, which are uncorrelated with unobservables that affect investment. Further, the instrument is relevant because military spending reduces national saving, i.e. spending is a form government dissaving. The IV regressions yield qualitatively similar estimates to the OLS regressions, suggestive of a closer, even causal relationship, between domestic saving and investment. All told, the evidence in this paper suggests a general decline in the saving-investment relationship indicative of the strong forces of globalization at play and the recent uptick relates to a pull-back of cross-border capital investment following the Great Recession.

Section I provides an overview of Feldstein and Horioka (1980) and the surrounding literature. **Section II** describes my data and methodology. **Section III** presents my results, including IV estimates of the FH regression. **Section IV** concludes.

Section I. A Survey of the Feldstein Horioka Puzzle

Feldstein and Horioka found a high cross section relationship between saving rates and investment rates and took this as evidence against perfect capital mobility. If capital were perfectly mobile, savings should flow to the area of most productive capital regardless of borders, limiting the relationship between domestic saving and investment. Instead, the high correlation between saving and investment suggested that saving was likely staying in the

country of origin, meaning that economies functioned more like closed economies where saving equals investment rather than open economies where saving equals investment plus net exports. In their seminal paper, FH regressed average investment shares on average saving shares over the over the 1960-74 period for 21 OECD-member countries:

$$\overline{\left(\frac{I}{Y}\right)}_i = \beta \overline{\left(\frac{S}{Y}\right)}_i + \propto + \varepsilon_i \qquad [1]$$

where $\overline{\left(\frac{I}{Y}\right)}$ and $\overline{\left(\frac{S}{Y}\right)}$ are the average investment and saving for country i as shares of GDP respectively over the given period. FH averaged investment and saving rates over a 15-year period, reasoning that average rates would smooth out short term fluctuations that were not indicative of long term trends. Feldstein and Bachetta (1983) later interpreted β as the "savings retention coefficient" an estimate of how much saving was "retained" and translated into domestic investment. Of course, FH acknowledged that saving and investment rates could be endogenously determined, but they still argued that a high value of β would present strong evidence against perfect capital mobility and that the burden of finding omitted variables rested on others. FH calculated a coefficient of 0.89 in a sample of 16 OECD countries. They suggested that a $1 increase in saving would result in an $0.89 increase in domestic investment. To the extent that the majority of saving stayed in the home country and became domestic investment, this interpretation implies that capital was relatively immobile in their sample. This view upset conventional wisdom because high financial and physical integration was widely accepted as narrowing interest rate differentials implied.

The interpretation of the coefficient is subject to endogeneity critiques, issues associated with taking long-period averages of investment and saving that limit the "savings retention" interpretation, and the question of whether saving-investment co-movements say anything about capital mobility. The potential for endogeneity is significant as many papers in response to FH

pointed out. Taylor (1994) contends that omitted variables like growth, pricing structures and demographic changes affect both saving and investment, which accounts for the strong relationship. The inclusion of those factors in Taylor's framework reduces the correlation to a spurious finding. Another common endogeneity critique, known as the "policy reaction argument," follows that governments systematically react to current account deficits by changing national saving to reduce the imbalance (Tobin, 1983; Summers, 1988; Bayoumi, 1990). The policy reaction, not the transformation of saving into investment, drives the close relationship between saving and investment. In general, endogeneity critiques have less teeth because instrumental variable strategies, including those used by Feldstein and Horioka (1980) and Frankel (1987), find a strong relationship between national saving and investment. FH instruments net saving with the gross saving rate and finds similarly high estimates. Frankel et. al. (1987) instruments public and private saving with military spending and dependency ratios respectively and still finds a strong relationship between saving and investment on samples up to the year 1984. In general, the saving-investment relationship in samples from 1960-1980 remains quite high and robust to the above empirical critiques with estimated coefficients ranging from 0.8 to 0.9.

Another challenge associated with the FH framework is that using long-period averages of investment and saving may alter the savings retention interpretation and applicability of β to policy. While averaging long periods of investment and saving rates may help avoid the cyclical endogeneity critique since long-period averages dampen the effect of business and policy cycles, using these long period limits the ability of the coefficient to speak to the short-run relationship between saving and investment, especially if they are to make policy that has an effect during the length of an administration, anywhere from 4-8 years. A panel regression better sheds light on

what one can expect in the years following an incremental shock to saving—which may be of more interest to policymakers with limited time horizons. Indeed, results based on panel approach that captures short-run dynamics may not even be the same as those from a cross-sectional approach that mainly speaks to the long-run relationship. Obstfeld and Taylor (1998) argue that long-period averages of investment and saving will always yield a close relationship between the two because in the long run all countries must abide by a balanced current account to satisfy their own intertemporal budget constraint. This thesis will explicitly approach the short run and long run dynamics of the relationship by comparing the FH method (short run) to a pooled approach (long run).

A third challenge with the FH framework—one of the most divisive questions in the literature—is whether saving-investment correlations tell us anything about capital mobility. Economists who interpreted low interest rate differentials as evidence for high capital mobility were not inclined to accept the FH findings. In response, Feldstein and Bacchetta (1989) made clear that they were only testing the strict condition of whether capital was *perfectly* mobile. Thus, FH coefficients that are less than unity (i.e. a coefficient of one) and above zero are hard to interpret on their own and must be interpreted relative to another period. The coefficient is not a yardstick: it must be compared to other periods that have undisputed high or low capital mobility to get a sense of the *extent* of capital mobility (Obstfeld and Taylor, 1998). Frankel (1991) writes that "If the saving investment regressions were a good test for barriers to financial market integration, one would expect to see the coefficient decline." Indeed, evidence of a slight decline in the saving-investment is present in 1990-1997 samples and countries that joined the EU (Rogoff and Obstfeld, 2000; Feldstein and Bacchetta, 1983). Feldstein and Bacchetta show that the coefficient decreased more for the OECD countries that joined the EU compared to those

who did not. They interpreted this as evidence for increased capital mobility amongst EU members due to the close institutional and commercial links created by the EU.

Relatedly, Rogoff and Obstfeld (2000) calculate a coefficient of 0.60 (0.09 se), but contend that it is "larger than one might expect in a world of fully integrated capital markets where global savings flows to the regions with the highest rates of return." Skeptical of using saving-investment correlations to indicate capital mobility, they claim that high saving-investment correlations can result because OECD current accounts are small relative to saving and investment. They model a world where trade costs can create international differences in real interest rates despite perfect asset market integration. If the current account is a function of the interest rate, international differences in interest rates can work in way that tempers the current account leading to a close saving-investment relationship. Importantly, the dampening of the current account has little to do with asset market integration, but rather transport costs. One possible critique of Rogoff and Obstfeld's model is that transport costs could really proxy for a type of home bias in physical investment, the very point that FH made in their study.[7] The main driver of the model's result implicitly relates to capital being less mobile. In any case, Rogoff and Obstfeld's model is representative of the literature that tries to reconcile high saving-investment correlations with high physical and financial integration.[8]

Frankel (1992) probably does the best job at unifying the approach to capital mobility. He posits that the FH condition for capital mobility (β=0, no saving-investment relationship) is the strictest condition for capital mobility because it implies the equalization of all real rates of return across countries, hence real interest rate parity (RIP). Since RIP did not generally hold in

[7] They include a measure of trade frictions that influences the result of their model, but trade frictions implicitly relate to capital being less mobile (i.e. transportation costs are like frictions that keep physical capital in). If this is the case, the model is not properly accounting

[8] Other studies include Frankel (1992) and Taylor (1996).

the 1980's because the US rate was higher than most of its trading partners, Frankel does not expect a zero relationship between savings-investment. He argues that the best way to look at the integration of capital markets is to look at rates of return, in particular the covered interest rate parity condition. One possible critique of Frankel (1992), which he acknowledges, is that interest rate arguments of capital mobility pertains to bonds, which are not perfectly substitutable with factories and machines (counted in the investment measure). Thus, even if bonds are traded freely across countries, equalizing rates of return, physical capital may *not* be able to move as easily, implying that changes in national saving may directly affect domestic investment. In other words, *physical* capital integration is different than *financial* capital integration.

With these caveats in mind, this thesis is motivated by determining *how much* and *why* the saving-investment relationship has changed over time, providing an update to the literature of the 1980s and 1990s.

Section II. Data and Methodology

My primary data source is the *Penn World Tables* (*PWT*) which reports national accounts data for 167 countries since 1950. Investment is measured by gross capital formation.[9] Gross capital formation measures the acquisition of fixed assets, less disposals, plus changes in inventories less disposals (*SNA,* 2008). The fixed assets under considerations are assets that are used to produce other goods, including factory equipment, technology systems for a corporation, residential and non-residential building, livestock, roads, bridges, etc. Notably, the measure *excludes* the purchase of land. Investment is reported as a share of real GDP in the *PWT*. Next, the savings as a share of real GDP is constructed by subtracting private consumption and

[9] Private consumption, investment, government spending, exports, and imports in the *PWT* are chained purchasing power parity (PPP) real values, in million 2011 US$ and are reported as shares of real GDP at current PPPs in million 2011 US$.

government spending shares from 100. The exact practice is also used in recent FH-related papers and accords with the accounting identity S=Y-C-G. [10] The idea behind this identity is that saving measures output that is not part of private or government consumption. Indeed, saving is often described as a "balancing item" in that it is "the part of income originating in production, domestically or abroad, that is not used for final consumption" (*SNA,* 2008).

Note that this paper uses modern and revised expenditure categories of GDP. Saving and investment measures used in this paper are the modern equivalent of those used in the original FH papers, but due to revision and reclassification they are not exactly the same as those used by FH (1980) and Obstfeld and Rogoff (2000). Nevertheless, a unified source of data like the *PWT* that follows one methodology to calculate expenditure measures allows a researcher to compare the saving-investment relationship over time.[11]

As an informal starting point, Figure 3 shows individual country saving and investment trends for selected countries. In the United States, saving and investment closely track each other from 1950 to 1980, and a minor decoupling begins in 1980. Since the United States is a safe haven for investors, most of its saving already stay within the country. Similarly, I expect less of a decoupling for a large open economy like the United States compared to a small open economy like the Netherlands. Nevertheless, the minor decoupling of saving and investment in the United States is consistent with a story of increasing globalization as a result of more integrated capital markets and companies like Apple and Microsoft investing in foreign supply chains. Therefore, the pressures of globalization can theoretically lead to the decoupling of saving and investment in large open economies, albeit to a lesser degree.

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[10] See Fouquau, Hurlin, Rabaud (2007) for the exact same saving rate calculation.
[11] A data set with one consistent methodology over the entire sample period is better than multiple datasets with different methodologies put together. The *PWT*'s consistent methodology allows for consistent comparisons over time.

The Netherlands (NLD) also tells a compelling story. Saving and investment tracked each other closely up until the sixties, when they decouple significantly. The pressures of globalization in what was already a very interconnected country—the Dutch are famous sea merchants in world history—could have driven this decoupling. Indeed, the Dutch were among the founding members of the European Economic Community in 1957, a precursor to the European Union, which created strong institutional links and lowered trade barriers between its members. The creation of these close links occurred right before the decoupling of NLD's saving and investment rates. Further, Germany (DEU) saw close saving-investment relationships until the 1990's when East and West Germany were reunified under a westward facing East Germany. A loosening of Cold War shackles fueled Germany's recommitment to international organizations and commerce, transforming Germany into an economic powerhouse. Berlin—a German city with enormous industrial potential but blockaded by the Soviet Union—was once again connected to western commerce. These reconnections likely meant that German investors looked internationally, presumably leading to the decline of their saving-investment relationship.

Another example is Japan where saving and investment doubled from 20% of GDP after World War II to 40% of GDP in the 1980's. This fact is consistent with the Japanese "miracle," a period of robust economic growth that made Japan into an economic powerhouse, drawing the envy of many advanced nations. Then, Japan entered into a period of economic stagnation and saw decreases in saving and investment rates. In this period, investment rates were lower than saving rates in part due to demographic trends like an aging population. Some of Japan's saving must have flowed abroad to obtain a suitable return, presumably weakening the saving-investment relationship.

These country specific examples highlight how the specific experiences of different countries can be different from others and vary widely across time. More broadly, the graphs suggest that increased globalization and integration coincide with a loosening of the saving-investment relationship, the central claim of the thesis, which will be explored more formally below.

Directly measuring the increased integration and globalization that may have affected saving-investment correlations is difficult. However, one specific manifestation is the loosening of capital controls over time. Chinn and Ito (2008, 2017) develop a measure of capital account openness, *kaopen*, which measures the ways in which governments have traditionally controlled exports and imports. *Kaopen* is an aggregation of a series of dummy variables, namely the establishment of multiple exchange rates, restrictions on the current and capital account, and the requirement of exporters to surrender export proceeds. This measure of capital account openness varies for different countries and increases significantly during the 1980's and 1990's, flattening once most OECD countries dropped all traditional measures of capital controls.

Two other measures of integration and globalization are trade openness and financial integration. These measures provide a finer picture of the ways that trade and financial developments have changed since they are not aggregations of dummy variables like *kaopen*. Trade openness is constructed for each country and year by summing exports and imports over GDP. On average, the OECD sample has increased its trade openness by a factor of two from 1970 to 2017 as Figure 3 demonstrates. Trade openness also declined during the financial crisis and has not recovered to its pre-crisis level. Finally, another measure of integration measures financial integration, which is constructed for each country and year by summing a country's foreign assets and foreign liabilities over GDP. Lane and Milesi-Ferretti (2004) construct this

measure and point out that it is a volume-based metric much like trade openness to measure integration. Financial openness for the 21 OECD sample is quite steady and remains low before the 1990's where it steps up to a new level. In the mid-nineties financial openness skyrockets, a three-fold increase from 7.5 in 1995 to 25 in 2017. The measure also declined during the financial crisis, but unlike trade openness it climbed to a higher level following the crisis. Trade openness and financial integration are finer measures of integration because they are a volume-based rather than indicator-based measurements of integration. Indeed, volume-based measurements capture the effect controls on trade and investment flows. Later in the thesis, I formally explore whether these measures have a direct relationship with the decline of the saving-investment relationship.

To more formally explore the weakening of the saving-investment relationship for OECD-member countries, I begin with a cross country approach similar to FH that sheds light on the long-term relationship. I estimate equation [1], reproduced below, over important periods studied in the literature or relevant to economic history like the run up to the financial crisis.

$$\overline{\left(\frac{I}{Y}\right)}_i = \beta \overline{\left(\frac{S}{Y}\right)}_i + \propto + \varepsilon_i \qquad [1]$$

These periods are 1960-1974, 1975-1989, 1990-1996, and 1997-2006, which correspond to the period used in FH's study, the period between FH and Obstfeld and Rogoff's (2000) study, the period in Obstfeld and Rogoff's (2000) analysis, and, finally, the decade before the financial crisis. As a reminder, I regress long-period average investment on long period average saving rates, estimating the long-run saving-investment relationship. Yearly fluctuations in saving and investment rates will be averaged out. In any case, I still expect the long run relationship between saving and investment to fall as a result of increased integration, which has allowed capital to reach areas where it is most productive and theoretically break down the relationship.

Next, I estimate a pooled form of the FH regression that sheds on the short run saving-investment relationship:

$$\left(\frac{I}{Y}\right)_{it} = \beta \left(\frac{S}{Y}\right)_{it} + \propto + \varepsilon_{it} \qquad [2]$$

where $\left(\frac{I}{Y}\right)_{it}$ and $\left(\frac{S}{Y}\right)_{it}$ are investment and saving as shares of GDP for country *i* in year *t*, respectively. Further, $\propto$ is an intercept and ε_{it} is an error term. The only difference between equation [1] and [2] is that the investment and saving shares vary by year, instead of long period averages like in the first equation. In order to compare the long and short estimates of the saving-investment relationship, I estimate equation [1] and [2] in 10-year rolling windows starting in 1960 and ending in 2017. The pooled regression better approximates the "savings retention" interpretation described by Feldstein and Bacchetta (1991) since it tracks saving and investment by country and year rather the closeness of long period averages. These results are presented in Figure 5 and discussed in the results section.

Equation [2] will capture the average decline of the coefficient over time, but it does not speak to patterns for individual countries. To quantify the country-specific decline, for each country, I estimate:

$$\left(\frac{I}{Y}\right)_{it} = \beta_{it} \left(\frac{S}{Y}\right)_{it} + \gamma_i \left(\frac{S}{Y}\right) * I(year > 1993)_{it} + \phi_{it}\, I(year > 1993)_{it} + \propto + \varepsilon_{it} \qquad [3]$$

where $I(year > 1993)_{it}$ is an indicator for the period after a structural break and $\left(\frac{S}{Y}\right) * I(year > 1993)_{it}$ is an interaction term between the savings rate and the structural break indicator. γ_i captures the decline of the savings retention coefficient following the break. My break in 1993 splits the time period 1970-2017 roughly in half, providing ample data on both sides of the break. These results are presented in Table 2.

Finally, to explain the decline of the saving-investment coefficient, I regress the change in the savings retention captured by γ_i in [3] on the change in the measures capital account openness, trade openness, and financial integration:

$$\gamma_i = l\ \Delta\text{openness}_I \qquad [4]$$

The main goal is to test whether countries that saw more trade and financial liberalization experienced a larger decline in savings retention. A country that restricts capital, trade, and financial flows is likely to see a close relationship between saving and investment since it will tend to behave more like a closed economy where saving equals investment. On the other hand, a country that promotes capital, trade, and financial flows is likely to see saving leave to the area of most productive capital. This country will tend to behave more like an open economy where saving equals investment plus net exports. Therefore, I expect an increase in openness to be associated with a decrease in savings retention. I estimate equation [4] with three measures of openness that I discuss above: capital account openness, trade openness, and financial integration. These results are presented in Figures 5 and 6.

Section III. Results

The first goal of this thesis is to explore the weakening of the saving-investment relationship. In order to do so, I employ a cross-country approach similar to FH that sheds light on the long-term relationship, and then I employ pooled approach that sheds light on the short-term relationship. Both of these approaches show measurable declines in the saving-investment relationship.

Quantitative evidence of the breakdown of the saving-investment relationship is seen in Figure 3, which plots average investment and saving rates over long periods and the OLS line of best fit. The slope of the line is β, the FH coefficient in equation [1], is reported in each of the panel and for clarity is reported in Table 2. The saving-investment coefficient for the 1960-1974

period studied in FH is 0.68 (0.65), which is both high and statistically significant as Feldstein and Horioka found. These estimates are lower than those found by FH (1980) because of changes in the national accounts data, but it is equivalent to estimates found in recent papers. With the same methodology that this paper uses, Bai and Zhang (2010) find a coefficient of 0.67 for the 16-country sample in the period 1960-1974 and argue that they confirm the general result of the puzzle with revised data. The saving-investment relationship then progressively declines to 0.40 in the 1975-1989 period and 0.30 in the 1990-1996 period, the period closely studied in Obstfeld and Rogoff (2000). They find a coefficient of 0.68 for the 1990-1996 period, but since the national accounts data has been revised these estimates are based on different saving and investment data. The most significant change to the national accounts data has been to gross capital formation, the investment measure. Gross capital formation now includes expenditure that was not previously considered like capital spending on technology systems, leading to higher shares of investment and lower FH coefficients (Bai and Zhang, 2010). Finally, in the decade before the financial crisis, the saving-investment relationship completely breaks down in the cross section with a statistically insignificant coefficient of 0.01 (0.032) and the model loses explanatory power with an R-squared of 0.1%. In economic history, the period before the financial crisis represents the height of globalization, where capital and labor flowed across boarders without any restrictions. At least in terms of saving-investment correlations, the world was truly flat as the title of Tom Friedman's book, *The World is Flat*, implied.

The pooled variant of the FH regression yields qualitatively similar results. Figure 4 estimates the cross-section and pooled estimates in a rolling window. Remarkably, these two estimates are qualitatively similar to each other, showing long decreases in the FH coefficient, reaching a nadir in the period before the financial crisis. To the extent that pooled and cross

section estimates represent the short and long run, the long run and short run saving-investment relationship are similar to each other. The pooled regression also charts a near zero FH coefficient in the period before the financial crisis. Another interesting takeaway from Figure 4 is the recent uptick of the coefficient after the financial crisis. The pooled coefficient in the years after the crisis, 2010-2017, is statistically significant at 0.20 (0.036) with an R-squared of 23%. The rolling window regression cannot distinguish between discrete jumps in the relationship and gradual increases since it adds one year while dropping another. So, discrete post-crisis developments like an immediate pull back of international investment that increase the relationship will only show up gradually in the rolling window. Nevertheless, the FH coefficient increased after the financial crisis.

The second goal of this thesis is to explore saving-investment relationship for individual countries, motivated by the fact that countries have a wide range of economic experiences that affect these trends. Table 2 charts a wide range of FH coefficients for the sample and the change after the 1993. I find that most countries begin with relatively high coefficients in the period and see large decline in the relationship, although there are notable exceptions. The United States maintained a high savings retention, while other countries like Australia, Finland, and Great Britain started with high savings retention and saw significant decreases in the retention. It is not surprising that United States maintained such a large FH coefficient given it's the breadth of investment opportunities. US saving does not have to look abroad to find suitable investment opportunities. On the other hand, smaller economies like Canada and Finland saw decreases in retention which is consistent with a story of increased integration and those economies behaving like small open economies where saving equals investment plus net exports.

In the next step part of the thesis, I explore whether the decreases in the saving-investment relationship directly relate to measures of openness by estimating equation [4]. I find a negative statistically significant relationship between the change in savings retention and changes in financial integration as Figure 5 makes clear. In other words, countries that saw larger increases in financial integration saw larger decreases in their saving-investment relationship. This negative relationship suggests that saving-investment correlations say something about integration and globalization. That is, since the correlations have fallen over time and they decline more in countries that saw larger increases in financial liberalization, the correlations can tell a story about integration. More evidence for this point of view is evident in the negative relationship between changes in savings retention and trade openness, but the relationship is not statistically significant. Finally, there is no statistically significant relationship between the changes in savings retention and changes in capital controls. This is likely due to the fact that the capital control measure, *kaopen,* does not sufficiently measure the extent of openness. That is, since *kaopen* is an aggregation of binary indicators for traditional capital controls, it does not sufficiently capture the *extent* of openness and integration like the volume-based measures do.

Instrumental Variable Approach

Finally, I estimate my pooled using military spending as an instrument for saving, building off the work of Frankel (1987). The third goal of this thesis is to determine whether a causal relationship exists between domestic saving and investment. I find qualitatively similar results to my OLS results, suggesting that there is strong even causal relationship between saving and investment. The intuition behind my instrumental variable (IV) strategy is that I use a small part of the exogenous variation in saving created by government spending shocks to estimate the effect of saving on investment. First, military spending is a relevant instrument since it decreases

public saving, a component of national saving. In order to formally test, this prediction I regress the saving on military spending and capture the first stage F-statistic. The results are presented in Figure 7, indicating that military spending is relevant in periods after 1980. This is likely the case because *SIPRI* estimates of military spending are unreliable before 1980—the database estimates these shares before this date. Consequently, I estimate the model only for the period for which the instrument is relevant.

Second, military spending is plausibly exogenous to the extent that military spending changes as a result of geopolitical factors like wars and conflict uncorrelated with unobservables that affect investment. Indeed, military spending often increases as a result of wars and conflict that are unrelated to unobservables that affect investment. The IV estimates yield qualitatively similar estimates to the OLS panel and cross-sectional regressions, suggesting that the correlation between domestic saving and investment conditional on government-spending shocks is similar to the unconditional correlation.

Section IV. Discussion and Conclusion

The first goal of this thesis is to chart the declining investment-saving relationship, which I explored through pooled and cross section estimates of the FH regression. The second goal is to explore country-specific investment-saving relationships and attempt to explain them with measures of financial openness. Finally, the paper sets out to explore whether the correlations are truly causal. This paper provides evidence for three claims. First, with regards to the original 21 country sample, the savings retention coefficient declined, reaching zero in the period before the financial crisis. As a result, I define this era to be the height of financial integration and interconnectedness. Then, following the financial crisis, savings retention increased, which is consistent with ideas of financial repression or capital staying within the country due to regulation and "moral suasion" by governments (Reinhart, 2011). Second, countries that saw the largest increases in financial integration also saw the largest decreases in savings retention, suggesting that saving-investment correlations can proxy for integration. Finally, IV estimates of the FH regression chart a qualitatively similar decline followed by an increase after the crisis.

Appendix Tables and Figures:

Table 1. Advanced Economies listed in the IMF's Fiscal Monitor Database.

Advanced Economies			
Australia*	Germany*	Lithuania	Spain**
Austria*	Greece*	Luxembourg**	Sweden*
Belgium*	Hong Kong SAR	Malta	Switzerland**
Canada*	Iceland**	Netherlands*	United Kingdom*
Cyprus	Ireland*	New Zealand*	United States*
Czech Republic	Israel	Norway**	
Denmark*	Italy*	Portugal	
Estonia	Japan*	Singapore	
Finland*	Korea	Slovak Republic	
France**	Latvia	Slovenia	

Note: FH included 16 OECD countries in their cross-sectional regression (marked *). Out of the 21 OECD countries in 1980, 5 were excluded (marked **) from their sample because of changes in the country's accounting methodology.

Table 2. Cross-section estimates of the Feldstein-Horioka regression in the periods: 1960-1974, 1960-1974, 1990-1996, 1997-2006.

Time Period	1960-1974	1975-1989	1990-1996	1997-2006
VARIABLES	$\overline{\left(\frac{I}{Y}\right)}$	$\overline{\left(\frac{I}{Y}\right)}$	$\overline{\left(\frac{I}{Y}\right)}$	$\overline{\left(\frac{I}{Y}\right)}$
$\overline{\left(\frac{S}{Y}\right)}$	0.684**	0.397**	0.298**	0.013
	(0.036)	(0.035)	(0.039)	(0.032)
Observations	21	21	21	21
R-squared	0.005	0.031	0.037	0.001
Robust Standard Errors	Yes	Yes	Yes	Yes

Note: The table presents estimates of equation [1], $\overline{\left(\frac{I}{Y}\right)}_i = \beta\,\overline{\left(\frac{S}{Y}\right)}_i + \propto + \varepsilon_i$, where $\overline{\left(\frac{I}{Y}\right)}$ and $\overline{\left(\frac{S}{Y}\right)}$ are the average investment and saving for country i fractions of GDP, respectively, over the given period. Further, $\propto$ is an intercept and ε_{it} is an error term. These estimates can be seen graphically in Figure 4.

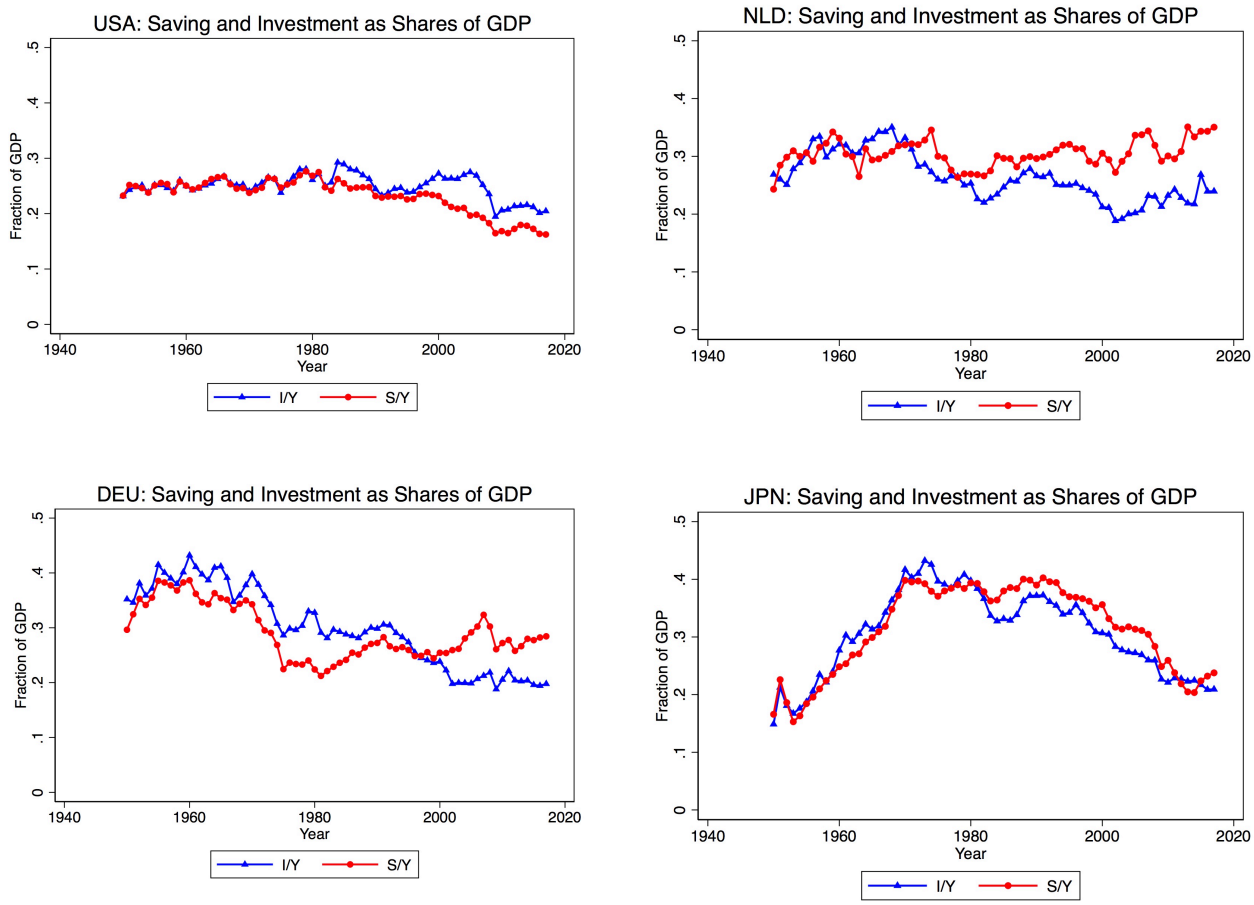
Table 3. Savings Retention during the period 1970-1993 and ensuing change in the period 1994-2017. Results from estimating equation [3] for each country in the sample.

Country Name	Savings Retention Coefficient (β_i)	Change in Savings Retention (γ_i)
Australia	0.79**	-0.58**
Austria	0.88**	-0.73
Belgium	0.35**	-0.79**
Canada	0.20	-0.07
Switzerland	0.72**	-0.76**
Germany	0.75**	-1.28**
Denmark	0.01	0.11
Spain	0.58	0.18
Finland	1.26**	-1.13**
France	0.79**	-0.66**
United Kingdom	0.94**	-0.52**
Greece	0.95**	-0.15
Ireland	-0.34**	0.65**
Italy	0.93**	-0.52**
Japan	0.98**	-0.20**
Luxembourg	0.12	-0.49**
Netherlands	0.74**	-0.45
Norway	-0.58**	0.31**
New Zealand	0.19	0.26
Sweden	0.49**	-0.65**
United States	0.84**	-0.07
	0.55**	-0.36**

Note: Equation [3]:

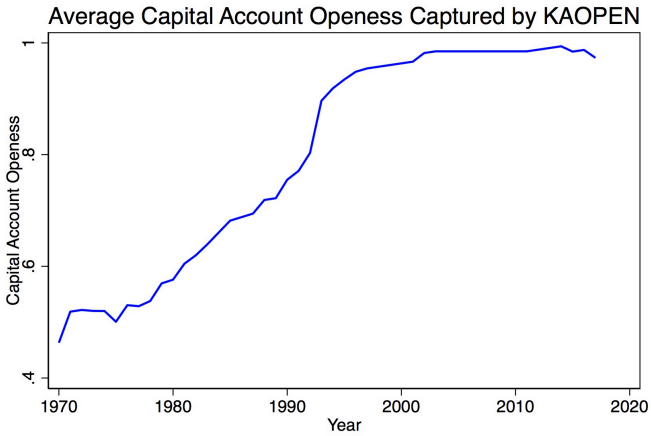
$$\left(\frac{I}{Y}\right)_{it} = \beta_i \left(\frac{S}{Y}\right)_{it} + \gamma_i \left(\frac{S}{Y}\right) * I(year > 1993)_{it} + \phi_{it}\, I(year > 1993)_{it} + \propto + \varepsilon_{it}$$

Figure 1. Saving and investment shares of GDP for the United States (USA), Germany (DEU), Japan (JPN), and the Netherlands (NLD).

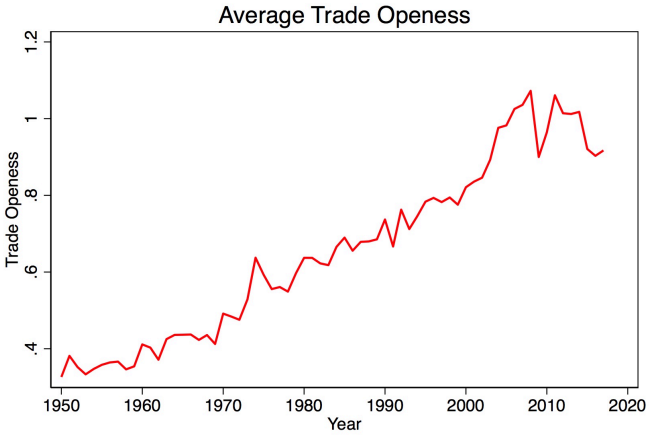


Note: Investment as a share of real GDP is reported in the *PWT* at current PPPs in million 2011 US$. Saving as share of real GDP is constructed by subtracting private and government consumption shares also found in the *PWT* from 100, which is consistent with the accounting identity S=Y-C-G. Source: *PWT*.

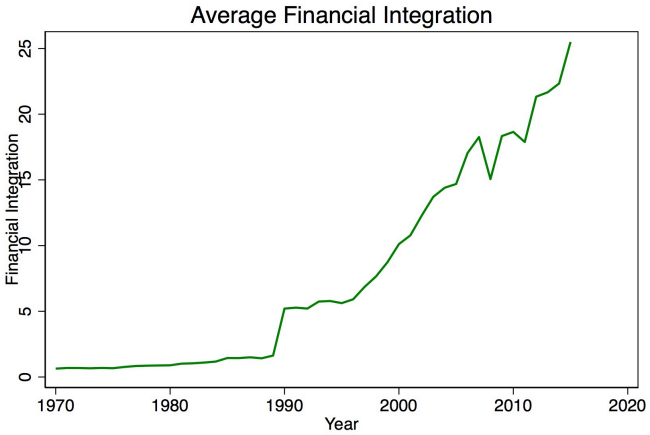
Figure 2. Average measures of capital account openness, trade openness, and financial integration for the 21 OECD country sample.



Note: kaopen is the average of four indicator variables of export/import restrictions. Source: Chinn and Ito (2017)

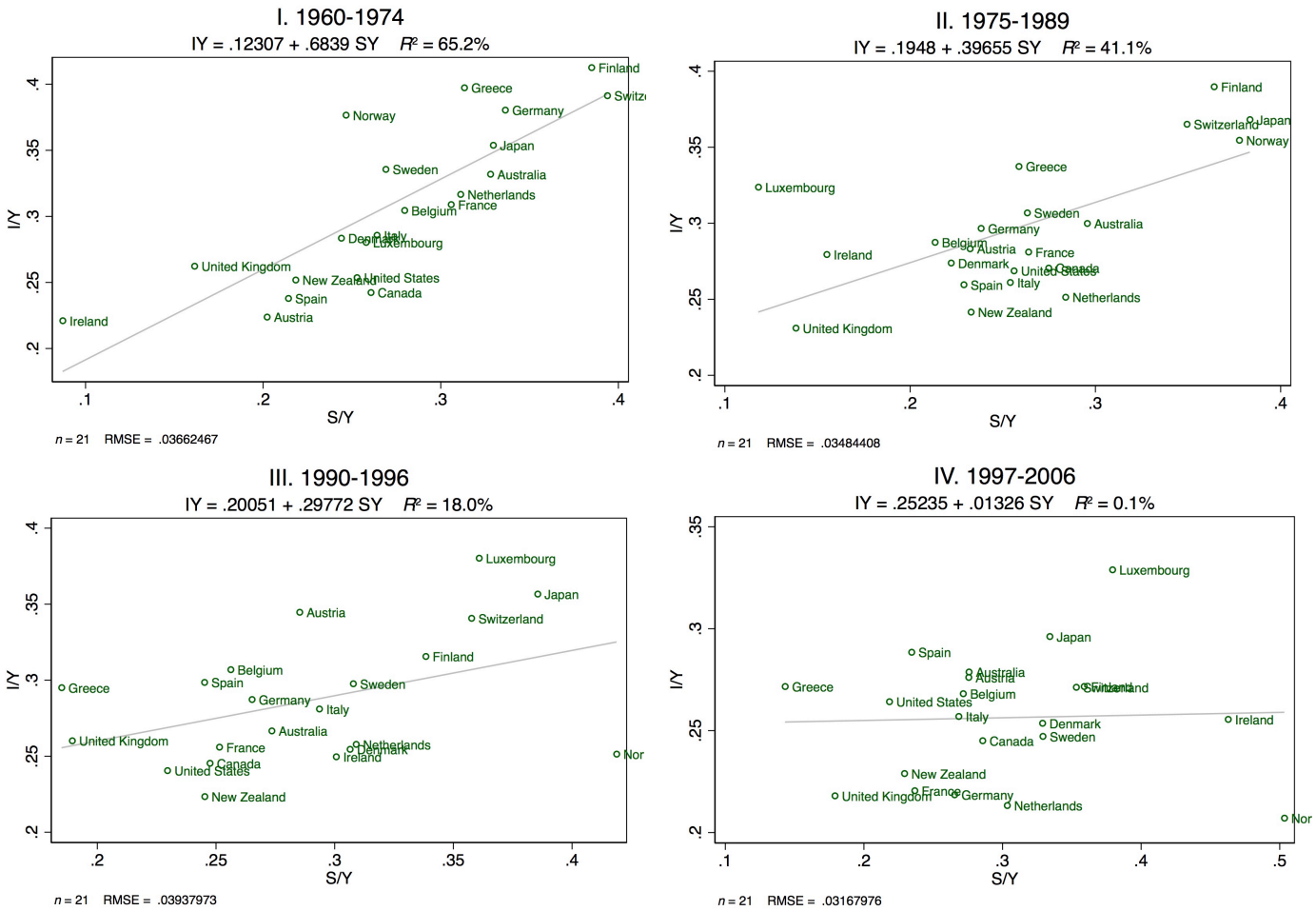


Note: For a given country and year: trade openness=(exports+imports)/GDP. Source: PWT



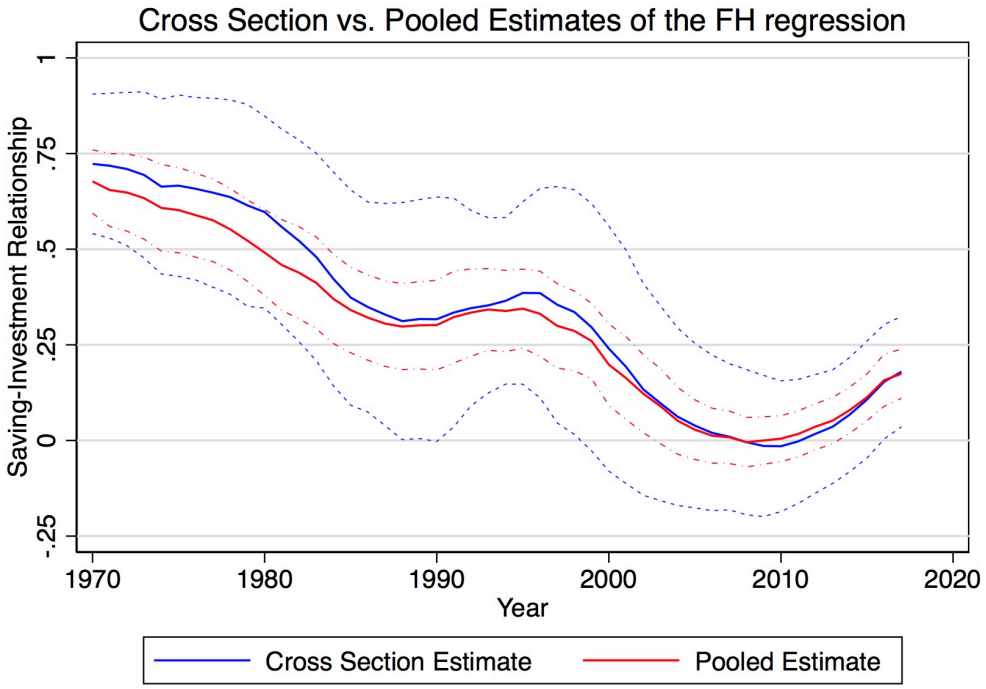
Note: For a given country year: financial integration=(foriegn assets+foriegn liabilities)/GDP. Source: EWN

Figure 3. The Decline of the Saving-Investment Relationship. Each graph represents a cross sectional regression based saving and investment averages for the given periods (1960-1974, 1975-1989, 1990-1996, 1997-2006) for 21 OECD countries. In the four panels, I/Y and S/Y stand for the average investment and saving as shares of GDP, respectively. The coefficients are equivalent to the estimates of equation 1: $\overline{\left(\frac{I}{Y}\right)}_i = \beta \overline{\left(\frac{S}{Y}\right)}_i + \propto + \varepsilon_i$.



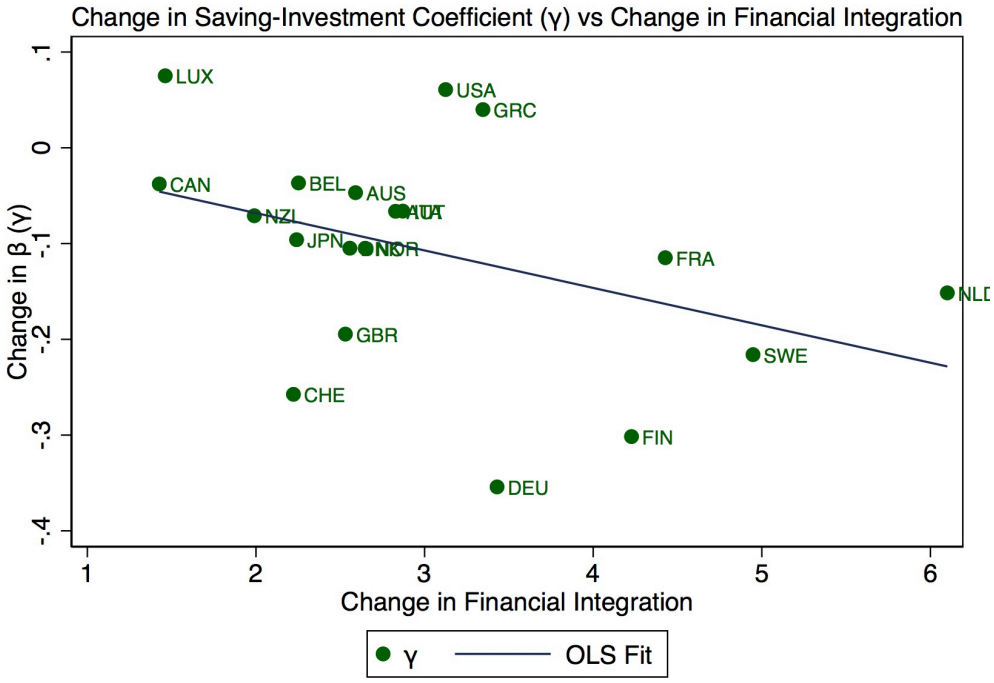
Note: FH referred to 21 OECD countries, but conducted analysis on only 16 of the 21 OECD countries. The inclusion of 5 additional countries (France, Luxembourg, Norway, Spain Switzerland) to FH's 16 country sample does not significantly change the coefficient or the trend of a smaller coefficient over time. While these estimates are lower than those found by FH (1980) and Rogoff and Obstfeld (2000)—since they are based on revised data sets—they are equivalent to estimates found by recent papers (Bai and Zhang, 2010). Finally, in order to increase the sample size, I use 21 OECD countries in my analysis.

Figure 4. Long Run (Cross Section) and Short Run (Pooled) Approaches to the Feldstein-Horioka Question. 11 year rolling window estimates.



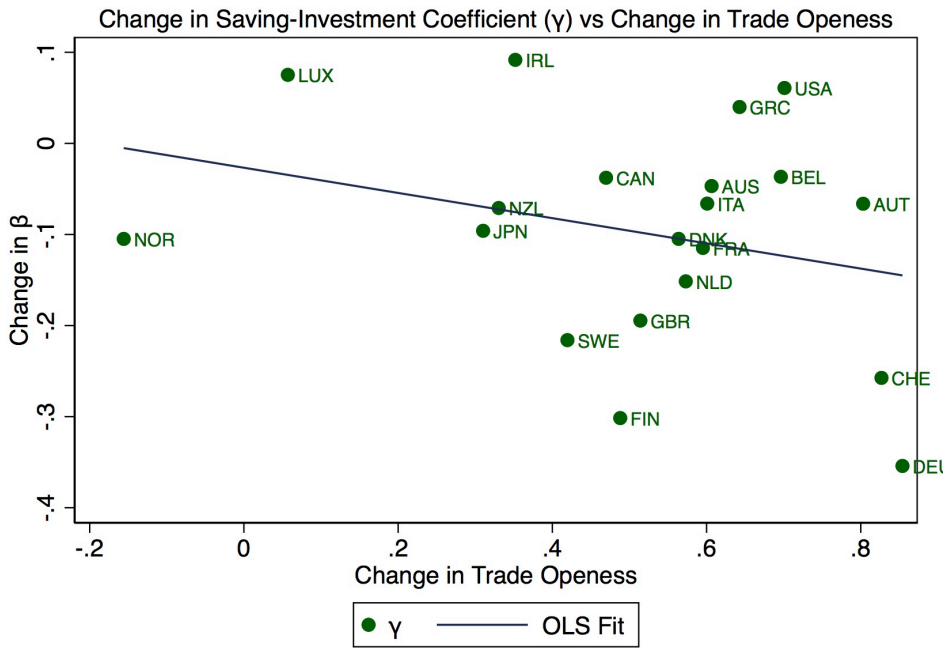
Note: The x axis denotes the year at the end of the rolling window. For example, the estimates for the year 1970 are estimations of equation [1] and [2] for the period 1960-1970; the estimates for 1971 are estimations of equation [1] and [2] for the period 1961-1971 and so on. The cross-section approach, equation [1], regresses 11-year average investment rates on 11-year average saving rates, and is indicative of the long run saving-investment relationship. The pooled approach, equation [2], regresses yearly investment rates on yearly saving rates, and is indicative of the short run relationship.

Figure 5. Change in saving-investment relationship vs. change in financial integration from the pre-period (1970-1993) to the post-period (1994-2017).



Note: Spain (ESP) and Ireland (IRL) are removed from the sample. Spain changed national accounting methodology during the pre-period, and neither their savings-retention coefficient nor the decline is statistically significant. Feldstein and Horioka also drop Spain from their sample. Ireland, a small open economy heavily affected by foreign investment, started with a negative saving-investment relationship and it increased in the post-period, an unexpected result and not consistent with the other 19 countries in the sample. The line of best fit has a slope coefficient of -.0391 (.017) with robust standard errors. It is significant at the 95% confidence level.

Figure 6. Change in the saving-investment relationship vs. change in trade openness from the pre-period (1970-1993) to the post-period (1994-2017).



Note: Spain (ESP) is removed from the sample because it changed national accounting methodology during the pre-period, and neither their savings-retention coefficient nor decline of the saving-investment relationship is statistically significant. The line of best fit has a slope coefficient of -0.138 (.25) with robust standard errors, so it is not statistically significant at the 95% confidence level.

Figure 7. First Stage F-statistic for each of 11-year rolling window period from 1960-2017. That is, the F-statistic is captured in the rolling window regression of saving fraction of GDP on military spending fraction of GDP. The dotted line represents the critical value of one restriction.

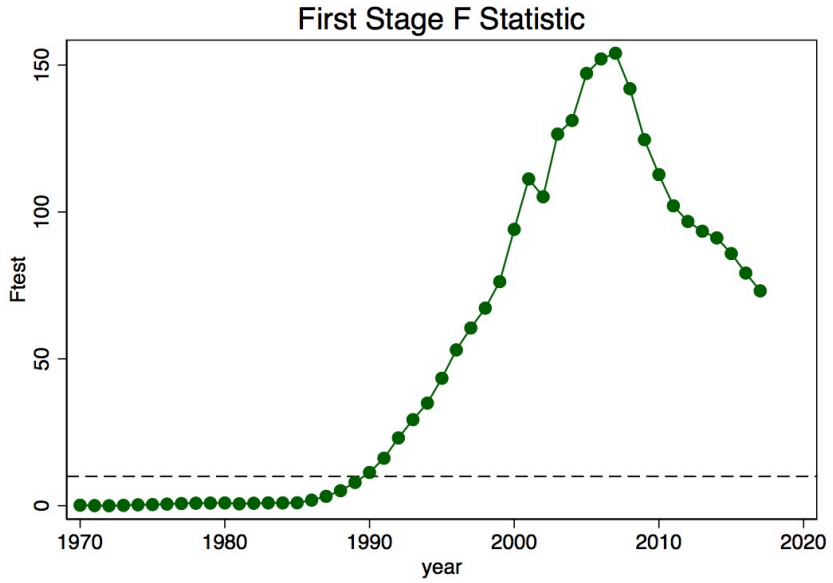
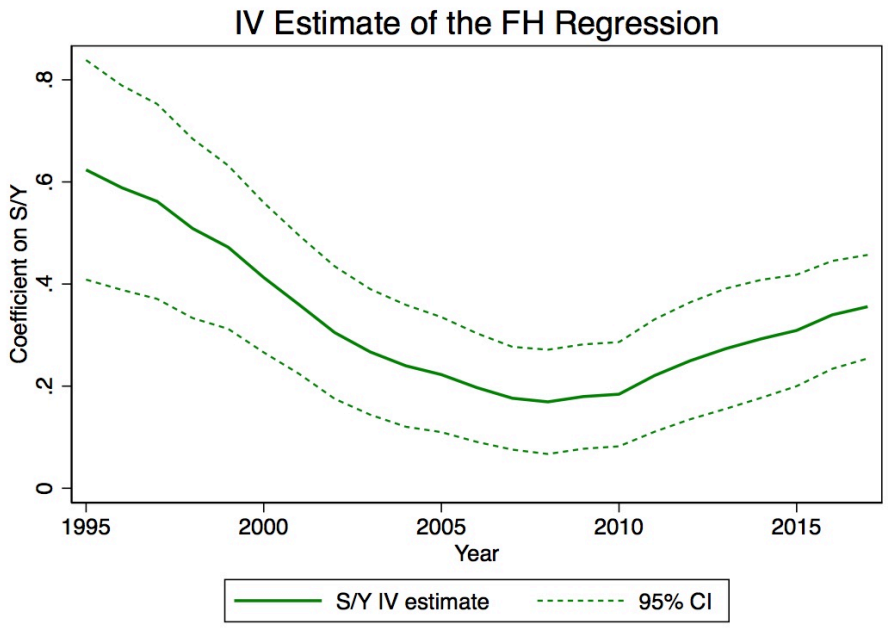


Figure 8. IV estimate of the pooled FH regression, instrumenting the saving rate in equation [2] with military spending rate. The IV estimate is displayed for each 11-year rolling window period from 1985-2017, a period for which the instrument is relevant.



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