A Competitive Equilibrium Asset Pricing Model with Imputation and Partially Segmented Markets

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Abstract

The full effect of a dividend imputation tax system on domestic asset prices is not completely understood. A dividend imputation system eliminates double taxation by attaching tax credits for already paid company tax to distributed dividends. Certain domestic shareholders can utilise these credits to reduce their personal taxes. The interplay between imputation eligible domestic investors and ineligible foreign investors complicates the credit valuation. We develop a one period multi-investor, multi-economy asset pricing model, exploring the effects of imputation and partial market segmentation on investor holdings, asset prices, and the market value of imputation credits. We find that an imputation system increases domestic investor utility with the market value of imputation credits increasing in both imputation tax benefit and market segmentation.

Key words: Asset pricing, segmented markets, dividend imputation
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Under a dividend imputation tax system, dividends that are paid out of profits that have been taxed at the corporate level have a tax credit attached to them. These tax credits allow certain domestic shareholders to reduce the personal taxes that they would otherwise pay, but are of no value in the hands of foreign investors. Given that Australia shares tend to be held by a mixture of domestic investors who value imputation credits, and foreign investors who dont, it is not obvious how these imputation credits might affect the value of Australian shares.

Obtaining a reliable estimate of the market value of imputation credits is of considerable practical importance for two reasons. First, Officer (1994) demonstrates that the value of imputation tax credits, which he denotes as γ or gamma, is an important component of firm valuation in dividend imputation tax systems.[2] Second, the estimated value of gamma is one of the key elements of the regulation of monopoly infrastructure assets a change in the value of gamma can result in the allowed revenue for a single regulated business to change by tens of millions of dollars per year. For example, a recent Australian Competition Tribunal decision to reduce the value of gamma from 0.65 (as proposed by the Australian Energy Regulator) to 0.25 was the largest contributor to increased allowable revenues for three electricity distribution network operators by around AUD$850 million over five years.[3]

Two schools of thought have developed in relation to the extent to which imputation credits might be expected to affect asset prices. One school notes that Australia is a small, open economy that is a net importer of capital. It is argued that (a) since foreign capital is required by domestic businesses, and (b) foreign investors receive no benefit from imputation credits, the equilibrium outcome must be that imputation credits have

[2] See the Appendix to Officer (1994) for an illustration of how the various cash flows and discount rate expressions are adjusted for imputation to value a firm under the assumption of a constant stream of cash flows in perpetuity.

[3] The Australian Competition Tribunal on 19 May 2011 handed down its decision on the appeals by the South Australian (ETSA Utilities) and Queensland electricity distribution network operators (Energex and Ergon Energy). See the press release on the Australian Energy Regulators website for more details: http://www.aer.gov.au/content/index.phtml/itemId/746345.

a negligible effect on the value of Australian shares. That is, foreign investors will not rationally pay a premium (in the form of a higher share price) in relation to imputation credits that are of no value to them.

The alternative argument is to note that the majority of Australian shares are owned by Australian residents and to conclude that this implies that imputation credits will have a material effect on Australian share prices. Under this explanation, the presence of foreign investors is explained in terms of diversification benefits the cost of relatively higher share prices is more than offset by diversification benefits.

In this paper, we seek to test these two conceptual arguments using a simulated economy methodology.

Lally (1996) present a model that doesn't take into account asymmetry of either imputation credits or investment barriers—both domestic and foreign investors receive a tax rebate for shorting both foreign and imputation credit paying assets. This rebate causes investors to fund leverage positions in their local assets using proceeds from shorting rebate generating non-local assets.

Wood (1997) extends the approach of Black (1974) and Stulz (1981), ignoring investment barriers, but giving the advantage of imputation tax credits to domestic investors. Both foreign and domestic investors who borrow, then short, imputation credit paying domestic assets, must compensate the security's lender for any foregone credits. This introduces an asymmetry between long and short positions on domestic securities. Wood (1997) only investigates the two extremes of market segmentation; complete integration and complete segmentation. An imputation taxation system combined with partial market segmentation is not explored.

Australian is a net capital importer with domestic investors favouring local assets; Lau, Ng, and Zhang (2010) find that domestic Australian funds hold 78% of their wealth in local assets. We describe a model that incorporates both imputation tax advantages and barriers to international investment to investigate the joint effects of imputation credits and foreign investment barriers on domestic asset prices. Our one period model contains two economies—domestic and foreign. At period start both domestic and foreign investors allocate their wealth among a set of income producing assets and the risk less asset. Each risky asset produces a stochastic terminal cash flow at period end. Assets are in fixed supply. Investors are risk averse with varying levels of aversion. All investors attribute homogeneous expectations to the distribution of terminal cash flows.

Investors face differing costs and taxation when investing in local and non-local assets. International investment barriers and home biases are affected by penalizing locals for investing in non-local assets. Investors maximize their end-of-period utility—positively related to expected end-of-period wealth and negative related to the variance of end-of-period wealth. Short sales with full use of proceeds are allowed; however, investors may be penalized for shorting securities depending on the barriers in effect. There are no transaction costs and investors can long or short an unbounded amount of any security. Trades only occur at equilibrium prices.

1 Competitive Equilibrium Model

A single risk-free asset and a collection of N risky assets trade across two economies. Each asset n trades in either the domestic $n \in D$ or the foreign economy $n \in F$. K risk averse investors make a single period investment decision, allocating their initial wealth W_k^0 among assets to maximize their expected end of period utility. Investors are domiciled in either the domestic $k \in D$ or foreign economy $k \in F$ and are subject to economy and asset specific investment rebates and barriers.

All assets pay a stochastic terminal cash flow d_n at period end; the risk-free asset pays d_f with certainty. Investors hold homogeneous expectations regarding the distribution of terminal cash flows—terminal cash flows follow a N dimensional multivariate normal distribution with mean $\overline{\mu} = [\mathbb{E}(d_1), \mathbb{E}(d_2), \ldots, \mathbb{E}(d_N)]^T$ and covariance structure Σ. Although the model can easily incorporate heterogeneous expectations, where $\overline{\mu}$ and Σ vary across investors, we investigate only the homogeneous case.

Investors are granted an initial endowment of π_n^k shares across risky assets and π_f^k in the risk free asset. The supply of risky assets in the market is fixed; thus the market supply

$\bar{\pi}_n$ for risky assets is

$$\bar{\pi}_n = \sum_{k=1}^{K} \pi_n^k. \tag{1}$$

We allow for either a fixed or infinite supply of risk free asset. In the fixed case the market supply of the risk free asset is

$$\bar{\pi}_f = \sum_{k=1}^{K} \pi_f^k. \tag{2}$$

Risky assets have initial prices $\mathbf{p}_0 = [p_{0,1}, p_{0,2}, \ldots, p_{0,N}]$ and the risk free asset has an initial price of p_f. Each investor's initial wealth W_k^0 is set to be consistent with their initial endowment and initial asset prices.

Investors have negative exponential CARA utility functions $U^k(w) = -e^{-\theta_k w}$ with per-investor risk aversion θ_k. Each investor maximizes their utility by observing market prices and forming an optimal mean-variance portfolio. In forming their optimal portfolio an investor chooses the number of shares of each asset to hold long $\mathbf{w}_k$ and short $\mathbf{v}_k$. Both $\mathbf{w}_k \geq 0$ and $\mathbf{v}_k \geq 0$ are $N \times 1$ vectors such that $\mathbf{w}_k - \mathbf{v}_k$ is an investor's net holding.

Investors may face both investment barriers and receive investment rebates. Domestic investor k, taking a position in foreign security n, suffers a tax of $D_{k,n}^{F,w}$ for every share held long, $D_{k,n}^{F,v}$ for every share held short, $D_{k,n}^{P,w}$ for every dollar held long, and $D_{k,n}^{P,w}$ for every dollar held short. For each investor $\mathbf{D}_k^{\{F,P\},\{w,v\}}$ are four $N \times 1$ vectors of these barriers where the nth element corresponds to security n. The total tax applied on long w and short v positions for investor k is

$$\tilde{\mathbf{D}}_k^{\{w,v\}} = \mathbf{D}_k^{F,\{w,v\}} + diag(\mathbf{D}_k^{P,\{w,v\}})\mathbf{p}_0. \tag{3}$$

Investment barriers and rebates can thus be proportional to the number, as well as the value of shares held, and may vary across investors and securities.

Each investor maximizes their CARA utility by solving

$$\max_{\mathbf{w}_k, \mathbf{v}_k} J^k = \overline{\mu}^T(\mathbf{w}_k - \mathbf{v}_k) - \frac{\theta_k}{2}(\mathbf{w}_k - \mathbf{v}_k)^T \Sigma (\mathbf{w}_k - \mathbf{v}_k) - \tilde{\mathbf{D}}_k^w \mathbf{w}_k - \tilde{\mathbf{D}}_k^v \mathbf{v}_k + x_k^f d_f. \tag{4}$$

The coefficient on the final term

$$x_k^f = \frac{W_0 - p_0^T(\mathbf{w}_k - \mathbf{v}_k)}{p_f} \tag{5}$$

reflects the condition that all wealth not allocated to risky assets is invested in the risk less asset. A negative net holding of the risk less asset indicates borrowing.

1.1 Market Clearing Condition

All investors make their allocation decision based on observed market prices. Given a set of initial endowments and asset prices, investor's collective optimal holdings may not equilibrate supply and demand. This presents a fixed point problem—we must jointly solve for the weights and prices that bring the market into competitive equilibrium. Let $\mathbf{z}_k(p_0, p_f)$ be investor k's optimal allocation given p_0 and p_f. We assume trades occur only at equilibrium prices, thus the equilibrium asset prices $\bar{p}_0, \bar{p}_f$ satisfy the market clearing conditions

$$\sum_{k=1}^{K} \mathbf{z}_k(\bar{p}_0, \bar{p}_f) = \overline{\pi}, \tag{6}$$

and

$$\sum_{k=1}^{K} \frac{W_k^0 - \bar{p}_0^T \mathbf{z}_k(\bar{p}_0, \bar{p}_f)}{\bar{p}_f} = \overline{\pi}_f. \tag{7}$$

In the case of an unlimited supply of the risk-free asset the previous constraint is ignored and p_f set to an exogenous constant.

1.2 Numerical Solution

Each investor's maximization of expected terminal CARA utility $J^k(\mathbf{w}_k, \mathbf{v}_k)$ equivalent to the quadratic programming problem

$$\min_{\mathbf{x}_k} \frac{1}{2} \mathbf{x}_k^T \mathbf{H} \mathbf{x}_k + f^T \mathbf{x}_k, \tag{8}$$

subject to the constraint

$$\mathbf{A}\mathbf{x}_k \leq \mathbf{b}, \tag{9}$$

such that

$$\mathbf{x}_k = \begin{bmatrix} \mathbf{w}_k \\ \mathbf{v}_k \end{bmatrix}, \tag{10}$$

$$f = -\begin{bmatrix} \overline{\mu} - \tilde{D}_k^w - \frac{p_0}{p_f} d_f \\ \\ -\overline{\mu} - \tilde{D}_k^v + \frac{p_0}{p_f} d_f \end{bmatrix}, \tag{11}$$

and

$$\mathbf{H} = \mathbf{F}^T \Sigma \mathbf{F}, \tag{12}$$

where

$$F = \begin{bmatrix} I^N & -I^N \end{bmatrix}. \tag{13}$$

I^N is the $N \times N$ identity matrix. Note that $\mathbf{x}_k$ and f are both $2N \times 1$ vectors, $\mathbf{H}$ is a $2N \times 2N$ matrix, and f depends on both p_0 and p_f.

We use the Gauss-Newton algorithm to simultaneously solve

$$\sum_{k=1}^{K} \mathbf{z}_k(p_0, p_f) - \bar{\pi} = 0, \text{ and} \tag{14}$$

$$\sum_{k=1}^{K} \frac{W_k^0 - p_0^T \mathbf{z}_k(p_0, p_f)}{p_f} - \bar{\pi}_f = 0, \tag{15}$$

for equilibrium assets prices and per-investor optimal portfolio allocations.

2 Single Economy

We first validate the model by reproducing the CAPM result—all asset returns lie on a security market line where an asset's return is a linear function of its covariance with the market portfolio.

A single closed economy contains $N = 10$ securities with expected terminal cash flows of $\overline{\mu} = [1.08, \ldots, 1.16]$, standard deviations $[0.03, \ldots, 0.08]$. Terminal cash flows are positively correlated with coefficient 0.2. The risk free asset is available in infinite supply for 1, paying a terminal cash flow of 1.05 with certainty. All risky assets have a fixed supply $s_k = 100$ and initial price $p_k = 1$. $K = 10$ investors with equal initial wealth $W^k = 110$ have risk preferences λ^k varying linearly from 0.5 to 1.5.

$\mathbf{x}_k$ is the vector of proportional wealth that each investor k allocates to individual risky assets. World wealth is then the total of all investor's wealth

$$W^W = \sum_{k=1}^{K} W^k \tag{16}$$

of which

$$W^R = \sum_{k=1}^{K} \mathbf{x}_k \mathbf{1} W^k, \tag{17}$$

is invested in risky assets with the remainder $W^W - W^R$ allocated to the risk free asset. The world market portfolio is then the value weighted portfolio held by all investors

$$\mathbf{w}_M = \frac{1}{W^R} \sum_{k=1}^{K} \mathbf{x}_k W^k, \tag{18}$$

which has return and variance

$$r_M = \mathbf{w}_M^T \mathbf{R},\ \sigma_M^2 = \mathbf{w}_M^T \mathbf{V} \mathbf{w}_M. \tag{19}$$

The covariance of investor k's portfolio with the market portfolio is

$$\sigma_{k,M} = \mathbf{w}_k^T \mathbf{V} \mathbf{w}_M, \tag{20}$$

giving a portfolio beta of

$$\beta_k = \frac{\sigma_{k,M}}{\sigma_M^2}. \tag{21}$$

Similarly the covariance of asset returns with the market portfolio is

$$\sigma_{\mathbf{N}} = \mathbf{V}.\mathbf{w}_M, \tag{22}$$

giving the vector of individual asset betas

$$\beta_{\mathbf{N}} = \frac{\sigma_{\mathbf{N}}}{\sigma_M^2}. \tag{23}$$

Consistent with the CAPM, all asset and investor portfolio lie on the security market line (Figure 1) defined by the risk free asset and the tangent market portfolio. As expected, investors with a lower degree of risk aversion (lower λ^k) hold high beta portfolios.

3 Integrated Economies

Consider two economies; one domestic and one foreign. Each economy has five investors $K_D = K_F = 5$ where the kth domestic investor has the same level of risk aversion as the

kth foreign investor. Investor risk aversions range linearly from 0.8 to 1.2. Each economy contains five risky securities $N_D = N_F = 5$ with the nth domestic security having the same expected return and volatility as the nth foreign security. The same risk-free asset is available to both domestic and foreign investors and is in unlimited supply. Within economy assets returns are correlated at 0.3 while across economy returns are correlated at 0.1. Tables 1 and 2 describe this setup in detail.

The two economies are integrated; investors gain no advantage investing locally and suffer no disadvantage investing abroad. With no restrictions on asset allocation, both domestic and foreign investors hold a combination of the market portfolio and the risk-free asset (Figure 2). The resulting market equilibrium in Table 3 reflects the symmetry of the setup. The input parameters result in a realistic range of asset betas from 0.469 to 1.59 and a market risk premium of 7.42%.

4 Partial Segmentation

We now introduce partial market segmentation—domestic investors face additional costs when holding gross asset positions in the foreign economy. Black (1974) derives an equilibrium pricing model where net foreign asset returns are taxed. This tax is proportional to net asset holdings and is simply subtracted from expected portfolio return. The side effect of this treatment is that short sales are subsidized; because the tax is subtractive, a domestic investors will favour a short position in a foreign security over a similar position in an otherwise identical domestic security. A more realistic specification reduces the expected returns on both long and short positions, effecting returns asymmetrically. Costs associated with foreign investment barriers are applied to the gross, rather than the net, asset holdings.

Stulz (1981) extends the Black (1974) model, building an equilibrium pricing model with taxes on gross positions. They find that once barriers are introduced no universally optimal world portfolio exists—the mutual fund separation theorem no longer holds. We replicate this result within our framework.

We modify our setup of two integrated economies, imposing a barrier to foreign investment on domestic investors $C^{\{w,v\}}_{D,F} = \phi_D$—domestic investors incur a ϕ_D penalty on gross cash flows in the foreign economy. This specification models a number of potential barriers such as information search costs and capital export restrictions. Foreign investors face no barriers in either the foreign or domestic economy $C^{\{w,v\}}_{F,F} = C^{\{w,v\}}_{F,D} = 0$.

Table 5 shows the market equilibrium in the presence of a one-way investment barrier. When a subset of investors is penalized for holding foreign assets, the linear relationship between β and returns is destroyed. As explored by Stulz (1981), the optimal portfolio for an investor facing international investment barriers is no longer a combination of the risk-free asset and the world portfolio. From the domestic investor's perspective, the world portfolio is inefficient. A mutual fund cannot exist where the domestic investor is indifferent between holding their optimal portfolio and holding a weighted combination of the risk-free asset, mutual fund, and the world market portfolio. Tax on long and short positions prevents a domestic investor from costlessly transforming the mutual fund into their optimal portfolio.

5 Imputation

The share price of two otherwise identical companies, one paying a 100% franked dividend, the other paying an unfranked dividend, should differ only by the value of the franking credit. Imperfect markets and differing tax clienteles result in franking credits not begin priced at their face value. Trading of imputation credits is restricted—foreign investors, unable to use their credits, are prevented from selling them to eligible tax payers. If credits could be costlessly traded then we'd observe the full value of credits reflected in share prices. The parameter θ captures the market value of a unit of franking credits; $\theta = 1$ implies franking credits are fully priced.

We again consider two economies, adding imputation taxation system to the domestic economy. Domestic investors holding local assets receive franking credits equal to a fraction ψ of domestic asset's terminal payoffs; foreign investors receive no imputation benefit. Securities lending agreements require both foreign and domestic investors who hold short positions in the domestic economy to compensate the lender with the full value of distributed franking credits (Faulkner and King, 2005). These conditions create an asymmetric barrier, where domestic investors holding local assets gain an additional return of ψ on long position while suffering a penalty of ψ on short positions. Foreign investors holding local assets receive no positive benefit on long positions but must compensate the security lender ψ for short positions.

θ is the market's average valuation of a unit of franking credits over all domestic securities

$$\theta = \frac{1}{N_D} \sum_{n \in D} \frac{\tilde{p}_n - p_n}{\mathbb{E}(d_n)\,\psi}. \tag{24}$$

Where $\tilde{p}_n$ is the equilibrium price of asset n calculated with imputation effect ψ and $\mathbb{E}(d_n)$ is asset n's expected terminal cash flow.

We calculate the value of θ for varying levels of imputation for both integrated and partially segmented markets. A higher level of imputation incentivizes domestic investors to hold a higher proportion of domestic assets. Domestic investors affect this change in holding by both borrowing more at the risk-free rate and shifting capital from foreign assets. This increased demand for domestic assets raises their prices and makes them less attractive for foreign investors. Foreign investors still receive diversification benefits form domestic stock holdings. Figure 6 shows the relationship between imputation benefits and theta for a completely integrated market and a partially segmented market.

Comparing equilibrium asset holdings in the integrated case with those in the imputation case (Figures 3c and 5c) we see the shift in domestic asset holdings from the foreign economy into the domestic. Domestic investors also shift from net lending to net borrowing, leveraging their domestic positions by borrowing the risk-free asset.

6 Conclusion

We present a competitive equilibrium asset pricing model that allows for asymmetric investor and economy specific investment barriers and rebates. In its simplest form this model replicates the CAPM result. We explore the market equilibrium resulting from integrated economies, partially segmented economies, and economies containing imputation taxation systems.

As expected, when subject to foreign investment costs, domestic investors withdraw capital from the foreign market, returning it to their domestic economy. Compared with an otherwise identical foreign investor, a domestic investor's utility decreases as investment barriers increase. The opposite effect is observed when domestic investors receive a investment rebate from imputation credits—again domestic investors pull funds from the foreign market, investing them for greater yield in domestic securities. This bidding up of domestic securities be imputation beneficiaries reduces the desirability of domestic assets to foreign investors.

By comparing the imputation to the non-imputation scenario we calculate the market value of a distributed imputation credit θ. We find that the market value of imputation credits is increasing in level of imputation tax benefit.

In reality, the Australian market is a small fraction of the world market. As yet, we have only explored the case of equal initial endowments between the economies. By using a simplifying CARA utility function we forgo the ability to endow investors with varying initial wealth. Investors with CARA utility are indifferent to starting wealth—always leveraging themselves to the same asset holdings by shorting the risk free asset. We intend to relax the assumption of CARA utility, initially allowing power CRRA utility, and ultimately arbitrary utility functions. This will allow a strongly asymmetric wealth distribution with foreign investors having a much greater initial wealth.

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Tables and Figures

Table 1

Integrated market assets.

	Domestic		Foreign	
	Expected Payoff	S.D	Expected Payoff	S.D.
1	1.08	0.03	1.08	0.03
2	1.1	0.0425	1.1	0.0425
3	1.12	0.055	1.12	0.055
4	1.14	0.0675	1.14	0.0675
5	1.16	0.08	1.16	0.08

Table 2

Integrated market investors.

	Domestic	Foreign
Risk Aversion	Initial Wealth	Initial Wealth
0.8	100	100
0.9	100	100
1	100	100
1.1	100	100
1.2	100	100

Table 3

Integrated market equilibrium. Risk-free equilibrium price 1.0000, return 5.00%. MRP world 7.42% domestic 7.42% foreign 7.42%.

	Price	Ret	β_w	$\beta_{\{D,F\}}$	MktCap
Domestic 1	0.996	8.48	0.469	0.469	89.6
2	0.998	10.2	0.707	0.707	89.8
3	0.998	12.2	0.972	0.972	89.8
4	0.997	14.4	1.27	1.27	89.7
5	0.993	16.8	1.59	1.59	89.4
Foreign 6	0.996	8.48	0.469	0.469	89.6
7	0.998	10.2	0.707	0.707	89.8
8	0.998	12.2	0.972	0.972	89.8
9	0.997	14.4	1.27	1.27	89.7
10	0.993	16.8	1.59	1.59	89.4

Table 4

Integrated market investor utility.

Risk Aversion	Utility	Cashflow	Risk	Long Barrier	Short Barrier	Risk-free
Domestic 0.8	109	123	-4.08	0	0	-10.3
0.9	109	110	-3.62	0	0	2.52
1	108	98.8	-3.26	0	0	12.8
1.1	108	89.8	-2.96	0	0	21.1
1.2	108	82.3	-2.72	0	0	28.1
Foreign 0.8	109	123	-4.08	0	0	-10.3
0.9	109	110	-3.62	0	0	2.52
1	108	98.8	-3.26	0	0	12.8
1.1	108	89.8	-2.96	0	0	21.1
1.2	108	82.3	-2.72	0	0	28.1

Table 5

Partially segmented market equilibrium. Asset and investor setup is the same as integrated case expected domestic investors experience a penalty of 5% on gross foreign payoffs. Risk-free equilibrium price 1.0000, return 5.00%. MRP world 8.78% domestic 8.88% foreign 8.72%.

	Price	Ret	β_w	$\beta_{\{D,F\}}$	MktCap
Domestic 1	0.996	8.48	0.463	0.601	89.6
2	0.998	10.2	0.699	0.906	89.8
3	0.998	12.2	0.961	1.25	89.8
4	0.997	14.4	1.25	1.62	89.7
5	0.993	16.8	1.57	2.04	89.4
Foreign 6	0.981	10.1	0.47	0.346	88.3
7	0.974	12.9	0.715	0.493	87.7
8	0.971	15.3	0.987	0.782	87.4
9	0.969	17.6	1.29	1.16	87.2
10	0.966	20.1	1.61	1.58	86.9

Table 6

Partially segmented market investor utility.

Risk Aversion	Utility	Cashflow	Risk	Long Barrier	Short Barrier	Risk-free
Domestic 0.8	108	95.3	-3.06	-1.31	0	17.2
0.9	108	84.7	-2.72	-1.16	0	26.9
1	107	76.2	-2.45	-1.05	0	34.7
1.1	107	69.3	-2.22	-0.952	0	41.1
1.2	107	63.5	-2.04	-0.873	0	46.4
Foreign 0.8	111	152	-5.82	0	0	-35
0.9	110	135	-5.17	0	0	-19.4
1	110	121	-4.65	0	0	-7
1.1	109	110	-4.23	0	0	3.18
1.2	109	101	-3.88	0	0	11.7

Table 7

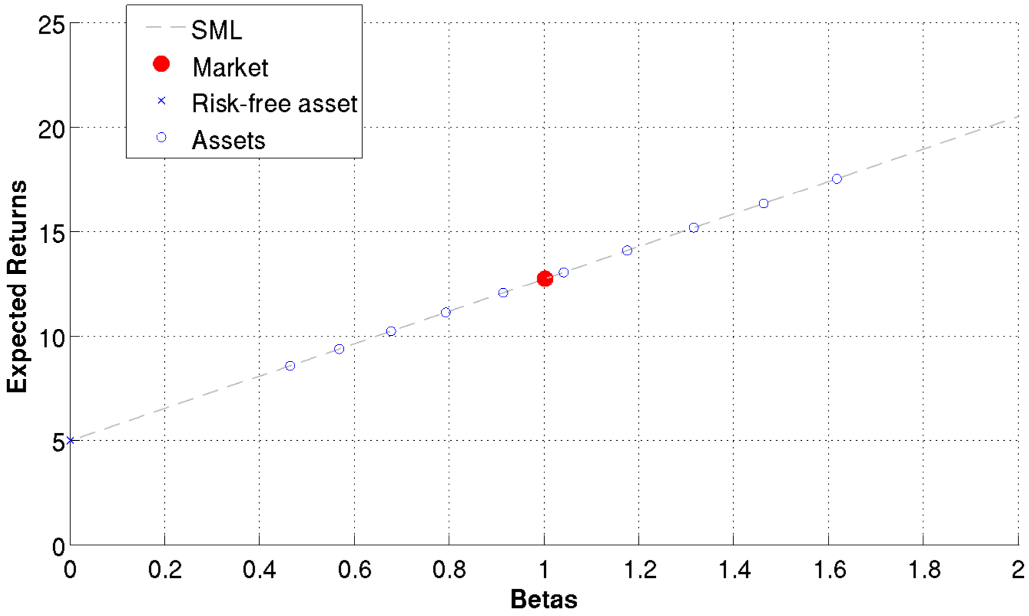
Integrated market equilibrium with **imputation**. Asset and investor setup is the same as integrated case expected domestic investors experience a rebate of 3% on long domestic payoffs while all investors experience a penalty of 3% on short domestic payoffs. Risk-free equilibrium price 1.0000, return 5.00%. MRP world 6.48% domestic 5.86% foreign 7.36%.

	Price	Ret	β_w	$\beta_{\{D,F\}}$	MktCap
Domestic 1	1.02	6.38	0.464	0.529	91.4
2	1.01	8.54	0.702	0.786	91.2
3	1.01	10.4	0.965	1.01	91.3
4	1.01	12.6	1.26	1.26	91.2
5	1.01	14.9	1.58	1.54	90.9
Foreign 6	0.996	8.48	0.473	0.403	89.6
7	0.998	10.2	0.713	0.607	89.8
8	0.998	12.2	0.98	0.835	89.8
9	0.997	14.4	1.28	1.09	89.7
10	0.993	16.8	1.6	1.36	89.4

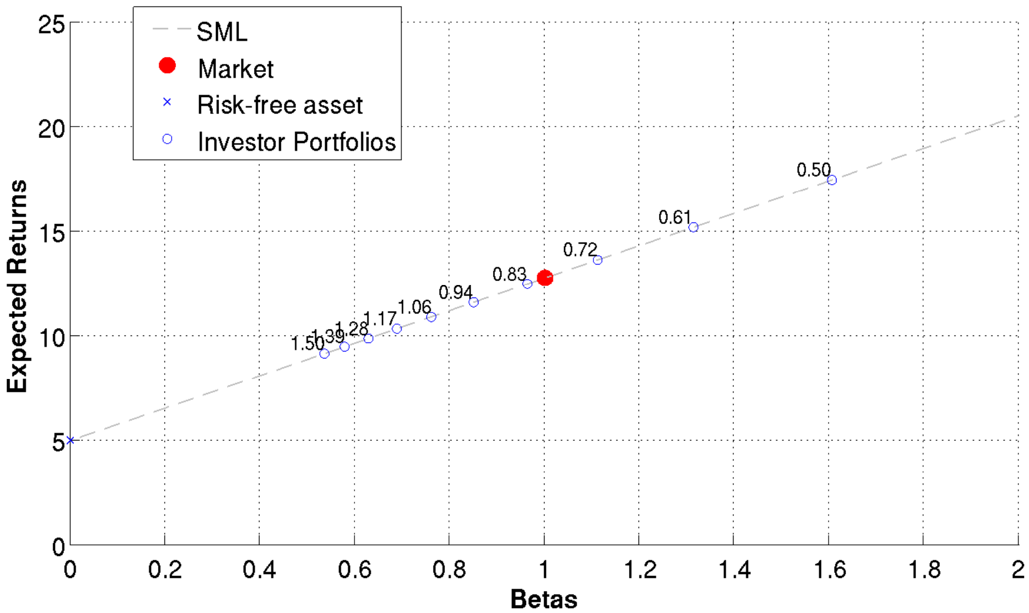
Table 8

Integrated market investors utility with **imputation**.

Risk Aversion	Utility	Cashflow	Risk	Long Barrier	Short Barrier	Risk-free
Domestic 0.8	110	144	-5.12	2.62	0	-31.6
0.9	110	128	-4.55	2.33	0	-16.4
1	109	115	-4.1	2.09	0	-4.24
1.1	109	105	-3.72	1.9	0	5.69
1.2	108	96.1	-3.41	1.75	0	14
Foreign 0.8	108	103	-3.37	0	0	9.02
0.9	108	91.3	-2.99	0	0	19.7
1	108	82.2	-2.69	0	0	28.2
1.1	107	74.7	-2.45	0	0	35.2
1.2	107	68.5	-2.24	0	0	41

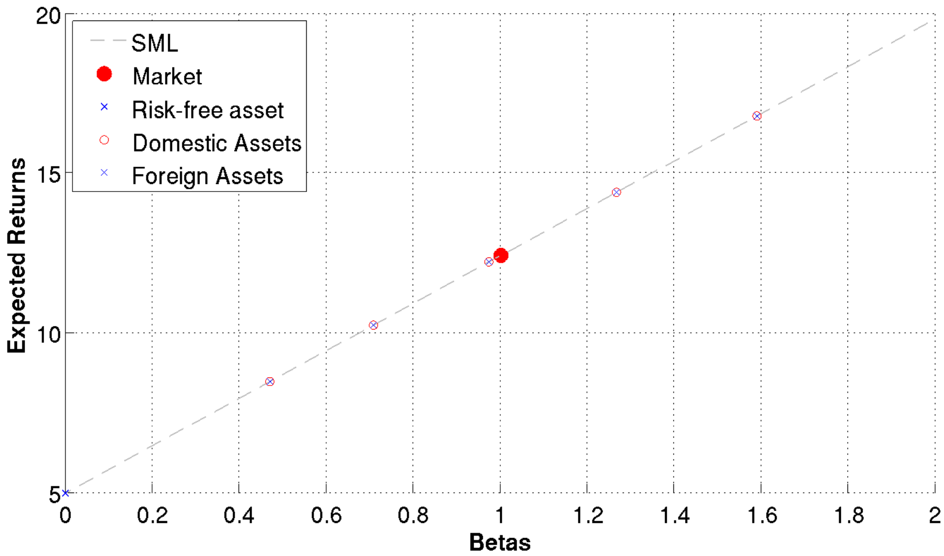


(a)

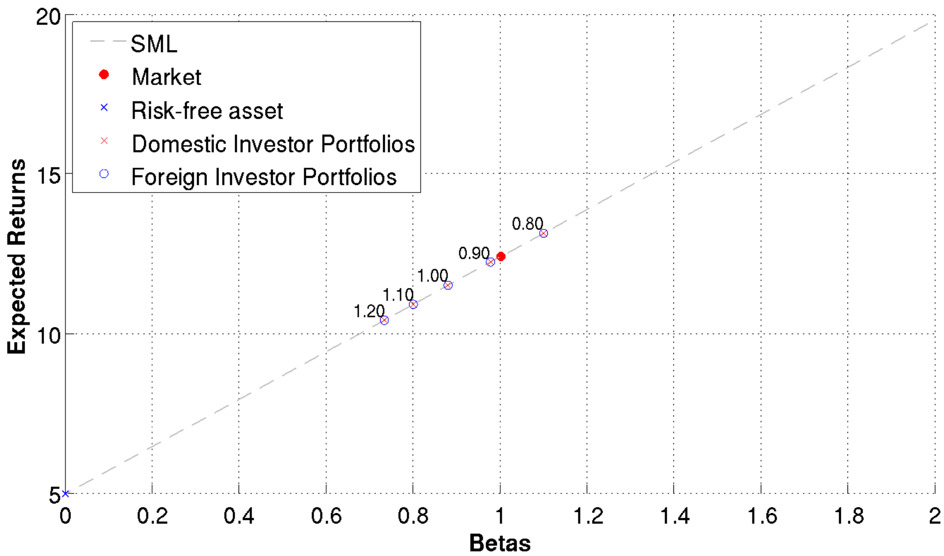


(b)

Fig. 1. (a) Asset returns and (b) Investor portfolio returns against market β for ten investors $N = 10$ and ten assets $N = 10$ with expected terminal cash flows and standard deviations of these cash flows varying linearly from 1.08 to 1.16 and 0.03 to 0.08 respectively. All risky assets asset have a fixed supply of 100 units and an initial price of 1 per unit. The risk-free asset is in unlimited supply with a price of 1 and certain payoff 1.05. Investors are each endowed with 110 units of initial wealth. The labels on (b) are investor's risk aversions λ.

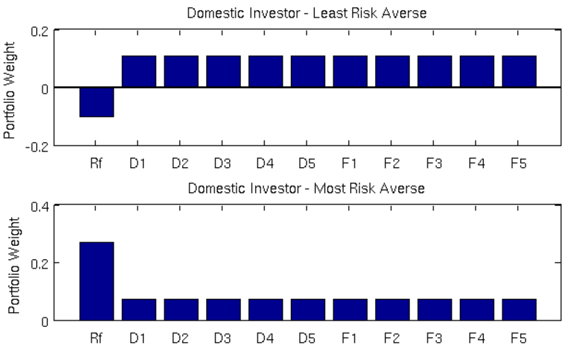


(a)

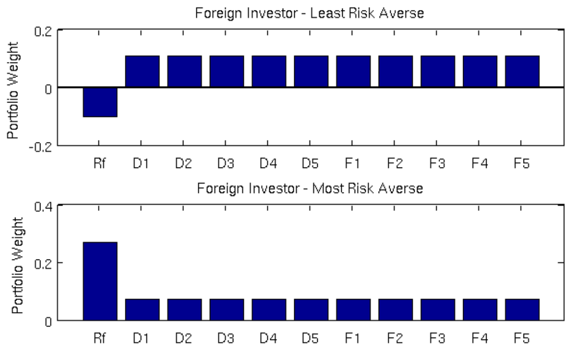


(b)

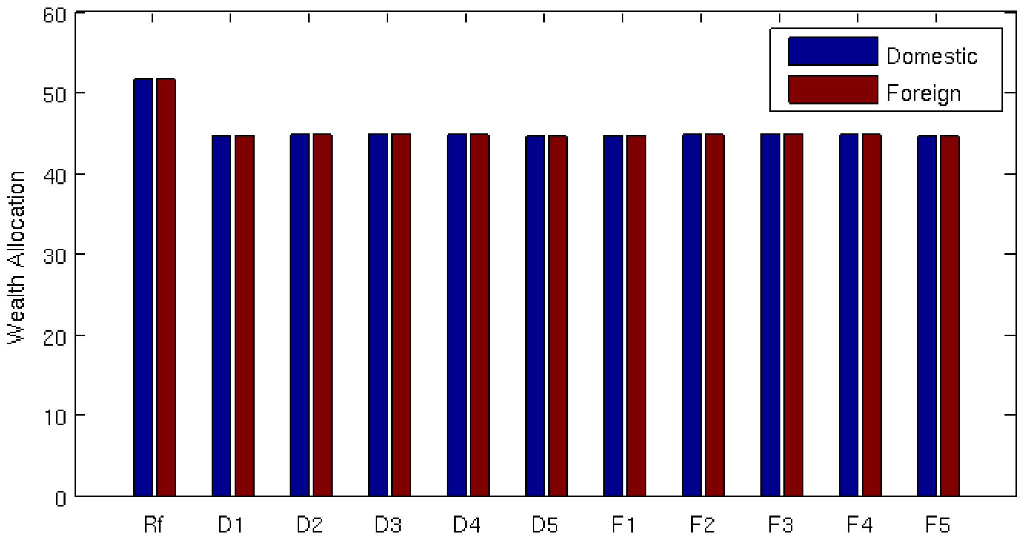
Fig. 2. (a) Asset returns and (b) Investor portfolio returns against world market β for five domestic $K_D = 5$ and five foreign $K_F = 5$ investors. The kth domestic and kth foreign investors share the same risk tolerance. The world economy contains five domestic $N_D = 5$ and five foreign $N_F = 5$ assets. The nth domestic and nth foreign asset have identical terminal cash flow distributions. Expected returns and standard deviations vary linearly from 1.08 to 1.16 and 0.03 to 0.08 respectively. All terminal cash flows within an economy are pair-wise correlated at 0.3; terminal cash flows across economies are correlated at 0.1. There are no investment barriers—investors face no penalty for holding long or short positions in their opposing economy. The labels on (b) are each investor's risk aversion λ.



(a) Domestic Investor Weights

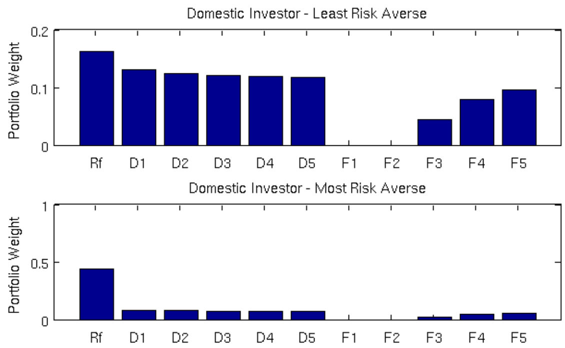


(b) Foreign Investor Weights

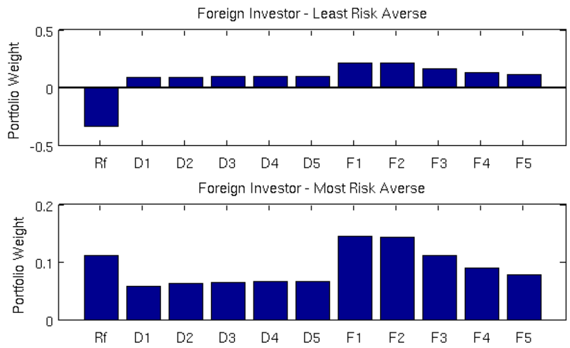


(c) Net Investor Holdings by Domicile

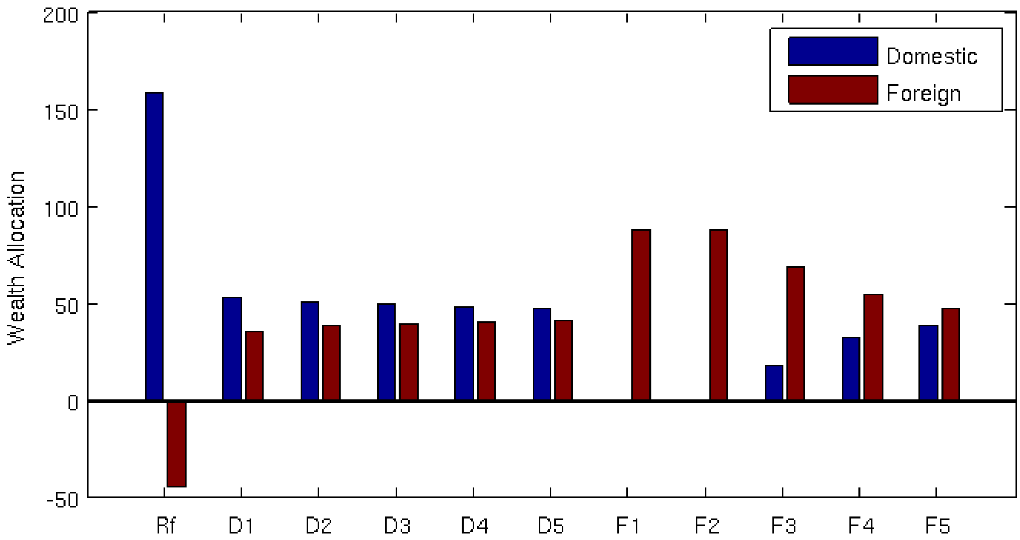
Fig. 3. Equilibrium asset allocations for **integrated markets**. (a) and (b) show portfolio weights of least and most risk averse investors in the domestic and foreign market respectively. (c) shows the net wealth allocated to each asset grouped by domiciled economy.



(a) Domestic Investor Weights

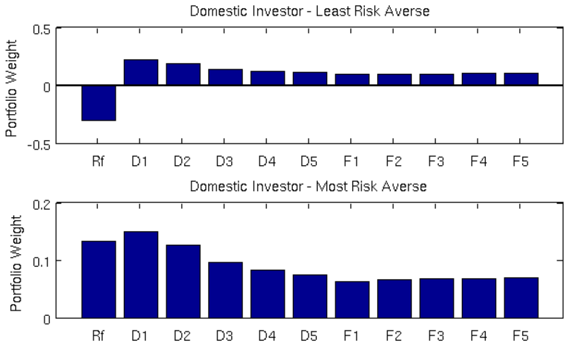


(b) Foreign Investor Weights

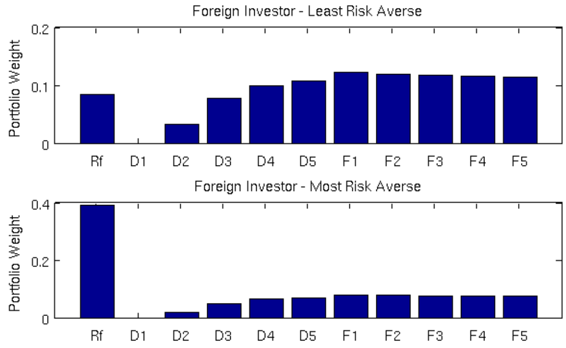


(c) Net Investor Holdings by Domicile

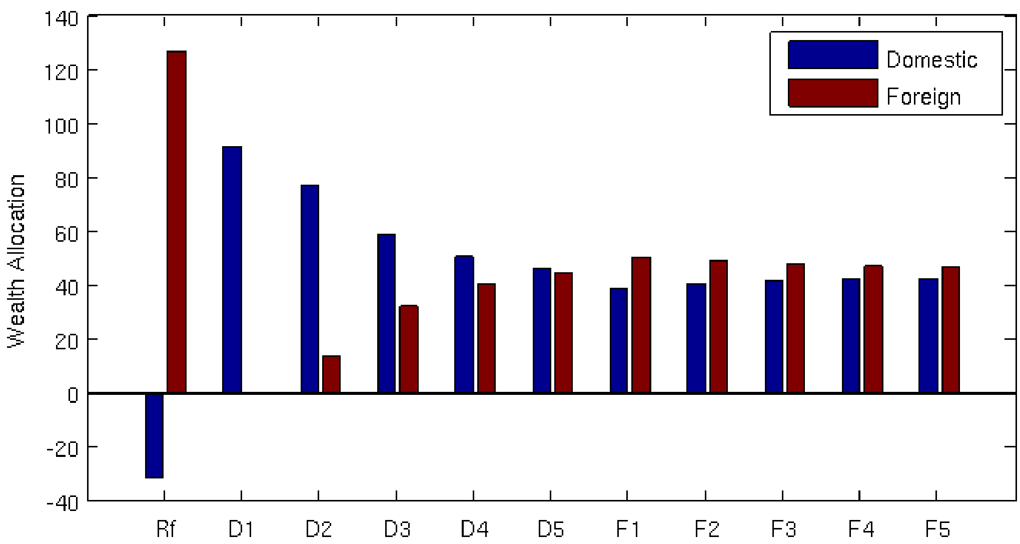
Fig. 4. Equilibrium asset allocations for **partially segmented markets**. (a) and (b) show portfolio weights of least and most risk averse investors in the domestic and foreign market respectively. (c) shows the net wealth allocated to each asset grouped by domiciled economy.



(a) Domestic Investor Weights



(b) Foreign Investor Weights



(c) Net Investor Holdings by Domicile

Fig. 5. Equilibrium asset allocations for partially segmented markets **with imputation**. (a) and (b) show portfolio weights of least and most risk averse investors in the domestic and foreign market respectively. (c) shows the net wealth allocated to each asset grouped by domiciled economy.

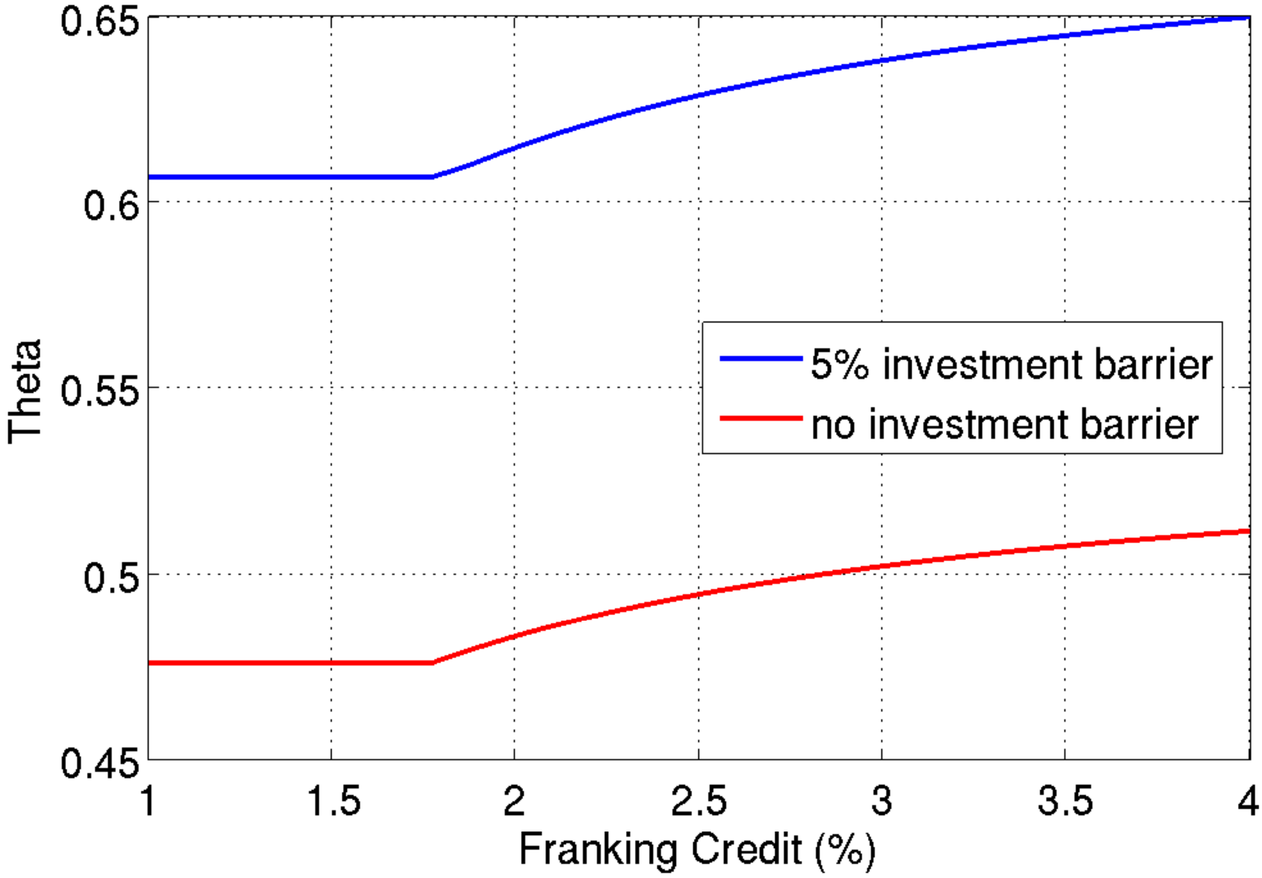


Fig. 6. Market's implied value of franking credits θ for different levels of imputation in both integrated (no barrier) and partially segmented (5% investment barrier on opposite-economy holdings) markets.