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Saving-Investment: A Spacey Relationship

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The objective of this paper is to show that saving-investment regressions are biased toward capital immobility because of the failure to control for the endogeneity of investment rates across countries. Using a spatial autoregressive lag process, we show the saving coefficient is significantly lower and statistically insignificant from zero for small open economies. We assume investment is correlated using the differences in saving rates across countries, i.e. high saving countries are more likely to invest in low saving countries, which will increase the correlation between investment rates across countries.

Keywords: Saving, Investment, Feldstein-Horioka Puzzle, Spatial Autocorrelation, Capital Mobility

JEL Classification: C31, C33, F32, F41

I. Introduction

There has been a tremendous level of debate surrounding the usefulness of the Feldstein and Horioka (1980) result that shows a large degree of capital immobility across OECD countries. The Feldstein-Horioka Puzzle (hereafter FH) stems from finding a high correlation between domestic saving rates and national investment rates for a sample of 16 countries.[1] This result has spurred a great deal of research and controversy over the validity of using a simple two variable regression to measure capital mobility. Past researchers who have used the saving and investment regression to measure capital mobility have ignored relevant variables including interest rate differentials, political risk, and geographic proximity to explain capital mobility. Nonetheless, more than 30 years have passed since the original result, and the saving-investment (SI) relationship is still being applied as a measure of capital mobility. Given the difficulty of measuring the capital mobility, many researchers still consider the SI regressions an informative but incomplete measure of capital mobility.

The SI puzzle started as an OLS regression where domestic saving rates were regressed on national investment rates. Under the assumption of perfect capital mobility, saving should flow to countries offering the highest returns and have little correlation with domestic investment rates. For example, if one country experiences a positive shock to investment, marginal product of capital will increase leading due to an increase in capital inflows. Domestic investment will increase while saving will remain relatively unchanged; the correlation between both variables should decrease.

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[1] FH estimates $\frac{I}{Y}=\alpha+\beta\frac{S}{Y}+e_i$, where β is referred to the saving-retention coefficient. FH found β=0.89, statistically insignificant from 1, which they interpreted as domestic saving being a perfect predictor of national investment therefore capital must be immobile.

Within the context of the SI regression this country would have a lower saving coefficient. However, if capital markets are closed, countries will need to finance new investment through an increase in domestic saving.

It is this logic that motivates our empirical model. Looking across developed economies, countries that generally offer a similar risk profile, we expect saving rate differentials across countries to be a key factor explaining capital mobility. As capital mobility increases we expect funds to be channeled from high saving countries to low saving countries. Figure 1 presents saving and investment rates expressed as a percent of gross domestic product (GDP) averaged by year over 26 OECD countries.[2] Additionally, Table 1 presents the correlation between saving and investment rates across decades. From 1950 through 1979 both variables moved together with a correlation of 0.950, but starting in the 1980's average saving rates throughout OECD countries began to increase while investment rates remained relatively constant. The simple correlation from 1980 through 2009 fell to 0.685, and was considerably lower in the 1980s and 1990s.The high SI correlation has persisted in the literature despite advances in econometric testing, longer time spans, and better theoretical models.[3] In this paper we add to the literature by proposing a spatial autoregressive (lag) process which assumes that a country's investment rate is dependent on other countries' saving rates. Standard neoclassical growth theory shows that saving is more likely to flow from a high saving country into a low saving country. Countries with lower saving rates offer higher rates of return (seen through a higher marginal product of capital). If capital markets are closed, saving and investment rates will be equalized within countries and cause a significant divergence in investment rates across countries. Instead, investment rates are relatively constant across countries. Using spatial modeling our results provide evidence that investment rates are equalized across countries whereas saving rates differ significantly.

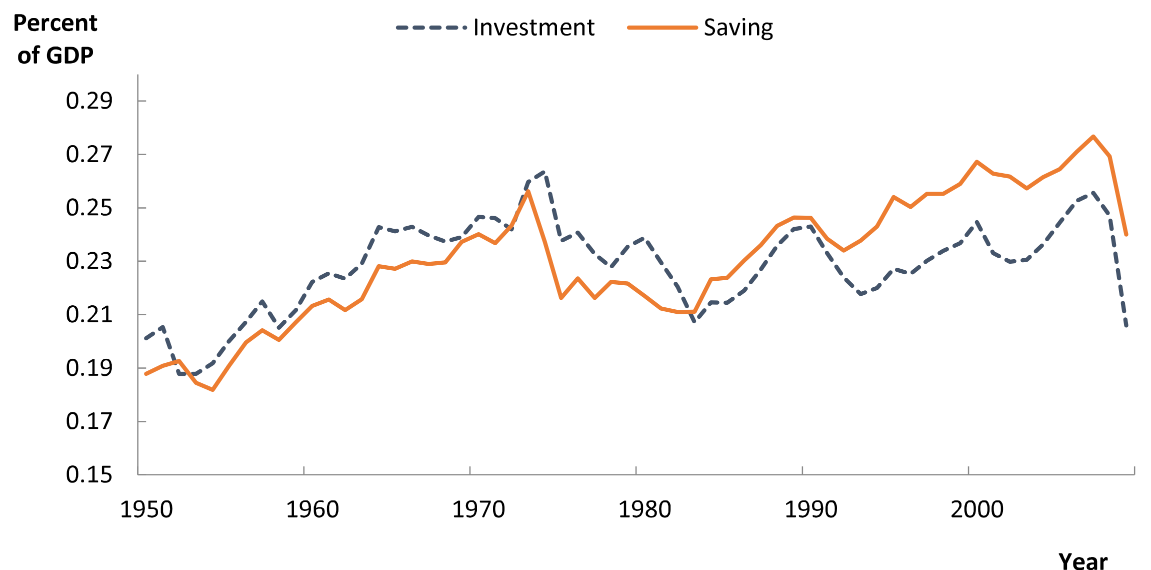
Table 1: Decade Correlations, 1950-2009

Decade	Correlation
1950-59	0.809
1960-69	0.903
1970-79	0.763
1980-89	0.527
1990-99	0.451
2000-09	0.973
1950-79	0.950
1980-09	0.685
1950-2009	0.729

[2] Data are from the Penn World Table, version 7.2. Countries include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States.

[3] See Apergis and Tsoumas (2009), and Coakley *et al*. (2004) for a more thorough review of the literature.

Figure 1: Investment and Saving Rates Averaged Across Countries, 1950-2009



Source: Penn World Table, 7.2 and authors' calculation

We show the correlation between saving and investment rates is significantly lower after controlling for the endogeneity of investment rates across countries. In some cases, especially for small open economies, the SI regressions show evidence of perfect capital mobility. These results are also robust to the inclusion of country and time fixed effects following Krol (1996) and Jansen (1996). The rest of this paper is set out as follows. Section II reviews the relevant literature, Section III reviews our econometric approach, Section IV discusses the data and results, and Section V concludes.

II. Literature Review

Since FH's seminal paper, the relationship between domestic saving and investment has been examined from numerous perspectives (e.g. Dooley *et al.* (1987); Tesar (1991); Taylor and Sarno (1997); Glick and Rogoff (1995); Coakley *et al.* (1998); Obstfeld and Rogoff (2000); Corbin (2004); and Bryne *et al*. (2009)). Most of these papers either argue that saving and investment can be correlated even if capital is mobile, or offer alternative explanations for the high correlation found by Feldstein and Horioka (1980). Recently, Bai and Zhang (2010) show that the cross-sectional relationship between saving and investment rates measures the relationship of financial frictions, and that after controlling for these frictions, the relationship goes to zero. The basic approach of these studies stems from FH's estimation of the relationship between domestic investment and saving:

$$\frac{I}{Yi}=\alpha+\beta\,\frac{S}{Yi}+\varepsilon_i \qquad (1)$$

where, for country i, $(I/Y)_i$ is domestic investment as a share of gross domestic product (GDP), and $(S/Y)_i$ is domestic saving as a share of domestic GDP. FH originally finds β equal to 0.89 for a sample of 16 OECD countries spanning 1960 to 1974.

The earliest extensions focused on applying the SI regressions to varying datasets controlling for time, country size, and trade openness. Originally, proposed by Baxter and Crucini (1993) and Tesar (1991), relatively small economies with a large exposure to trade should have a significantly lower SI correlation. Smaller economies are more dependent on foreign capital, which weakens the domestic SI relationship. Subsequent work has since expanded Equation (1) to include panel estimators (see Sinn (1992), Jansen (1996), Krol (1996), and Kollias *et al.* (2008)) and times series techniques [see Miller (1988)]. However, regardless of the approach taken, the focus of the literature is on β, named the saving-retention coefficient. A saving-retention coefficient near one indicates a high correlation between domestic saving and investment, which implies that capital may not be mobile across international borders as domestic saving is retained in the home country.

A number of explanations for the high correlation between domestic saving and investment have been offered. The most widely accepted explanation is that countries face a long-run solvency constraint within their current account balance. Saving less investment is approximately equal to a country's current account balance. In the short run, countries can sustain a current account imbalance, but over time both variables move together to eliminate any deficit or surplus. As such, Jansen (1996) shows that the simple ordinary least squares (OLS) model originally estimated by FH is effectively measuring a binding long-run solvency constraint, and that by using long-term data, average saving and investment rates should be equal. Jansen then uses a vector error correction model to show that saving and investment rates are cointegrated, implying a stationary current account. Nevertheless, the short-run SI coefficient can be used as a measure of capital mobility when using annual data.

Jansen's work has since opened the door for research testing the short- and long-run relationships between saving and investment rates as they apply to both capital mobility and current account dynamics, respectively. More recently, Pelgrin and Schich (2008) and Kim *et al.* (2005) use a dynamic panel error correction model to show that the relationship is significantly weaker in the short run, but is highly correlated in the long run. Similarly, Herwartz and Xu (2010) use a functional coefficient model to show that trade openness, age dependency ratios, and government consumption affect the saving coefficient in the long run. Georgopoulos and Hejazi (2009) add to this literature by incorporating a time trend into the SI regressions, showing that the home bias has significantly weakened over time. Finally, Fouquau *et al.* (2008) use a panel threshold smoothing process and find that varying levels of trade openness, country size, and current account balances impact the saving coefficient, while Evans *et al.* (2008) use a time-varying coefficient approach to show that the saving-retention coefficient is unstable over time.

Despite the large amount of research devoted to the FH puzzle, we believe one omission in the literature is the failure to control for the endogeneity within investment rates across countries. In particular we show that investment rates are positively correlated across countries, and that the failure to adequately control for this endogeneity biases the saving coefficient upward. Debarsy and Ertur (2010) assume investment is correlated across countries, conditional on proximity. Accordingly, the greater the proximity of two countries, the greater is the level of capital flows between these countries. However, given the efficiency of global financial markets, there is no reason to suspect that capital will always flow to a neighboring country. For example, the United States receives large amounts of capital inflows from Germany, Luxembourg, Norway, and Switzerland. As such, instead of weighting investment rates by geographic proximity as is common in the literature [e.g. Baltagi *et al.* (2007); Blonigen *et al*. (2007); Bobonis and Shatz (2007); Coughlin and Segev (2000); and Garretsen and Peeters (2009)] we assume that investment rates between countries have a greater correlation with countries that have a large difference in saving rates, rather than by spatial proximity.

III. Empirical Methodology

In this paper, we add to the aforementioned literature by recognizing the implicit assumption underlying capital mobility. That is, if capital is mobile, it will flow to the country with the greatest return on investment. As such, investment in one country is money that cannot be invested in another country, making each country's level of investment dependent upon the investment in other countries. Given this relationship, we empirically model Equation (1) as a spatial autoregressive (lag) process:

$$\frac{I}{Yit}=\alpha+\beta\frac{S}{Yit}+\varrho W\frac{I}{Yit}+\varepsilon_i. \quad (2)$$

In estimating Equation (2), we use data from the Penn World Table version 7.2, which span 1950 through 2009. Within these data, there are 26 countries. All countries span the complete time period with the exceptions of Germany (1970-2009), Greece (1951-2009), and Korea (1953-2009). As is standard in the literature, both saving and investment rates are expressed relative to gross domestic product (GDP), with saving rates calculated as the residual of GDP less household and government consumption.

Empirically, Equation (2) is an ordinary least squares (OLS) specification of the SI relationship, with an additional term, $\varrho W(I/Y)_{it}$, which captures the impact of investment in one country on the level of investment in another country. Specifically, W is a block diagonal spatial weighting matrix, with each block, W_t, being of dimension n x n, where n is the number of observations in each year.[4] The on diagonal elements of W_t are set to zero to prevent a country's investment from being regressed on itself, while the off diagonal elements are equal to the absolute value of $(S/Y)_{it}-(S/Y)_{jt}$.[5] As is typical in the spatial econometrics literature, the specification of the weighting matrix is chosen based on one's belief about the relationship between spatially related observations.[6] In our case, this means that we rely on the SI literature and deviate from more common specifications of a spatial weighting matrix based on geographic proximity.[7]

Specifically, we define space as differences in saving rates. This is done because, if capital is mobile, one would expect that it would flow from high saving counties with a relatively low marginal product of capital to lower saving countries with a high marginal product of capital. Under the assumption of perfect capital mobility we would expect saving plus/minus net capital outflows to equate across countries. Countries with high saving rates today would invest in countries with lower saving rates (and higher returns to investment). Further, under the assumption

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[4] Note that the aforementioned data represent an unbalanced panel. While this can potentially cause empirical problems as the weighted average is missing information in some years, our results are nearly identical to those obtained from running the same estimation procedure on a balanced panel without the countries for which we have missing years.

[5] To control for potential bias using the right hand side variable as the potential weighting instrument, we also use the difference in the lagged saving rates. The results are quantitatively similar and available upon request.

[6] See Anselin (1988) for an overview of spatial econometrics and modeling.

[7] For example, Baltagi *et al*. (2007); Blonigen *et al.* (2007); Bobonis and Shatz (2007); Coughlin and Segev (2000); and Garretsen and Peeters (2009) all use neighboring countries to capture spatial effects when examining various patterns in foreign direct investment.

of perfect capital markets and low transaction costs, there is no reason to expect the foreign investment decision to depend on proximity, but solely on rates of return.

The spatial weighting matrix, W, is row standardized so that $W(I/Y)_{it}$ can be interpreted as the weighted average investment of other OECD countries, with ϱ being the estimated term in Equation (2), relating the effect of the weighted average investment rate on domestic investment. Given this empirical model, if capital is mobile, one would expect both the estimated coefficient on the domestic saving rate, $(S/Y)_{it}$, to be small, and the estimated spatial coefficient, ϱ, to be positive, as increases in investment in other countries should increase the relative marginal return in the domestic country, thus increasing domestic investment.

The presence of the $W(I/Y)_{it}$ in Equation (2) above makes OLS estimation of Equation (2) biased as this term is endogenous. Therefore, we use maximum likelihood methods to estimate Equation (2) to account for this endogenous term. In later extensions we include controls for trade openness and country size, along with time and country fixed effects, to assess the SI relationship.

IV. Results

A. Summary Statistics

A complete set of summary statistics is provided in Table 2. We also present the statistics for trade openness, measured as the sum of exports and imports relative to GDP, and country size, measured as GDP for country i divided by the sum of all GDP for all countries by year. Table 5 presents the descriptive statistics for saving and investment, trade openness, and country size by decade.

Table 2: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Saving Rates	1536	0.2312	0.0772	-0.0136	0.5640
Investment Rates	1536	0.2287	0.0568	0.0625	0.45183
Trade Openness	1536	60.516	40.679	2.6359	324.3633
Country Size	1536	0.0391	0.0744	0.0002	0.4689

Table 3 presents the results for two panel unit root tests. Both tests offer a slightly different alternative hypothesis. We estimate the unit root tests following *Im et al*. (2003) and Choi (2001) (henceforth IPS and Choi, respectively). The IPS test allows the coefficient on the autoregressive parameter to be heterogeneous across panels. The IPS test has an alternative hypothesis that allows unit roots for some but not all of the individual panels. In essence the IPS test is based on the augmented Dickey-Fuller statistics averaged across all panels. We report the mean of the augmented Dickey-Fuller test statistic (t_{bar}) and the standardized t_{bar} statistic, Z_{t-bar}. Both statistics are consistent across variables. The IPS test confirms $s_{i,t}$ and $i_{i,t}$ follow a stationary process.

Finally, we estimate the panel unit root test following Choi (2001). Choi uses a GLS detrending method which follows from Elliott *et al.* (1996) and an error correction model to specify cross-sectional correlations. Choi reports three test statistics P_m, Z, and L^* which follow a standard normal distribution under the null hypothesis.[8] Under the Choi test we reject the null of non-stationarity at the 1% level of significance for both variables.

Table 3: Unit Root Tests in Panel Data

Variable	$i_{i,t}$	$s_{i,t}$
IPS (2003) - t_{bar}	-2.669***	-2.344***
IPS (2003) - Z_{t_bar}	-6.481***	-4.665***
Choi (2001) – Pm	7.639***	4.864***
Choi (2001) – Z	-6.329***	-4.348***
Choi (2001) - L*	-6.476***	-4.389***

* p<0.10, ** p<0.05, *** p<0.01
IPS: under alternative hypothesis some panels are stationary.
Choi: under alternative hypothesis at least one panel is stationary.

B. Baseline Results

The results of estimating the spatial lag model given by Equation (2) are presented in three sections. The first section examines the estimated coefficients from a baseline model with only saving rates and the spatially weighted investment of other countries included in Equation (2). The second section then includes additional time variables to capture the change in the relationship over time, and finally, the third section includes explanatory variables capturing both trade openness and country size.

Table 4 presents the results from estimating Equation (1) via OLS in columns (1), (3) and (5) and Equation (2) via maximum likelihood, including the spatial lag term, in columns (2), (4) and (6). Note that the statistical significance of the spatial lag term, ϱ, in all three of the maximum likelihood regressions indicates that OLS suffers from omitted variables bias by not accounting for the weighted average investment rate of other countries. This bias is particularly problematic in estimating these SI regressions as the estimated coefficient in the OLS specifications is much larger in magnitude than those with the spatial lag term present, which would tend to point towards less mobile capital, the crux of the FH puzzle. In the baseline OLS regression (Model 1) the saving retention coefficient is 0.501, but after the inclusion of the spatial term, this coefficient is nearly cut in half to 0.264.

To this model, country fixed effects are included to control for the potential downward bias that results from the inclusion of Luxembourg, Switzerland, and other countries that offer unique circumstances. In addition, year fixed effects are added to control for the global business cycle.[9] The results incorporating these fixed effects are shown in models (3) and (4) with country fixed effects and the results with both country and year fixed effects are presented columns (5) and (6).

[8] For details of all three unit root tests we suggest reading Maddala and Kim (2003).

[9] In order to minimize short-term fluctuations and business cycle shocks, FH used time averaged data, which has subsequently been shown to bias the results upward as time averaged saving and investment rates are more a reflection of a stationary current account than capital mobility. The inclusion of year fixed effects will control for random shocks across countries and allow for the use of annual data.

As was shown previously, the specifications including the spatial lag term [models (4) and (6)] exhibit saving-retention coefficients that are statistically smaller than the OLS counterparts.[10]

Table 4: Baseline Saving Regressions

	(1)	(2)	(3)	(4)	(5)	(6)
Saving	0.501***	0.264***	0.522***	0.414***	0.526***	0.375***
	(0.022)	(0.018)	(0.104)	(0.023)	(0.110)	(0.251)
Const.	0.113***	0.018***	0.108***	0.038***	0.027***	0.013***
	(0.005)	(0.004)	(0.024)	(0.006)	(0.040)	(0.004)
ϱ		0.654***		0.404***		0.429***
		(0.023)		(0.034)		(0.032)
R^2	0.464		0.425		0.507	
N	1536	1536	1536	1536	1536	1536
i FE	No	No	Yes	Yes	Yes	Yes
t FE	No	No	No	No	Yes	Yes

White standard errors in parentheses
*,**,*** Denote significance at the 10, 5, and 1 percent levels, respectively.

While our estimated saving-retention coefficients are significantly lower when accounting for the spatial dependence of investment, we note that they are still statistically different from zero. Given the previous literature, this result is not surprising, as the literature has well documented that investors have a preference for domestic assets, even after accounting for an appropriate risk premium. Another explanation for a non-zero saving-retention coefficient stems from the diversity of the OECD countries and time periods under consideration. Periods prior to the capital liberalization post-Bretton Woods are likely to push the saving-retention coefficient upward. However, in the next section, we show that for certain country groupings, the saving-retention coefficient is statistically insignificant.

Turning our attention to the estimated coefficients on the spatial lag term, ϱ, our estimates are positive and significant, providing further evidence of capital mobility. Were capital immobile, we would expect a statistically insignificant estimate for our spatial lag term as investment in one country would not impact investment in another country. However, the statistically significant positive estimate on this variable indicates that investment is positively correlated across borders, indicating that capital is mobile. That is, increases in investment in other countries will lower the marginal return in those countries and increase investment in the domestic country where the relative marginal return on investment is higher. Of particular importance to this relationship is the weighting of investment rates based on the differences in saving rates, as opposed to geographic distance. High saving countries will use their savings to purchase domestic capital causing the marginal returns to capital to decrease, eventually reaching a level where domestic savings will begin to flow to foreign economies, which have the relatively higher marginal product. As such, countries with a higher marginal return to capital are likely to be low saving, high growth

[10] Note that these results are higher than those found by estimating the spatial lag model without country and year fixed effects.

economies. Thus, our results in Table 4 show the mobility of capital, the smaller estimated coefficients on the domestic saving rate, and the positive statistically significant estimates on the spatial lag term.

In terms of the FH puzzle, these results are consistent with using SI regressions to shed light on the pattern of capital mobility. FH originally found a saving-retention coefficient which was statistically insignificant from one, while our results presented here show evidence of greater capital mobility. Extending these results to account for many of the aforementioned alterations to the original FH specification in the literature, we next allow the saving-retention coefficient to vary across decades and differing levels of trade openness and country size.

C. Extensions

We extend the baseline model by allowing the saving-retention coefficient to vary over time, country size, and trade openness. These results are presented in tables 6-10 (tables 9 and 10 appear in the appendix). These extensions are useful as they allow us to incorporate results from the SI literature. Specifically, it has been well documented that countries that are more dependent on foreign trade (see Fouquau *et al.* (2008), Krol (1996), and Tesar (1991)), and countries that are smaller in terms of GDP (see Kumar (2011) and Baxter (1993)), are more dependent on foreign capital. Further, we expect the saving-retention coefficient to decline over time as the world economy becomes more interconnected. Table 5 provides the summary statistics for saving and investment rates by decade, level of trade openness, and country size. These statistics point towards investment rates increasing slightly over time, with average saving rates increasing significantly during the last decade. It is also worth noting that the difference between saving and investment rates (a country's current account) has also increased in the 1990s and 2000s, as countries have been able to sustain longer current account imbalances during this period. This leads us to expect increased capital mobility and a lower saving-retention coefficient compared to the past two decades.

Table 5: Mean Values of Saving and Investment Rates by Decade

	1950s		1960s		1970s		1980s		1990s		2000s	
	S/Y	*I/Y*	*S/Y*	*I/Y*	*S/Y*	*I/Y*	*S/Y*	*I/Y*	*S/Y*	*I/Y*	*S/Y*	*I/Y*
Total	0.194	0.201	0.224	0.234	0.231	0.243	0.225	0.225	0.247	0.229	0.263	0.238
Trade Openness												
Low	0.168	0.183	0.199	0.220	0.222	0.240	0.217	0.215	0.226	0.231	0.237	0.254
Mid	0.192	0.203	0.223	0.233	0.214	0.232	0.200	0.215	0.217	0.227	0.197	0.227
High	0.271	0.250	0.281	0.270	0.273	0.266	0.257	0.241	0.291	0.231	0.309	0.242
Country Size												
Low	0.217	0.228	0.238	0.251	0.243	0.262	0.240	0.239	0.258	0.227	0.306	0.247
Mid	0.185	0.192	0.219	0.233	0.228	0.240	0.226	0.226	0.259	0.236	0.251	0.227
High	0.176	0.179	0.214	0.217	0.224	0.229	0.212	0.211	0.228	0.226	0.237	0.239

Similarly, the summary statistics show that relatively closed economies have higher investment rates (i.e., net debtor countries), whereas more open countries have significantly higher saving rates (i.e., net creditor countries). Finally, small economies also have higher saving rates on average, while large economies have higher investment rates. One striking observation based on these averages is the change in investment and saving rates across groupings. Over the last four decades investment rates have remained nearly constant across differing levels of trade openness and country size, while saving rates have varied dramatically. For example, in the 1990's saving rates ranged from 0.226 to 0.291 percent for relatively closed, and relatively open economies, respectively. However, despite the varying levels of saving rates, investment rates are identical at 0.231. This result further motivates our use of saving differentials when controlling for the endogeneity of investment rates between countries. It must be that high saving countries are investing in low saving countries.

Incorporating these observations into our results, Table 6 presents the results of allowing the saving-retention coefficient to vary across decades. Previous work by Debarsy and Ertur (2010) split the same sample into three time periods, 1960-1970, 1971-1985, and 1986-2000, and then estimated a separate spatial autoregressive model for each individual time period. By splitting the observations by decade, we hope to get a better idea of how capital mobility has changed over time using more narrowly defined time intervals. Additionally, instead of sample splitting and estimating separate regressions, we interact saving rates with decade specific dummy variables, and restrict the constant to be equal across decades. This is done to maintain the benefits of our large dataset.

Our results show that the models incorporating the spatial lag term have saving-retention coefficients which are significantly lower than their OLS counterparts. Further, the coefficient on the spatial lag term remains positive and significantly different than zero. The results also indicate that the saving-retention coefficient has declined over time, and is robust to the inclusion of country and time fixed effects.

Model (1) displays little evidence of changing capital mobility across periods, with the saving coefficient being the highest in the 1970s (0.585), and the lowest in the 2000s (0.466). The inclusion of our spatial lag term lowers these estimated coefficients in all periods, but does not provide much evidence of capital mobility changing over time. With the inclusion of both country and year fixed effects, the saving-retention coefficient declines, with the highest value being 0.564 for the 1950s, and the lowest value being 0.190 for the 2000s. These results support the hypothesis that capital mobility has increased over time.

Table 6: Saving Regressions with Varying Decade Coefficients

	(1)	(2)	(3)	(4)	(5)	(6)
S_{1950}	0.496***	0.206***	0.570***	0.432***	0.698***	0.564***
	(0.027)	(0.025)	(0.100)	(0.029)	(0.109)	(0.044)
S_{1960}	0.571***	0.283***	0.627***	0.492***	0.718***	0.543***
	(0.023)	(0.021)	(0.092)	(0.025)	(0.096)	(0.038)
S_{1970}	0.585***	0.306***	0.633***	0.505***	0.593***	0.454***
	(0.026)	(0.022)	(0.091)	(0.025)	(0.133)	(0.048)
S_{1980}	0.523***	0.234***	0.571***	0.439***	0.530***	0.423***
	(0.022)	(0.020)	(0.093)	(0.026)	(0.083)	(0.035)
S_{1990}	0.488***	0.243***	0.537***	0.425***	0.486***	0.411***
	(0.024)	(0.018)	(0.100)	(0.024)	(0.121)	(0.033)
S_{2000}	0.466***	0.262***	0.515***	0.422***	0.226***	0.190***
	(0.023)	(0.019)	(0.094)	(0.023)	(0.106)	(0.026)
Const.	0.108***	0.019***	0.096***	0.412***	0.152***	0.088***
	(0.005)	(0.004)	(0.022)	(0.004)	(0.023)	(0.009)
ϱ		0.657***		0.348***		0.299***
		(0.023)		(0.033)		(0.034)
R^2	0.499		0.494		0.601	
N	1536	1536	1536	1536	1536	1536
I FE	No	No	Yes	Yes	Yes	Yes
T FE	No	No	No	No	Yes	Yes

White standard errors in parentheses
*,**,*** Denote significance at the 10%, 5%, and 1% levels.

Table 7 presents the result allowing the saving-retention coefficient to vary conditionally on a country's level of trade openness. The levels of openness are selected in an *ad hoc* fashion, with the sample being divided into thirds.[11] The coefficient on variable S_{low} measures the degree of capital mobility for countries in the lowest third of trade openness, i.e., relatively closed economies. A more detailed process of splitting the data would be to estimate the model searching for the value of trade openness that maximizes some F-statistic, and/or using information criteria (i.e., a threshold estimation process following Herzog (2010) or Fouquau *et al*. (2008)). This process would likely strengthen our results by causing the coefficient on the saving rate for relatively more open countries to decrease, while increasing the estimate for countries that are relatively closed; however, tests incorporating threshold effects with a spatial autoregressive lag time have yet to be developed.

Consistent with the literature, our estimated saving-retention coefficient is the smallest for the more open economies. The coefficient on the spatial lag term is also positive and statistically significant from zero. These results do show evidence of increased capital mobility for economies with a larger tradeable sector, but the variability in the saving-retention coefficient across levels

[11] We use the same selection process for country size.

of openness is minimal. In all cases, the saving-retention coefficients on S_{low} and S_{mid} are not statistically different. From Table 5, the more open countries are typically high saving countries with a current account surplus. While the average saving rates increased drastically for more open countries relative to the more closed economies, investment rates tend to be more similar. Finally, during the 1980s, 1990s, and 2000s, saving rates increased drastically for the more open economies, while there was very little difference between saving and investment rates for the other two subsets.

Table 7: Saving Regressions with Varying Trade Openness Coefficients

	(1)	(2)	(3)	(4)	(5)	(6)
S_{low}	0.628***	0.353***	0.623***	0.505***	0.586***	0.442***
	(0.022)	(0.020)	(0.092)	(0.026)	(0.103)	(0.026)
S_{mid}	0.636***	0.358***	0.615***	0.500***	0.592***	0.434***
	(0.023)	(0.020)	(0.092)	(0.024)	(0.104)	(0.026)
S_{high}	0.520***	0.286***	0.498***	0.407***	0.486***	0.344***
	(0.020)	(0.017)	(0.092)	(0.022)	(0.102)	(0.024)
Const.	0.093***	0.010***	0.097***	0.030***	0.079***	0.017***
	(0.005)	(0.004)	(0.021)	(0.006)	(0.022)	(0.009)
ϱ		0.624***		0.362***		0.409***
		(0.023)		(0.035)		(0.032)
R^2	0.509		0.508		0.531	
N	1536	1536	1536	1536	1536	1536
I FE	No	No	Yes	Yes	Yes	Yes
T FE	No	No	No	No	Yes	Yes

White standard errors in parentheses
*,**,*** Denote significance at the 10%, 5%, and 1% levels.

Table 8 presents the results of allowing for the saving-retention coefficient to vary by country size. Again, the results are consistent with the past literature in that the coefficient on the saving rate variable for relatively small countries is significantly lower than the coefficient for medium and large countries, with the saving-retention coefficient being smallest in the models that include the spatial lag term. Unlike the results controlling for trade openness, the saving-retention coefficients show a statistically significant decline from the large to medium to small economies. The saving-coefficient is lowest in Model (6) with a value of 0.247, but is similar across models. From Table 5, the investment rates are similar across differing degrees of country size, whereas small countries typically have high saving rates and large countries have lower saving rates. This suggests that small open countries use excess savings to fund investments in large closed economies. These results show an increase in capital mobility for all countries, including large economies. This helps to reconcile the baseline Feldstein-Horioka model with other measures of capital mobility.

Table 8: Saving Regressions with Varying Country Size Coefficients

	(1)	(2)	(3)	(4)	(5)	(6)
S_{low}	0.495***	0.258***	0.329***	0.270***	0.345***	0.247***
	(0.022)	(0.017)	(0.110)	(0.027)	(0.101)	(0.027)
S_{mid}	0.526***	0.282***	0.599***	0.471***	0.588***	0.424***
	(0.021)	(0.017)	(0.048)	(0.025)	(0.057)	(0.026)
S_{high}	0.529***	0.300***	0.632***	0.530***	0.629***	0.487***
	(0.022)	(0.017)	(0.045)	(0.022)	(0.052)	(0.024)
Const.	0.109***	0.014	0.110***	0.026***	0.083***	0.009
	(0.005)	(0.004)	(0.013)	(0.007)	(0.015)	(0.009)
ϱ		0.657***		0.358***		0.388***
		(0.023)		(0.034)		(0.031)
R^2	0.468		0.484		0.556	
N	1536	1536	1536	1536	1536	1536
I FE	No	No	Yes	Yes	Yes	Yes
T FE	No	No	No	No	Yes	Yes

White standard errors in parentheses
*,**,*** Denote significance at the 10%, 5%, and 1% levels.

Finally, it is useful to understand how capital mobility has changed over time while controlling for varying degrees of country size and trade openness. Tables 9 and 10, available in the appendix, present the results of allowing the saving-retention coefficient to vary across decades while also controlling for differing degrees of openness and country size. Table 9 presents the results of allowing for varying degrees of trade openness. Analyzing these results, we see capital mobility was highest in the 1950s, and diminished in the 1960s and 1970s. The 1980s show some evidence of increased mobility, but the 1990s, plagued with financial crises, have decreased levels of capital mobility. For the most open countries, the saving-retention coefficient is actually statistically insignificant from zero. The estimated saving-retention coefficient for the most open economies is 0.085 in the 1950s, and 0.068 in the 2000s. During the 1960s and 1970s this same saving-retention coefficient is greater than 0.500 for all levels of openness. The original FH results used averaged data from 1960-1974, and given our results, it should not be surprising that FH found a high level of capital immobility.

The same pattern of capital mobility is displayed in Table 10, with perfect capital mobility being present for the smallest countries during the 1950s, 1980s, and 2000s. In the 2000s large countries also display evidence of capital mobility. The 1960s have the lowest level of capital mobility, while the 1990s show evidence of decreased capital mobility, which could be the result of the frequency of financial crises in Asia, South America, and Europe.

V. Conclusion

This paper provides two significant contributions to the literature. Within the SI literature we show that the saving-retention coefficient is biased upward due to the failure to adequately control for the endogeneity of investment rates across countries. Using a spatial autoregressive (lag) process, the saving-retention coefficient is cut in half when compared to the simple OLS model.

Further, controlling for time, country size, and trade openness, we find evidence of perfect capital mobility during the 1950s, 1980s, and 2000s. Throughout the estimation process, small open economies displayed significantly more evidence of capital mobility than large, relatively closed economies.

The second contribution made is within the spatial literature linking countries through differences in saving rates. Past literature has focused mainly on spatial linkages based on geographic proximity, where investment in country i would be correlated with investment in the nearest economies. There are two main issues when using geographic proximity to construct the weighting matrix. First, if capital markets are efficient and have low transaction costs, we would expect capital to flow into those countries offering the greatest returns, all else equal. Using geographic distance primarily serves as a proxy for transportation costs, but technological advances have significantly reduced such transportation costs, leading us to believe proximity should not be a determining factor in capital mobility. Second, we expect the relationship between investments across countries to vary over time. Using proximity fails to control for the changing relationships between countries. Using differentials in country saving rates more accurately captures the relationship between investment rates across countries. Domestic investors have a preference for domestic assets, but given a positive shock in another country, domestic investors will shift excess savings to these countries. As such, only countries with excess savings will be able to take advantage of the higher returns.

Further extensions would allow the development of a richer model that measures capital mobility controlling for spatial differences in saving rates. Capital mobility has increased following the capital account liberalization that began at the conclusion of the Bretton Woods period. With these results, we are left asking if the Feldstein-Horioka result is still a puzzle; accounting for the endogeneity of investment provides ample evidence in support of perfect capital mobility. Over the last ten years, nearly all OECD countries display evidence of perfect capital mobility.

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Appendix

Table 9: Saving Coefficients by Decade for Varying Degrees of Openness

	(1)	(2)	(3)	(4)	(5)	(6)
			1950			
S_{low}	0.617	0.602	0.377	0.361	0.266	0.256
S_{mid}	0.645	0.628	0.347	0.334	0.235	0.228
S_{high}	0.581	0.558	0.235	0.224	0.091	0.085
			1960			
S_{low}	0.703	0.647	0.902	0.900	0.889	0.888
S_{mid}	0.688	0.637	0.832	0.831	0.827	0.827
S_{high}	0.645	0.584	0.700	0.700	0.695	0.696
			1970			
S_{low}	0.681	0.530	0.658	0.653	0.674	0.664
S_{mid}	0.659	0.561	0.630	0.626	0.627	0.619
S_{high}	0.606	0.480	0.534	0.533	0.508	0.505
			1980			
S_{low}	0.623	0.550	0.323	0.330	0.275	0.287
S_{mid}	0.660	0.593	0.316	0.316	0.254	0.261
S_{high}	0.611	0.545	0.286	0.282	0.243	0.245
			1990			
S_{low}	0.697	0.600	0.703	0.706	0.657	0.654
S_{mid}	0.704	0.618	0.626	0.624	0.577	0.577
S_{high}	0.524	0.443	0.522	0.521	0.460	0.459
			2000			
S_{low}	0.405	0.288	0.557	0.558	0.280	0.282
S_{mid}	0.347	0.207	0.442	0.442	0.131	0.134
S_{high}	0.257	0.153	0.396	0.398	0.063	0.068

Savings-retention coefficient is reported, complete results are available upon request

Table 10: Saving Coefficients by Decade for Varying Degrees of Country Size

	(1)	(2)	(3)	(4)	(5)	(6)
			1950			
S_{low}	0.586	0.567	0.157	0.135	0.067	0.052
S_{mid}	0.543	0.549	0.360	0.343	0.268	0.259
S_{high}	0.508	0.554	0.564	0.554	0.432	0.429
			1960			
S_{low}	0.645	0.577	0.766	0.763	0.763	0.762
S_{mid}	0.661	0.630	0.842	0.841	0.832	0.833
S_{high}	0.606	0.592	0.867	0.865	0.871	0.871
			1970			
S_{low}	0.617	0.480	0.422	0.415	0.399	0.385
S_{mid}	0.620	0.514	0.731	0.727	0.713	0.704
S_{high}	0.586	0.457	0.752	0.744	0.733	0.720
			1980			
S_{low}	0.594	0.521	0.143	0.132	0.075	0.075
S_{mid}	0.616	0.554	0.366	0.348	0.313	0.307
S_{high}	0.581	0.508	0.513	0.621	0.392	0.463
			1990			
S_{low}	0.463	0.357	0.378	0.378	0.416	0.408
S_{mid}	0.554	0.461	0.540	0.540	0.545	0.555
S_{high}	0.586	0.481	0.560	0.559	0.576	0.586
			2000			
S_{low}	0.214	0.124	0.330	0.332	0.101	0.106
S_{mid}	0.221	0.157	0.454	0.457	0.154	0.163
S_{high}	0.315	0.227	0.584	0.582	0.039	0.036

Savings-retention coefficient is reported, complete results are available upon request