Conditions for the Usage of Multiple Media of Exchange[*]

Denver M. Casey**

Abstract

A modified Kiyotaki & Wright type model is used to consider the conditions necessary for the acceptance of multiple media of exchange in an economy. The model is extended so that there is a cost of using a medium that can be mitigated and a cost that cannot. The extended model is then empirically tested with the results lending moderate support.

Keywords: competitive monies, currency substitution, multiple media of exchange

*JEL Classification***:** E40, E49, E59, F39, G18

[*] A version of this article appears in *EON Journal of Arts, Humanities and Social Sciences*. 1, no. 3 (Aug): 1-19. The only substantial difference is that article uses Iterated Generalized Least Squares, whereas this one uses fixed effects panel regression with Driscoll-Kraay standard errors.

**Denver M. Casey, George Mason University, 4400 University Drive, Fairfax, Virginia 22030, E-Mail: dcasey3@gmu.edu

1. Introduction

Models of currency substitution typically focus on two currencies competing against each other for primacy, with co-circulation existing only as a knife-edge phenomenon (e.g., Giovanni & Turtelboom (1992), which surveys other currency substitution literature), or with an incomplete adoption of a competing currency (Luther, 2016). Yet in several situations, including cases of hyperinflation and small economies heavily reliant on tourism, significant and extended co-circulation of multiple currencies is observed. Here a general model that identifies the conditions under which several different currencies co-circulate, and conversely the conditions under which one currency dominates, is developed. The model is then empirically tested with significant but mixed results.

With the aim of constructing a model with differentiated goods and media of exchange, a circular spatial model of monopolistic competition akin to Salop (1979) is an attractive starting point. As Kiyotaki & Wright (1989, P.928, f.1) note, cash-in-advance models are useful for introducing the need for money into a model so that the questions relating to monetary matters can be discussed quicker. The search-theoretic style that those authors use (1989, 1993) is also appealing due to simplicity and tractability. Additionally, the framework produced by these authors can be easily applied to a model involving circular spatial properties. (1993, P.64, f.2) In the following sections a search-theoretic model similar to and combining elements of is constructed, along with elements from Salop (1979).

Hogan & Luther (2019) extend the works of Kiyotaki & Wright (1989,1991, 1993) by focusing on a setting where agents have a specific partner that they exchange with, but the actual good consumed is subject to some random element. In a similar vein, agents in the model developed below will have a set of trading partners they will be willing to trade with, which will then lead to a choice of currency for the potential trade. The partner that an agent meets in a period is subject to randomness. Since the purpose of this model is not to examine the genesis or continuance of a monetary equilibrium but rather the conditions under which multiple media of exchange equilibria can obtain, a cash-in-advance constraint is added so that monetary matters can be addressed.

2. Basic Model

Let there be $N = 2^n$ infinitely lived agents spaced evenly on the circumference of a circle, where n is an integer ≥ 2. Every agent i is endowed with indivisible good i, and produces this good after consuming, receiving the instantaneous utility u from consumption. Each agent has a most-preferred consumption good, k, produced by the agent exactly across from them on the circle. Agents receive utility from goods $j \neq k$ in proportion to the shortest distance on the arc between the two goods, given by $U = u - m$ where m (formally defined below) is the reduction in utility associated with the shortest distance between goods j and k as measured along the circumference of the circle. For completeness, assume agents receive zero utility from consuming their own production good.

Every period, agents are randomly matched with other agents. Agents can hold only one good at a time, and trading partners are anonymous; thus, credit transactions are precluded in this

scenario. All prices are unity as goods must be traded on a one for one basis. Assuming all agents have the same value for *u* and the same function m, then by construction either both parties will be willing to trade if $u > m$, or neither will be willing if $m > u$. For simplicity, assume that $m \neq u$ so that agents are never indifferent to a trade. Discussion of the effects of not trading on utility is deferred to the next session to avoid clutter.

Attention is now returned to the disutility of accepting less preferred goods, *m*. Formally, $m \equiv m(|j-k|), \Delta m/(\Delta|j-k|) > 0$, and $\partial U/\partial m < 0$. The function *m* describes how quickly utility diminishes as agents accept less desired goods, and in doing so determines the percentage of the circle of goods agents are willing to trade for. Ceteris paribus, an increase in m implies agents are less willing to accept less desired goods, and vice versa. It is important to note that for sufficiently small values of n, a change in m may not increase or decrease the number of acceptable trade opportunities. This is because, by construction, agents are evenly spaced along the circle, with the distance between any agent and its closest neighbors given by $2\pi/2^n$, and each unit increase in *n* decreases this distance by exactly half. Thus, while changes in *m* always affect the intensive margin regarding utility derived from close substitutes, the extensive margin (where goods are marginally accepted or declined) is not necessarily changed enough to include or exclude partners as the distribution of agents is not necessarily continuous. Only as $n \to \infty$ does a marginal decrease in m assure new acceptance of goods.

Now suppose that there is a technology d available that allows agents to reduce the utility cost of imperfect goods such that $U = u - dm - 1/d$, where $0<d<1$. For now, we can think of the goods as specific types of food and the technology as spices and seasonings; an agent may crave a certain type of food, say a hamburger, but is willing to accept a close enough substitute, perhaps a hotdog. Investment into the technology, which in this imagined scenario may be condiments, increases the utility of consuming less preferred goods. For simplicity, the "perfect" good is exactly what the agent craves and cannot be improved upon. A lower value of *d* increases utility by reducing the penalty from accepting an imperfect good, but also decreases utility thanks to the last term, which can be considered the cost of the investment into the technology. The first order condition is given by $0 = -m + 1/d^2$ which implies $d = 1/\sqrt{m}$. The second order condition is $-(2/d^3) < 0 \forall d > 0$. To simplify matters, assume that agents need not invest if they do not want to so that $d=1$ is defined so that it reproduces the original utility function.

$$U \equiv \begin{cases} u - dm - (1/d), & 0 < d < 1 \\ u - m, & d = 1 \end{cases}$$

The specification of $0 < d < 1$ and the cost of the investment as $1/d$ prevents normalizing u to 1 as any valid value of d will result in negative utility. Instead, *u* will be considered as a percentage and normalized to 100.

Agents now face the utility maximization problem $\max_d \mathrm{E}U = \mathrm{E}(u - dm - 1/d)$. Since *u* is constant and *d* is a choice variable, the only expectation agents have is the disutility from accepting a less preferred good from a potential trading partner, *m*. By construction, there is always 1 potential trading partner holding good *k* that will produce no disutility from trade ($m=0$). The probability of meeting an agent such that $u > dm + 1/d$ is dependent on *n*, as previously discussed. Defining *x* as the percentage expressed as a decimal of the circle containing acceptable substitute goods, the number of agents that have such a good is given by $2\lfloor Nx \rfloor$and the odds of an agent meeting one of these agents for trade is given by $2\lfloor Nx \rfloor/(N-2)$, where $\lfloor Nx \rfloor$ is the largest integer not greater than Nx. Assuming agents are aware of the odds of

being paired with a partner with an acceptable good and how much utility a specific good provides, then it follows that agents will be able to correctly decide if and how much of an investment into the technology to make.

3. Modifying the Model

So far, the model has not dealt with monetary matters, relying instead on double coincidences of want. This section modifies the model with the eventual goal of accounting for multiple simultaneous currencies. Let $N/2$ agents be initially endowed with one unit of a specific indivisible currency instead of their production good. Agents holding currency will be referred to as "buyers", and agents holding real goods will be referred to as "sellers". Furthermore, assume that buyers are always matched with sellers, and vice versa, so that all exchanges are currency for real goods. Lastly, assume the technology *d* discussed earlier is available only to sellers.

The model now exhibits a cash-in-advance constraint. Because a seller can only consume if they first acquire currency, thereby becoming a buyer in the next period, they are always willing to trade. On the other hand, a buyer may not be willing to trade even if the good in question yields positive utility, as the expected utility from waiting a period and potentially being offered a more desired good could exceed the utility from buying immediately. Because a buyer that fails to trade in one period remains a buyer in the next, buyers now face

$$U_{\mathrm{B}} \equiv \max_{I} U = I_t(u - m_j) + I_n \mathrm{E} \sum_{t=1}^{\infty} \beta^t (u - m_v^t) \tag{1}$$

where *I* is an indicator variable equal to 1 if the seller takes an action (in this context, trading or not trading) and equal to 0 if not, the subscripts *t* and *n* indicating trade or not trading respectively, and β is the inter-temporal discount rate between zero and one. The good offered this period, *j*, is not necessarily the same good offered in the next period, *v*, but it is a possibility, the probability of which is again based on the number of agents, *N*. The specification that units of currency are indivisible removes the possibility of price competition from the model. While this may seem odd, it is not a new assumption for a model of this type, (for example, see Kiyotaki & Wright (1993, p.64-5)) and simplifies the analysis significantly. A way of introducing inflation is considered later.

4. Multiple Media of Exchange

Now let initial buyers be endowed with one of $M > 1$ types of currency. One of these currencies, M_D, is the domestic currency while all others are various types of foreign currency, M_i where $i \neq D$. The domestic currency is defined as imposing no cost upon sellers while foreign currencies do impose such a cost; that is, $m_D = 0, m_i > 0, i \neq D$, and $(M_D^N + \sum_1^{i \neq D} M_i^N = M_k^N = N/2)$. This cost can be thought of as a transaction cost stemming from dealing with an unfamiliar currency. It could be the time and effort having to "translate" a price for exchange rates, or any number of "psychic disutility" causing considerations.

Sellers must now consider the cost of accepting foreign currency, the cost and benefit of technology *d*, and the probability of future buyer offers and future seller acceptance of foreign

currency. An important feature of the model is that sellers must decide to invest in technology *d* before each meeting with a buyer, when the currency to be offered is unknown. Formally, sellers now face two utility maximization problems in sequential order:

$$\max_{d} \mathrm{E}[\beta U_{\mathrm{B}} - (dm_k + 1/d)] \tag{2}$$

and then

$$\max_{I} \mathrm{E}[\, I_t(\beta U_{\mathrm{B}} - dm_k - 1/d) + \, I_n(-1/d + \left[\sum_{t=1}^{\infty} (\beta^{t+1} U_{\mathrm{B}} - \beta^t (d_t m_k^t + 1/d_t))\right])] \tag{3}$$

So far, the investment into technology *d* by sellers is likely to be quite low given that the domestic currency has no utility cost in acceptance by definition. This assumption is now modified so that both m_D and $m_i \geq 0$. Additionally, the disutility from accepting a particular currency is now specified as $m_k \equiv \, m_k^{\text{verify}} + \, m_k^{\text{other}}$; the first term is the cost of verifying the authenticity of currency *k* while the latter term is a vector of all other costs associated with the currency. These other costs can include any multitude of factors that would cause a seller to hesitate to accept the currency in question that cannot be alleviated by the technology. This can include a chronic depreciation relative to other currencies, or perhaps a highly volatile exchange rate, or even the aforementioned "wrong" national heroes, etc. Further, assume that while the verification and other costs of foreign currency are non-negative, the verification cost for the domestic brand is strictly zero. ($m_k^{\text{verify}}, m_k^{\text{other}}$, and $m_D^{\text{other}} \, \geq 0; \, m_D^{\text{verify}} = 0$) Lastly, assume technology *d* is only available for verification costs.

Initially, use of the domestic currency was optimal as it imposed no utility cost upon sellers. As m_D^{other} increases relative to m_i^{other}, foreign currencies gain attractiveness to sellers as m_i^{verify} can be reduced by investment into technology *d*. That is, as the total cost of using the domestic currency increases, foreign currencies on the margin become relatively less costly. Given that the optimal level of $d = 1/\sqrt{m_i^{\text{verify}}}$ from the first order condition, this implies that the domestic currency will enjoy indifference from sellers only if $m_D^{\text{other}} = \, m_i^{\text{other}} + 2\sqrt{m_i^{\text{verify}}}$. Assuming this equality holds implies $\partial m_D^{other} / \partial m_i^{verify} = 1/\sqrt{m_i^{verify}} = d$; that is, to keep indifference, the increase of the other costs of accepting the domestic currency is bound by investment into the verification cost reducing technology. As investment into the technology increases (which lowers the value of *d*), the other costs involved in using the domestic currency are increasingly constrained. An entity only concerned with the circulation of the domestic currency (i.e., the issuer) will have to reduce the other costs of using the domestic currency in proportion to the amount of investment into the verification cost reducing technology to ensure continued circulation, barring some exogenous intervention (e.g., legal tender laws).

5. Extending the model

Now assume that sellers prefer a certain currency which depends on their production good such that sellers of goods that are close substitutes have similar preferences for currency, slightly echoing the setup in the original model where agents with similar production goods have similar tastes in consumption goods. This preference could manifest as an agent preferring a certain rate of inflation or deflation associated with a particular currency, such as in Engineer (2000), where one currency serves as a better store of value relative to another. It could be that the level of income and composition of purchases between foreign and domestic goods is a deciding factor, as shown in Seater (2008). In networking externality literature, the preference could be expressed as, or a result of, some non-network benefit (White, 2002). The preference could be something as simple as an aesthetic preference for the design of the currency, what matters in the present context is that there exists a preference that is not related to acceptance.

A seller's preference for real goods, however, is a random point on the circle with only the assumption that an agent's production good still yields no utility to the agent if consumed. Let the preference for currency *k* by seller *q* be shown as $m_{k\leftarrow q} \equiv m_{k\leftarrow q}^{\text{other}} + dm_k^{\text{verify}} + 1/d$, where $m_{k\leftarrow q}^{\text{other}} = 0$ and any other currency $i \neq k$ as $m_{i\leftarrow q}^{\text{other}} > 0$. Lastly, buyers now have the option to incur a utility loss to change which currency they are holding before they meet for the trade. This option gives buyers a two-step utility maximization problem similar to the problems faced by sellers,

$$\max_I \mathrm{E}[I_s^k(u - m_j - s) + I_{ns}^i(u - m_j)] \tag{4}$$

followed by the buyer's original problem,

$$\max_I U = I_t(u - m_j) + I_n \mathrm{E} \sum_{t=\mathrm{i}}^{\infty} \beta^t (u - m_v^t), \tag{5}$$

where the subscripts *s* and *ns* stand for the choice to swap currency or not, respectively; the superscripts denote which currency is to be brought to the meeting by the buyer, and the variable s is the utility cost of changing from one currency to another; all other symbols have the same meaning as before.

The seller's second problem is only slightly modified, taking the form of

$$\max_{I} \mathrm{E}\{\, I_t \left[\left(\beta U_B^s - d m_k^{\text{verify}} - m_k^{\text{other}} - 1/d\right) + \left(\beta U_B^{ns} - d m_k^{\text{verify}} - m_k^{\text{other}} - 1/d\right)\right] + I_n \Bigg(- (1/d) + \left[\sum_{t=1}^{\infty} \left(\beta^{t+1} U_B^s - \beta^t \left(d_t m_k^{\text{verify}} + m_k^{\text{other}} + 1/d_t\right)\right) + (\beta^{t+1} U_B^{ns} - \beta^t \left(d_t m_k^{\text{verify}} + m_k^{\text{other}} + 1/d_t\right)\right)\right]\Bigg)\}, \quad (6)$$

Where U_B^s, U_B^{ns} is defined as the buyer's problem after deciding to incur the switching cost or not, respectively. Sellers must now take possible currency switching costs into account when deciding whether to trade with a buyer offering a specific currency. It should be remembered that the first step in the buyer's and seller's problem takes place before the meeting takes place. The buyer must decide whether to change currencies, and the seller whether and how much to invest, before the trading partner is known.

There are three possible cases when a seller is offered a currency in exchange:

1. iff $U_B^{NS} > U_B^S, I_N(\dots)$, then the seller accepts the currency with the intent of spending it in a subsequent period.
2. iff $U_B^S > U_B^{NS}, I_N(\dots)$, then the seller accepts the currency, but with the intention of incurring the switching cost before attempting to meet for trade in subsequent periods.
3. iff $I_N(\dots) > U_B^S, U_B^{NS}$, then the seller refuses the currency offered and attempts to sell again in the next period.

Figure 2 shows how m_d^{other} and $(m_i^{\text{other}} + m_i^{\text{verify}})$ interact to determine the number of currencies in an economy. If the issuers of the domestic currency increase the other cost of their currency (e.g., higher relative rate of inflation), this is shown by a rightward shift of the vertical m_d^{other} line, which is shown in the figure as a movement from m_d^{other} to $m_d^{\text{other}\prime}$, which increases the number of circulating currencies by two.

This model can help explain what is observed when a central bank inflates its currency faster than other countries. While this model abstracts from prices and therefore inflation, inflation can be thought of falling into the other costs associated with using a currency. As relative inflation continues, this pushes the vertical m_d^{other} line to the right, which would imply that people will be increasingly likely to turn to other currencies, ceteris paribus. To combat this switch to other currencies, a government may try to offset the change in relative costs by reducing the cost of using the domestic currency via public receivability or legal tender laws; conversely, the government could increase the verification costs (say, by only allowing domestic currency in banking) or some aspect of the other costs associated with foreign currency. A government that is successful in pushing the $(m_i^{\text{other}} + m_i^{\text{verify}})$ line out as quickly as the other costs associated with the domestic brand could keep foreign currencies from circulating even

when hyperinflation is so bad as to warrant a return to barter. In observed cases of hyperinflation, however, foreign currencies almost always do begin to circulate.

6. Comparative Static Analyses

With the costs of using a particular currency considered in the preceding sections, attention is now turned to the effects the remaining exogenous variables have on the predictions of the model. To what extent accepting a less preferred good diminishes utility (i.e., how "choosy" buyers are in consumption) is given by *m* in the basic buyer's utility function, $U = u - m_j$. Since *m* is defined as how much disutility an agent suffers from consuming a less preferred good, being less "choosy" decreases *m* and increases *U* when accepting anything other than the agent's ideal good. This implies that a lower value for *m* leads to buyers being more willing to buy both in the intensive and extensive margins. That is, ceteris paribus, buyers are more willing to incur a switching cost and are willing to buy from more sellers.

In context of accepting different currencies, changes in *m* take on a different meaning. The preceding sections dealt with changes in the verification cost of accepting "foreign" currencies, m^{verify}, where it was shown that a decrease in the verification cost would lead to an increase in the number of circulating currencies, ceteris paribus, and vice versa. Changes in the other costs of accepting currency, m_d^{other} and m_i^{other}, are similarly intuitive. A decrease in the other costs of accepting the domestic currency would, all else constant, lead to a reduction in the number of currencies accepted. Conversely, a reduction in the other costs of accepting a foreign currency leads to an increase in the number of circulating currencies. In cases where both foreign and domestic currencies experience a simultaneous increase/decrease in other costs, the outcome is ambiguous. In theory, an identical change in the other costs for the domestic and foreign currencies would exactly offset and leave the number of circulating currencies unchanged; realistically, this is an unlikely coincidence.

Changes in *n* have some surprising implications. Recall that the number of agents, *N*, is defined as $N = 2^n$, where *n* is an integer greater than or equal to 2. By assumption, agents are evenly distributed along the circle or real goods arc. As before, beginning the analysis with the barter model and then considering the currency model will be easiest. From the view of any agent, every increase in *n* creates two new producers of goods that are closer substitutes for their preferred consumption good, two new producers of goods that are closer substitutes for their production good (which, by assumption, produces no utility in consumption), and the rest of the new agents producing goods varying between these two extremes. Since the disutility of accepting imperfect substitute goods, *m*, is based on the shortest distance between the most preferred good and the offered alternative, |*j*-*k*|, the expected distance for an agent at the start of a period is given by

$$\mathrm{E}(|j-k|) = 0 + (2/(N-1))\,(\pi/(N-2)) + (2/(N-1))\,(2\pi/(N/2)) + \cdots$$
$$+ (2/(N-1))\,(((N/2)-1)\pi)/\,(N/2) = (\big((N/2)-1\big)\pi)/(N-1)$$

$$\text{As } n \to \infty, \mathrm{E}(|j-k|) \to \frac{\pi}{2} \tag{8}$$

Conversely, the minimum number of agents, *N*=4, yields an expected distance of $\pi/3$. Comparing these findings indicates that *m* increases with *n*, and thus utility decreases with an increase in population. This is because, by construction, there is exactly 1 possible trading partner that has the most preferred good for each agent. Increasing the population by one increment has two effects; first, there is one new agent placed exactly halfway between each previous agent. This means that there are two new agents that are placed closer to a most preferred good than before, but also two new agents that are placed further than before. The placement of the agents exactly offset. Second, because the chance of an agent being randomly matched with their perfect trading partner is $1/(N-1)$, an increase in population therefore reduces the chance that these two will be randomly matched; however, each unit increase of n has a smaller effect than the increase before it. Formally, $\partial U/\partial n < 0, \partial^2 U/\partial n^2 > 0$.

There is one exceptional case worth noting. If the number of agents is quite small, it is possible that an agent and all potential trading parties (that is, all agents that produce a good for which the agent in question would receive positive utility from consuming) are randomly endowed with currency. In this case, no trade would take place. As such, an increase in *n* (and thus *N*) would increase utility, albeit temporarily, as new potential partners with a chance of holding real goods are introduced.

7. Econometric Model

The model being considered takes the form of $p = \alpha + \beta_1 q + \beta_2 \text{verification}_{\text{FC}} + \beta_3 \text{other}_{\text{FC}} + \beta_4 \text{other}_{\text{DC}}$, where *p* is the probability or proportion of sellers accepting a foreign currency, *q* is the probability or proportion of buyers offering a foreign currency, and the other variables are as previously discussed. The data used to estimate the model is panel data, described in further detail below. The data suffers from cross-panel heteroskedasticity, but not autocorrelation. To account for this, the model is estimated using fixed effect panel regression, corrected for cross-panel heteroskedasticity by using Driscoll-Kraay (1998) standard errors. This method for correcting cross-panel heteroskedasticity is taken from Hoechle (2007).

The values of sellers and buyers using foreign currency, *p* and *q*, are not directly observable. As such, proxy variables are used, with differing dependent variables proxying for *p* and differing measures of trade proxying for *q*. It is assumed that there is a linear relationship between a proxy and the variable of interest such that $p = \lambda_w(\text{proxy})_w, \lambda > 0 \forall \text{w}$, and similarly for *q*. Verification and Other costs are estimated using measures of economic freedom and rates of inflation, respectively, and are detailed below.

8. A note about Cryptocurrencies

With the collapse of the cryptocurrency exchange FTX in late 2022, the debate of whether any specific cryptocurrency, or cryptocurrencies in general, qualify as “money” will almost certainly continue for an extended time. While an in depth look at the mechanics of cryptocurrencies is far beyond the scope of this paper, excellent primers on the economics and inner workings of Bitcoin, the preeminent cryptocurrency, as well as discussion on if it qualifies

as “money”, can be found in Murphy (2013), Luther & White (2014) and more recently in Hazlett & Luther (2020).This debate is not pertinent to this article as one of the following statements must be true:

1. A specific cryptocurrency, or cryptocurrencies in general, is/are not money. If this is the case, there is no need for further discussion for obvious reasons.
2. A specific cryptocurrency, or cryptocurrencies in general, is/are money. In this case, the crypto(s) in question are treated as any other currency in the model and no special proviso is warranted.

9. Data Description

The data consists of 55 countries from the years 2001-2018, inclusive. All data comes from the World Bank, except for the figures for freedom indices, which come from the Heritage Foundation and the Fraser institute. For robustness, the model has been estimated using five dependent variables, three measures of trade, and five specifications of freedom, for a total of 75 regressions. Exact definitions and methodology of collection for the variables are available from the respective organizations’ websites. Summary descriptions are available in the appendix. While data on cryptocurrencies would be an exciting addition, the anonymous nature precludes the ability to integrate with national level data at any meaningful amount.

10. Model Predictions

Ceteris Paribus, the model predicts that a higher percentage of buyers offering foreign currency would lead to more sellers willing to accept to become buyers themselves sooner; thus, the coefficient associated with the proxy variables for q (the probability or proportion of buyers offering a foreign currency) should be positive. As the variable “inflation difference” increases, the inflation in the country increases relative to the United States. Assuming people prefer relatively stable currency to a relatively inflating one, there should be a positive correlation between this variable and the dependent proxies.

The variables being used to proxy for verification costs do not all share a common interpretation. Financial freedom measures, among other things, financial development, and as such should have a positive coefficient since a more developed and freer financial system will be able to handle foreign currency with less transaction costs. The other criteria included in this measure likely are positively correlated and will reinforce the positivity. Trade freedom, intuitively, should be positively correlated with the amount of international trade for a given country and should be positive. To the extent that Trade freedom and proxies for trade are correlated, there will likely be some downward biasing in an absolute sense in the respective coefficients. Monetary freedom shares a similar correlation problem to that found in Trade freedom in that the bulk of this index is concerned with inflation, which is already accounted for by the inflation differential independent variable; however, this freedom index does consider previous year’s inflation and price controls which are ignored by the inflation differential. The coefficient for Trade freedom should be negative, as the removal of price controls and domestic inflation would, in theory, make foreign currency less attractive to agents. The effects of Investment freedom may not be intuitive. On one hand, relaxing foreign exchange controls and screening of foreign investment should, in theory, increase the acceptance of foreign currency since this would ostensibly increase the number of agents offering foreign currency and reduce switching costs. On the other hand, reducing barriers to domestic investment would, to the extent

that investment at home is preferred to investing abroad, increase the relative amount of agents willing to accept the domestic currency and thus could reduce the number of buyers offering foreign currency, q.

The Fraser Institute specifications have three variables of interest. Freedom to Trade Internationally is likely positively correlated with exposure to foreign currency, and as such should have a positive effect on the dependent variables. The Sound Money variable has been adjusted to remove the Freedom to Own Foreign Currency subcategory, which is viewed separately. The other components of the Sound Money variable rate a country on the rate and volatility of inflation, the more stable the currency, the higher the score. Obviously, a stable domestic currency should have a negative effect on the willingness of its citizens to accept foreign substitutes, ceteris paribus. The Freedom to Own Foreign Currency has a very intuitive predicted effect. One note of caution: This variable only takes on three values, 0, 5, and 10 for respective levels of freedom. The discontinuous and possibly unvaried nature of this measure could lead to an understatement of its effects in the data.

The remaining independent variables do not have definitive predictions from the model and are used for control and robustness purposes. That is, Economic freedom combines indices that are expected to have contrary effects, and Total freedom and Overall freedom add "non-economic" freedoms that the model takes no view on. The model is similarly agnostic about the effects of recession, real per capita income, size of government, Legal System & Property Rights, and Regulation.

11. Results and Discussion

The results of the 75 regressions are summarized in Tables 1 and 2, denoting how often, as a total percentage of the regressions the variable was used, a variable was found to be positive, negative, or insignificant at the 5% level. Real per capita income has mixed results. While the majority of regressions show no significance, there is a strong minority of positive correlations, especially in the Fraser Institute measures. It is interesting to note that this variable is always positively significantly correlated with Net Foreign Assets and Private Net Foreign assets (and almost always at the 1% level) but is always statistically insignificant in the percent of GDP and per capita measures.

The U.S. recession dummy is almost universally insignificant; it is interesting to note that when there is a significant correlation that it is exclusively positive and only when the dependent variable is per capita PNFA. Of the 15 regressions using this as the dependent variable, the three using Heritage Foundation measures and the percentage point change in trade proxy are the same three showing positive significance at the 5% level. If you include 10% significance, the additional two instances of significance are again in per capita PNFA.

Tourism is significantly positive in 60% of regressions of both Heritage and Fraser measures. An interesting pattern here is that it is always significant at the 1% level for NFA/GDP and PNFA/GDP, and 5% significant (or better) for per capita PNFA. Tourism is never significant for total values of NFA or PNFA, in stark contrast to real per capita income, discussed above. Trade as a percentage of GDP is less often significant, and only in the absolute levels of NFA and PNFA, similar to per capita income and converse to tourism. The percentage point change in trade as a percent of GDP is universally insignificant, even at the 10% significance level. This isn't an unexpected result as this measure's inclusion is

intended as a robustness check. Changes here should be, and appear to have been, already incorporated into the trade as a percentage of GDP specifications.

Total freedom, Economic freedom, and Overall freedom are mostly insignificant. When there is significance, Total freedom and Economic freedom are negative and only observed in regressions where per capita PNFA is the dependent variable, this holds true even if expanded to the 10% level. The Fraser Institute's version of Total freedom, Overall freedom, is statistically insignificant in all regressions at the 5% level. Interestingly, if 10% significance is considered, Overall freedom is negatively correlated with per capita PNFA, just like the Heritage measures, but is positively correlated with Net Foreign Assets, in all three regressions.

Investment freedom is only significant in regressions using NFA as a percent of GDP, negative at the 1% level once and at the 10% level the other two times. Trade freedom is strongly positive, significant at the 1% level for all three versions of NFA and PNFA, 1% significant for NFA as a percent of GDP using tourism and trade proxies, and 5% significance in the percentage point change in trade specification. If expanded to 10%, Trade freedom is also positive for all three PNFA as a percentage of GDP regressions. Trade freedom is insignificant for all standard levels of significance in relation to per capita PNFA. Financial freedom is unique in that it has both positive correlation and negative correlation. It is always significantly positive at the 5% level when NFA is the dependent variable, and always significantly negative, again at the 5% level, when per capita PNFA is the dependent variable. Expanding to 10% significance only adds one instance of negative correlation, that being PNFA as a percent of GDP using trade as a proxy. Monetary freedom is insignificant at all standard levels of significance for all regressions. The variable for inflation difference is found to be significant only in Fraser institute measures using Overall freedom and per capita PNFA, where it is negatively correlated. It is worth noting that inflation difference is positive at the 10% level in regressions where the Fraser institute measures are considered individually and NFA is the dependent variable. The variables for the Fraser institute's Size of Government and Legal System & Property Rights are almost always insignificant at all standard levels of significance (Size of Government is negative twice at the 10% level, both in regard to NFA).

In a striking reversal, the Fraser Institute's Freedom to Trade Internationally is significantly negative in 60% of regressions, contra to Heritage's Trade Freedom being positive in 60%. Whereas Heritage has positive significance for NFA, PNFA, and NFA/GDP specifications, Fraser has negative significance for NFA, PNFA, and per capita PNFA. The measures have a similar structure where more freedom implies a higher score, and vice versa. It is therefore not clear why they have opposing signs in regard to Net Foreign Assets and Private Net Foreign Assets. Regulation is positively correlated with NFA and PNFA in nearly every instance, falling to 10% significance once. It is insignificant in all other dependent variables. While there is predicted sign from the model, it is an interesting pattern none the less.

Lastly, the adjusted Sound Money and Freedom to hold Foreign Currency variables are almost completely statistically insignificant. There is a pattern of Sound Money being positively correlated with NFA at the 10% level, and one instance of Foreign Currency Freedom being negatively correlated with per capita PNFA at the 5% level. These few instances of significance are in opposition to model predictions, which are that Sound Money should be negatively correlated, and Foreign Currency Freedom should be positive.

12. Conclusion

The findings of the econometric estimations moderately align with the predictions of the theoretical model. An increase in the offers to use foreign currency is assumed to be positively correlated with an increase in tourism and international trade, and certain combinations of these proxies and dependent variables do show this expected effect.

On the other hand, the model predicts that an increase in the other costs associated with using the domestic currency should be correlated with an increase in the use of foreign currency. This would imply that the Inflation Difference variable should be positive, while Monetary Freedom and the adjusted Sound Money variables should be negative. Any evidence of the Inflation Difference being positive is tepid at best, with just as much evidence suggesting that the adjusted Sound Money is positive. There isn't enough evidence to suggest Monetary Freedom is signed either way. While Foreign Currency Freedom is also mostly insignificant, this is probably due to a lack of variation in this score, which is limited to three values (0, 5, or 10).

There is a case to be made that a significant amount of foreign currency transactions occur in unrecorded "black markets" and are the way that people prefer to increase the use of foreign currency, especially in countries with otherwise restrictive regulations or developing banking structure. By the very nature of black-market transactions, these are unobservable and thus this assertion is conjectural.

Table 1

Summary of Results, Heritage measures, Fixed Effects Model with Driscoll-Kraay S.E.

	Per capita Income	**U.S. Recession Dummy**	**Inflation Difference**	**Tourism Proxy**	**Trade Proxy**	**Percentage Point change in Trade**
% Positive	$26.\overline{66}$	$6.\overline{66}$	0	60	$13.\overline{33}$	0
%Insignificant	$73.\overline{33}$	$93.\overline{33}$	100	40	$86.\overline{66}$	100
% Negative	0	0	0	0	0	0

	Total Freedom	**Economic Freedom**	**Investment Freedom**	**Trade Freedom**	**Financial Freedom**	**Monetary Freedom**
%Positive	0	0	0	60	20	0
%Insignificant	$93.\overline{33}$	$86.\overline{66}$	$93.\overline{33}$	40	60	100
%Negative	$6.\overline{66}$	$13.\overline{33}$	$6.\overline{66}$	0	20	0

Note: Shows the significance at the 5% level of independent variables across all 45 Fixed Effects specifications using the Heritage Foundation's measures of freedom, in percentage terms.

Table 2

Summary of Results, Fraser measures, Fixed Effects Model with Driscoll-Kraay S.E.

	Per capita Income	**U.S. Recession Dummy**	**Inflation Difference**	**Tourism Proxy**	**Trade Proxy**	**Percentage Point change in Trade**
% Positive	40	0	0	60	30	0
%Insignificant	60	100	90	40	70	100
% Negative	0	0	10	0	0	0

	Overall Freedom	**Size of Government**	**LS & PRs**	**Freedom to Trade Internationally**	**Regulation**
% Positive	0	0	0	0	$33.\overline{33}$
%Insignificant	100	100	100	40	$66.\overline{66}$
% Negative	0	0	0	60	0

	Sound Money (Adjusted)	**Foreign Currency Freedom**
% Positive	0	0
% Insignificant	100	$93.\overline{33}$
% Negative	0	$6.\overline{66}$

Note: Shows the significance at the 5% level of independent variables across all 30 Fixed Effects specifications using the Fraser Institute's measures of freedom, in percentage terms

Table 3

Tourism Proxy, Heritage Foundation measures, Fixed Effects Model with Driscoll-Kraay S.E.

Dependent Variable	**Per capita Income in 1995 USD**	**U.S. Recession Dummy**	**Inflation Difference**	**Tourism as a percent of GDP**	**Total Freedom**	**Constant**
NFA	9.601544 **(2.582245)****	326.2476 **(9922.07)**	1138.686 **(1081.416)**	-202.1283 **(1318.838)**	2230.124 **(1808.823)**	-200271.2 **(145717.5)**
PNFA	5.4334 **(1.997715)****	3519.028 **(5633.622)**	1161.976 **(1103.35)**	-571.9552 **(1303.8)**	2287.636 **(1912.278)**	-193995.7 **(146701)**
NFA/GDP	0.0006538 **(0.001113)**	2.443194 **(2.9575)**	0.0203534 **(0.1364255)**	2.255899 **(0.5470089)****	-0.1474043 **(0.4981255)**	19.9701 **(24.46528)**
PNFA/GDP	0.0004142 **(0.0010247)**	1.957617 **(2.026618)**	0.0243903 **(0.1714068)**	1.584868 **(0.5213179)****	-0.0673844 **(0.4752735)**	4.918175 **(25.51849)**
Per capita PNFA	0.9270454 **(0.6851404)**	1439.085 **(839.1759)†**	-21.18192 **(33.71999)**	861.9886 **(320.5664)****	-362.5396 **(177.8937)***	16388.66 **(4365.339)****

**, *, and † denote significance at the 1%, 5%, and 10% levels, respectively, with robust standard errors

Dependent Variable	**Per capita Income in 1995 USD**	**U.S. Recession Dummy**	**Inflation Difference**	**Tourism as a percent of GDP**	**Economic Freedom**	**Constant**
NFA	9.474293 **(2.496562)****	2483.722 **(10756.73)**	1101.614 **(1068.254)**	6.128706 **(1123.999)**	1563.789 **(1371.522)**	-161478 **(120248.2)**
PNFA	5.414119 **(1.870852)****	5516.889 **(6803.444)**	1071.063 **(1090.826)**	-256.7831 **(1090.746)**	1235.08 **(1447.114)**	-131072.5 **(120641.1)**
NFA/GDP	0.0006797 **(0.0011141)**	2.270025 **(3.030244)**	0.0145147 **(0.1364723)**	2.259313 **(0.5236397)****	-0.1616299 **(0.3389662)**	21.04416 **(18.63567)**
PNFA/GDP	0.004066 **(0.0010211)**	1.913003 **(2.018565)**	0.0308316 **(0.173707)**	1.5675 **(0.4916333)****	-0.0092078 **(0.3114812)**	1.368961 **(19.45287)**
Per capita PNFA	0.9213478 **(0.6754939)**	1138.811 **(807.3693)**	-3.134088 **(40.91012)**	803.5081 **(309.7318)***	-166.895 **(71.56473)***	4616.732 **(5758.162)**

**, *, and † denote significance at the 1%, 5%, and 10% levels, respectively, with robust standard errors

Dependent Variable	**Per capita Income in 1995 USD**	**U.S. Recession Dummy**	**Inflation Difference**	**Tourism as a percent of GDP**
NFA	8.446172 **(2.352741)****	2623.334 **(7395.657)**	1359.38 **(1410.116)**	127.8053 **(1087.477)**
PNFA	4.637224 **(1.860117)***	5298.113 **(4631.34)**	1446.083 **(1427.711)**	-52.06627 **(945.9352)**
NFA/GDP	0.000362 **(0.0010588)**	2.347017 **(2.505793)**	0.0908041 **(0.2037038)**	2.308427 **(0.4845757)****
PNFA/GDP	0.000264 **(0.0010251)**	1.873634 **(1.885263)**	0.0892772 **(0.2291983)**	1.60931 **(0.4628287)****
Per capita PNFA	0.9202053 **(0.7237153)**	1174.918 **(912.0558)**	-11.47449 **(37.68933)**	800.7212 **(306.8501)***

Dependent Variable	**Investment Freedom**	**Trade Freedom**	**Financial Freedom**	**Monetary Freedom**	**Constant**
NFA	-385.1892 **(257.1451)**	1649.476 **(326.1072)****	835.1836 **(378.153)***	943.7232 **(1397.417)**	-266160.1 **(165158.2)**
PNFA	-180.9788 **(273.6051)**	1222.578 **(315.7587)****	290.5889 **(398.0675)**	1189.878 **(1440.845)**	-229111.8 **(165156.6)**
NFA/GDP	-0.1616839 **(0.0454722)****	0.317456 **(0.1107222)****	-0.0931837 **(0.0796105)**	0.1485181 **(0.2741201)**	-6.630345 **(29.28357)**
PNFA/GDP	-0.0473187 **(0.0506769)**	0.1556308 **(0.0901763)†**	-0.0834879 **(0.0746606)**	0.1694857 **(0.2878115)**	-14.87107 **(28.35506)**
Per capita PNFA	-9.292782 **(18.35551)**	-48.13965 **(72.28158)**	-81.86765 **(37.44492)***	-61.43197 **(52.61919)**	6951.402 **(3472.882)***

**, *, and † denote significance at the 1%, 5%, and 10% levels, respectively, with robust standard errors

Table 4

Trade Proxy. Heritage Foundation measures, Fixed Effects Model with Driscoll-Kraay S.E.

Dependent Variable	**Per capita Income in 1995 USD**	**U.S. Recession Dummy**	**Inflation Difference**	**Trade as a percent of GDP**	**Total Freedom**	**Constant**
NFA	9.177023 **(2.542043)****	761.68 **(9670.394)**	1015.375 **(1016.622)**	206.6021 **(136.5372)**	2077.859 **(1551.739)**	-201808.1 **(127595.3)**
PNFA	4.887041 **(1.976737)***	4294.311 **(5358.021)**	1006.514 **(1038.042)**	300.1414 **(120.5039)***	1939.686 **(1672.84)**	-191926.4 **(131641.6)**
NFA/GDP	0.0006294 **(0.0009433)**	1.981911 **(3.25148)**	0.0718615 **(0.1424495)**	-0.0087494 **(0.1690675)**	0.1220826 **(0.5348848)**	12.64778 **(19.95988)**
PNFA/GDP	0.0005333 **(0.0008549)**	1.46242 **(2.321185)**	0.0646113 **(0.1703683)**	-0.0851564 **(0.1680068)**	0.0319308 **(0.4688738)**	10.58219 **(22.071)**
Per capita PNFA	0.7778705 **(0.5209444)**	1430.448 **(880.6345)**	-32.08882 **(27.62473)**	91.45386 **(108.9684)**	-306.764 **(187.9976)**	10110.58 **(5578.237)†**

**, *, and † denote significance at the 1%, 5%, and 10% levels, respectively, with robust standard errors

Dependent Variable	**Per capita Income in 1995 USD**	**U.S. Recession Dummy**	**Inflation Difference**	**Trade as a percent of GDP**	**Economic Freedom**	**Constant**
NFA	9.011802 **(2.421515)****	2874.967 **(10526.76)**	992.4324 **(1024.797)**	226.7975 **(130.3506)†**	1534.933 **(1286.002)**	-171392.7 **(113050.4)**
PNFA	4.824928 **(1.816121)****	6073.268 **(6587.677)**	939.2944 **(1044.316)**	321.9308 **(115.3212)****	1127.65 **(1367.51)**	-144347.4 **(115712)**
NFA/GDP	0.0006595 **(0.0009478)**	2.026786 **(3.306116)**	0.0516738 **(0.143288)**	-0.0064162 **(0.1642866)**	-0.0410401 **(0.3496715)**	22.66064 **(18.66179)**
PNFA/GDP	0.0005294 **(0.0008516)**	1.49753 **(2.278291)**	0.0648704 **(0.1726852)**	-0.0848767 **(0.1637096)**	0.0282681 **(0.3079466)**	10.75664 **(22.22349)**
Per capita PNFA	0.777399 **(0.5134121)**	1170.322 **(834.9338)**	-17.0398 **(27.40823)**	87.75392 **(106.6485)**	-144.792 **(74.88247)†**	480.1812 **(11290.31)**

**, *, and † denote significance at the 1%, 5%, and 10% levels, respectively, with robust standard errors

Dependent Variable	**Per capita Income in 1995 USD**	**U.S. Recession Dummy**	**Inflation Difference**	**Trade as a percent of GDP**
NFA	8.151465 **(2.363864)****	3018.83 **(7142.048)**	1232.927 **(1385.119)**	163.975 **(169.7789)**
PNFA	4.266826 **(1.890457)***	5810.019 **(4420.828)**	1288.313 **(1399.428)**	246.8243 **(168.3501)**
NFA/GDP	0.0004015 **(0.0009275)**	2.088142 **(2.846457)**	0.128002 **(0.2194269)**	-0.0345426 **(0.1724918)**
PNFA/GDP	0.0004046 **(0.0008883)**	1.433802 **(2.176957)**	0.1280226 **(0.2403373)**	-0.1058906 **(0.1759596)**
Per capita PNFA	0.7942989 **(0.5758831)**	1225.468 **(941.775)**	-37.11981 **(39.99803)**	90.61057 **(114.013)**

Dependent Variable	**Investment Freedom**	**Trade Freedom**	**Financial Freedom**	**Monetary Freedom**	**Constant**
NFA	-356.8707 **(236.6787)**	1554.64 **(325.3365)****	823.8512 **(364.0276)***	872.6642 **(1387.391)**	-262578.1 **(155348.3)†**
PNFA	-179.5502 **(258.5182)**	1081.542 **(321.5704)****	306.6873 **(379.312)**	1064.743 **(1428.062)**	-225644.2 **(157123.9)**
NFA/GDP	-0.1075779 **(0.0617461)†**	0.323665 **(0.1414935)***	-0.0770275 **(0.0491871)**	0.1526765 **(0.3022738)**	-0.0128769 **(26.56815)**
PNFA/GDP	-0.0331264 **(0.0468159)**	0.1784685 **(0.133768)**	-0.0847676 **(0.0496181)†**	0.1770885 **(0.3156366)**	-4.312347 **(27.07623)**
Per capita PNFA	0.1147422 **(16.87403)**	-65.80273 **(103.3092)**	-56.92618 **(27.7607)***	-88.18684 **(72.02571)**	5240.241 **(6254.071)**

**, *, and † denote significance at the 1%, 5%, and 10% levels, respectively, with robust standard errors

Table 5

Percentage point change in trade proxy, Heritage Foundation measures

Dependent Variable	Per capita Income in 1995 USD	U.S. Recession Dummy	Inflation Difference	Percentage point change in trade	Total Freedom	Constant
NFA	1.256236 **(0.0361322)****	-261.1622 **(148.4465)†**	-10.65975 **(8.791502)**	-11.16352 **(9.952479)**	-72.17001 **(8.746391)****	3907.163 **(498.8744)****
PNFA	0.0032843 **(0.006569)**	6.247222 **(12.32559)**	-5.951208 **(2.83766)***	0.8014716 **(0.5335291)**	-1.853989 **(1.217122)**	149.7661 **(71.04456)***
NFA/GDP	0.000426 **(0.0000303)****	-0.809476 **(0.5191131)**	-0.1988847 **(0.0331417)****	-0.0386626 **(0.0291006)**	-0.1971942 **(0.0299962)****	18.78914 **(1.769885)****
PNFA/GDP	0.0000114 **(0.0000246)**	0.1216407 **(0.2489528)**	-0.0391115 **(0.0157138)***	0.0211891 **(0.0165407)**	-0.0561278 **(0.015893)****	2.228159 **(0.8829634)***
Per capita PNFA	-0.022036 **(0.0011646)****	-1.268536 **(1.348056)**	-0.0391551 **(0.1727946)**	0.2345297 **(0.1190946)***	0.2893986 **(0.1127464)****	-8.400924 **(6.007216)**

**, *, and † denote significance at the 1%, 5%, and 10% levels, respectively, with robust standard errors

Dependent Variable	Per capita Income in 1995 USD	U.S. Recession Dummy	Inflation Difference	Percentage point change in trade	Economic Freedom	Constant
NFA	1.215922 **(0.0348196)****	-318.7612 **(141.5935)***	-18.59092 **(8.879959)***	-8.420922 **(9.623179)**	-47.46222 **(6.33644)****	2750.967 **(394.5588)****
PNFA	0.0016543 **(0.0065781)**	-2.786753 **(11.84905)**	-5.864736 **(2.899071)***	0.5556446 **(0.5380618)**	-1.689562 **(2.0273)**	147.1109 **(122.8065)**
NFA/GDP	0.0002414 **(0.0000273)****	-1.003936 **(0.5264097)†**	-0.1739845 **(0.0322618)****	-0.0392244 **(0.0282078)**	0.0297231 **(1.476355)**	7.26113 **(1.476355)****
PNFA/GDP	-0.0000613 **(0.0000225)****	0.1178811 **(0.2450786)**	-0.0253841 **(0.015882)**	0.0219619 **(0.0163159)**	-0.0090667 **(0.0111156)**	-0.3243065 **(0.6121275)**
Per capita PNFA	-0.0222729 **(0.0011196)****	-0.7536771 **(1.245392)**	0.0444504 **(0.1625531)**	0.272355 **(0.1107424)***	0.2441815 **(0.0612305)****	-5.630616 **(3.26766)†**

**, *, and † denote significance at the 1%, 5%, and 10% levels, respectively, with robust standard errors

Dependent Variable	Per capita Income in 1995 USD	U.S. Recession Dummy	Inflation Difference	Percentage point change in trade
NFA	1.284872 **(0.0350952)****	-13.38549 **(149.9818)**	-26.27056 **(11.11778)***	-6.341504 **(9.713571)**
PNFA	-0.001962 **(0.0069868)**	4.112571 **(8.562229)**	-6.567779 **(2.825502)***	0.5317526 **(0.3758987)**
NFA/GDP	0.0002686 **(0.0000271)****	-0.5279055 **(0.5164842)**	-0.189646 **(0.0342377)****	-0.0276337 **(0.0272664)**
PNFA/GDP	-0.0000359 **(0.000023)**	0.1854801 **(0.283188)**	-0.0457629 **(0.0170896)****	0.0248109 **(0.0173869)**
Per capita PNFA	-0.0186508 **(0.0013601)****	-0.4386073 **(2.856958)**	-0.7796592 **(0.2235704)****	0.2377911 **(0.1898578)**

Dependent Variable	Investment Freedom	Trade Freedom	Financial Freedom	Monetary Freedom	Constant
NFA	-44.03444 **(4.874507)****	-11.78692 **(6.141751)†**	13.71279 **(5.651245)***	-19.96827 **(5.902297)****	3644.607 **(608.0535)****
PNFA	-2.594196 **(0.7109514)****	1.292573 **(0.5984038)***	3.566266 **(1.474145)***	-0.5271336 **(0.6207201)**	-40.71552 **(103.9072)**
NFA/GDP	-0.0757568 **(0.0151243)****	0.0447559 **(0.0201928)***	0.0814691 **(0.0156315)****	-0.0222657 **(0.0254244)**	7.497694 **(2.209956)****
PNFA/GDP	-0.0665701 **(0.008855)****	0.0143247 **(0.0106688)**	0.0271082 **(0.0088399)****	-0.0194003 **(0.0147255)**	2.276266 **(1.232563)†**
Per capita PNFA	-0.6058686 **(0.1031755)****	0.2534848 **(0.1004514)***	0.1658204 **(0.0791704)***	-0.2314711 **(0.1327539)†**	34.95233 **(10.70683)****

**, *, and † denote significance at the 1%, 5%, and 10% levels, respectively, with robust standard errors

Table 6

Tourism Proxy, Fraser Institute Measures, Fixed Effects Model with Driscoll-Kraay S.E.

Dependent Variable	**Per capita Income in 1995 USD**	**U.S. Recession Dummy**	**Inflation Difference**	**Tourism as a percent of GDP**	**Overall Freedom**	**Constant**
NFA	9.084471 **(2.424989)****	2011.829 **(9495.576)**	2490.305 **(1718.111)**	-240.9364 **(1114.017)**	53405.79 **(30398.94)†**	-436153.6 **(243336.3)†**
PNFA	5.285507 **(1.879342)****	5146.063 **(6075.217)**	1966.972 **(1649.712)**	-296.1279 **(1045.988)**	32245.11 **(30547.95)**	-279648.4 **(237883)**
NFA/GDP	0.0006379 **(0.0011605)**	2.383434 **(3.211205)**	0.0553458 **(0.2674378)**	2.321394 **(0.5813118)****	0.8347367 **(8.135709)**	4.76166 **(51.07771)**
PNFA/GDP	0.0004398 **(0.0011001)**	1.881029 **(2.253738)**	0.0187487 **(0.2867892)**	1.711084 **(0.5533568)****	-0.3732201 **(8.488553)**	2.692237 **(52.63311)**
Per capita PNFA	1.013826 **(0.7417584)**	1103.166 **(1131.301)**	-136.8278 **(59.44456)***	921.3639 **(391.5493)***	-6604.897 **(3667.172)†**	39245.98 **(17056.48)***

**, *, and † denote significance at the 1%, 5%, and 10% levels, respectively, with robust standard errors

Dependent Variable	**Per capita Income in 1995 USD**	**U.S. Recession Dummy**	**Inflation Difference**	**Tourism as a percent of GDP**	**Size of Government**
NFA	5.652078 **(1.21984)****	5692.216 **(6536.19)**	5411.761 **(3181.936)†**	-122.7872 **(1739.207)**	-8021.707 **(5375.342)**
PNFA	2.487786 **(0.9032904)****	8157.582 **(5323.639)**	4501.566 **(3066.513)**	-67.08558 **(1399.532)**	-3679.885 **(5352.896)**
NFA/GDP	0.0002913 **(0.0011499)**	2.39631 **(3.043231)**	0.6099739 **(0.5016365)**	2.438458 **(0.6299764)****	-2.844544 **(2.255487)**
PNFA/GDP	0.0001972 **(0.0011172)**	1.673453 **(2.39386)**	0.5505547 **(0.5249912)**	1.919682 **(0.5542022)****	0.0762754 **(1.850382)**
Per capita PNFA	1.000012 **(0.7538187)**	832.709 **(1235.678)**	-73.10757 **(75.43348)**	999.785 **(397.0274)***	-54.87301 **(1003.874)**

Dependent Variable	**Legal System& Property Rights**	**International trade Freedom**	**Regulation**	**Sound money (Adjusted)**	**Foreign Currency Freedom**	**Constant**
NFA	-24069.26 **(22730.8)**	-24404.71 **(10521.34)***	46967.63 **(19444.37)***	41132.8 **(21323.4)†**	3082.426 **(1858.778)**	-360514.1 **(191939.3)†**
PNFA	-25520.75 **(22542.47)**	-22301.59 **(8913.717)***	36963.2 **(18470.48)***	32853.94 **(21504.57)**	256.5063 **(1259.386)**	-234223.2 **(193723.8)**
NFA/GDP	-5.270597 **(4.845505)**	-2.748847 **(1.779194)**	2.512795 **(3.905675)**	6.130227 **(3.795453)**	-0.1761552 **(0.23675)**	13.4839 **(43.5234)**
PNFA/GDP	-6.497954 **(5.254129)**	-3.174161 **(1.937214)**	-0.0590815 **(4.081611)**	5.800173 **(3.971241)**	-0.3110264 **(0.2074617)**	13.76037 **(43.75043)**
Per capita PNFA	55.14165 **(2064.531)**	-2751.024 **(983.7185)****	-3437.747 **(2184.22)**	-110.9675 **(818.006)**	-153.752 **(70.22281)***	38852.63 **(14361.04)****

**, *, and † denote significance at the 1%, 5%, and 10% levels, respectively, with robust standard errors

Table 7

Trade Proxy, Fraser Institute measures, Fixed Effects Model with Driscoll-Kraay S.E.

Dependent Variable	**Per capita Income in 1995 USD**	**U.S. Recession Dummy**	**Inflation Difference**	**Trade as a percent of GDP**	**Overall Freedom**	**Constant**
NFA	8.582201 **(2.293534)****	2326.772 **(9448.673)**	2369.984 **(1650.243)**	250.7309 **(151.4776)**	52459.11 **(28497.19)†**	-443472.1 **(229886.9)†**
PNFA	4.637103 **(1.757625)***	5491.612 **(6053.077)**	1848.164 **(1594.04)**	351.7018 **(139.1542)***	31123.03 **(28648.11)**	-293797.2 **(224598)**
NFA/GDP	0.0005985 **(0.0009676)**	2.186214 **(3.360735)**	0.1387318 **(0.2667786)**	-0.0111536 **(0.1696995)**	3.246788 **(7.507181)**	-1.869997 **(42.48352)**
PNFA/GDP	0.0005445 **(0.0009098)**	1.505708 **(2.459428)**	0.0739916 **(0.2871374)**	-0.0867751 **(0.1705252)**	0.891244 **(7.772141)**	6.464485 **(43.88249)**
Per capita PNFA	0.8502265 **(0.5646564)**	1098.225 **(1134.048)**	-125.4503 **(60.30568)***	89.44006 **(109.5121)**	-5649.605 **(3165.408)†**	30397.18 **(10161.77)****

**, *, and † denote significance at the 1%, 5%, and 10% levels, respectively, with robust standard errors

Dependent Variable	**Per capita Income in 1995 USD**	**U.S. Recession Dummy**	**Inflation Difference**	**Trade as a percent of GDP**	**Size of Government**
NFA	5.181117 **(1.08496)****	6198.302 **(6833.267)**	5271.74 **(3072.254)†**	434.3094 **(102.647)****	-8510.129 **(4747.615)†**
PNFA	1.781947 **(0.7436405)***	8624.477 **(5328.939)**	4425.244 **(2976.121)**	503.469 **(105.4216)****	-3539.921 **(4799.181)**
NFA/GDP	0.0002529 **(0.0009426)**	2.345702 **(3.17243)**	0.6229035 **(0.4946695)**	0.0180963 **(0.1615174)**	-3.335047 **(2.127812)**
PNFA/GDP	0.0002115 **(0.0009245)**	1.539632 **(2.441192)**	0.5388616 **(0.5204389)**	-0.0515607 **(0.1644554)**	-0.0327707 **(1.878086)**
Per capita PNFA	0.8242199 **(0.5776281)**	849.6047 **(1269.635)**	-59.14822 **(68.41343)**	100.6327 **(110.2873)**	-59.52696 **(840.677)**

Dependent Variable	**Legal System & Property Rights**	**International trade Freedom**	**Regulation**	**Sound money (Adjusted)**	**Foreign Currency Freedom**	**Constant**
NFA	-27974.76 **(22869.66)**	-20304.1 **(9490.12)***	44065.16 **(18294.22)***	40887.05 **(20829.2)†**	3035.228 **(1674.578)†**	-373724 **(183344.3)***
PNFA	-28249.38 **(22851)**	-20438.04 **(7589.714)****	34641.13 **(17359.1)†**	33327.56 **(20976.29)**	274.9963 **(1199.363)**	-256419.5 **(184188.4)**
NFA/GDP	-5.153963 **(4.326364)**	-1.02146 **(2.142363)**	3.655594 **(4.00259)**	5.679365 **(3.496438)**	-0.0094725 **(0.2100002)**	6.351512 **(37.81597)**
PNFA/GDP	-5.545686 **(4.594238)**	-3.099065 **(1.924638)**	1.415973 **(4.399335)**	5.332853 **(3.661519)**	-0.1907858 **(0.1790767)**	12.76317 **(38.50557)**
Per capita PNFA	-184.3085 **(1536.841)**	-2429.28 **(913.2176)****	-3209.59 **(2219.098)**	76.6384 **(525.1914)**	-15.3756 **(54.29768)**	31030.96 **(9747.675)****

**, *, and † denote significance at the 1%, 5%, and 10% levels, respectively, with robust standard errors

Table 8

Percentage point change in trade proxy, Fraser Institute measures, Fixed Effects Model with Driscoll-Kraay S.E.

Dependent Variable	**Per capita Income in 1995 USD**	**U.S. Recession Dummy**	**Inflation Difference**	**Percentage point change in trade**	**Overall Freedom**	**Constant**
NFA	8.94546 **(2.383707)****	1766.96 **(9377.137)**	2424.284 **(1644.699)**	-54.91537 **(160.3428)**	52479.86 **(28363.14)†**	-426543.4 **(231366.8)†**
PNFA	5.182058 **(1.857298)****	5339.109 **(6176.676)**	1906.874 **(1594.195)**	70.6802 **(140.1412)**	30968.73 **(28633.29)**	-269315.8 **(227312.9)**
NFA/GDP	0.000621 **(0.0011896)**	2.887508 **(3.111705)**	0.1214925 **(0.2584904)**	0.1628718 **(0.2194202)**	3.068043 **(7.517689)**	-1.948864 **(47.16828)**
PNFA/GDP	0.0004531 **(0.0011152)**	2.304363 **(2.138968)**	0.0421427 **(0.2809945)**	0.1624294 **(0.2028101)**	0.7291541 **(7.726334)**	1.18821 **(48.88407)**
Per capita PNFA	1.025965 **(0.7401976)**	1712.435 **(961.6652)†**	-124.0488 **(51.26416)***	173.0753 **(135.3603)**	-5848.316 **(3362.939)†**	37190 **(15809.92)***

**, *, and † denote significance at the 1%, 5%, and 10% levels, respectively, with robust standard errors

Dependent Variable	**Per capita Income in 1995 USD**	**U.S. Recession Dummy**	**Inflation Difference**	**Percentage point change in trade**	**Size of Government**
NFA	5.82407 **(1.15965)****	6028.917 **(6966.113)**	5243.255 **(3067.472)†**	40.11558 **(96.76403)**	-9047.032 **(4966.513)†**
PNFA	2.546508 **(0.8950775)****	8848.647 **(5656.712)**	4375.92 **(2974.287)**	140.3983 **(92.05151)**	-4218.394 **(4910.716)**
NFA/GDP	0.0003214 **(0.0011563)**	3.086921 **(2.978536)**	0.6097352 **(0.4918178)**	0.1805905 **(0.2084001)**	-3.491509 **(2.235116)**
PNFA/GDP	0.0001762 **(0.0011283)**	2.305964 **(2.220449)**	0.5302195 **(0.5170236)**	0.1730792 **(0.1954691)**	-0.1025566 **(1.901099)**
Per capita PNFA	1.011049 **(0.7486244)**	1496.661 **(1035.518)**	-77.4454 **(72.95714)**	172.672 **(137.4846)**	-308.4039 **(1004.191)**

Dependent Variable	**Legal System & Property Rights**	**International trade Freedom**	**Regulation**	**Sound money (Adjusted)**	**Foreign Currency Freedom**	**Constant**
NFA	-25955.3 **(22847.04)**	-19967.63 **(9719.534)***	45616.58 **(18612.24)***	39567.8 **(20706.52)†**	2802.481 **(1676.3)†**	-352369.1 **(180009.4)†**
PNFA	-25945.54 **(22734.94)**	-20148.54 **(7782.697)***	36408.08 **(17720.56)***	31795.54 **(20863.06)**	16.8399 **(1210.317)**	-230524.4 **(183026.5)**
NFA/GDP	-5.10823 **(4.797381)**	-1.038239 **(2.018804)**	3.669007 **(3.702892)**	5.639906 **(3.622133)**	-0.0168632 **(0.2176559)**	8.161307 **(39.50655)**
PNFA/GDP	-5.831823 **(5.137682)**	-3.168789 **(1.813846)†**	1.194275 **(3.959264)**	5.503295 **(3.811104)**	-0.1608886 **(0.2066623)**	11.11772 **(40.52685)**
Per capita PNFA	250.2541 **(1973.124)**	-2381.054 **(880.1215)****	-2891.628 **(1938.589)**	-217.878 **(827.3043)**	-65.49404 **(56.1098)**	36805.71 **(13175.59)****

**, *, and † denote significance at the 1%, 5%, and 10% levels, respectively, with robust standard errors

References

Driscoll, J., and A. C. Kraay. 1998. Consistent covariance matrix estimation with spatially dependent data. *Review of Economics and Statistics* 80: 549-560.

Engineer, M. (2000). Currency transactions costs and competing fiat currencies. *Journal of International Economics*, *52*(1), 113–136. https://doi.org/10.1016/s0022-1996(99)00026-4

Giovannini, A., & Turtelboom, B. (1992). *Currency Substitution*. NBER Working Paper. No. 4232. https://doi.org/10.3386/w4232

Hazlett, P. K., & Luther, W. J. (2020). Is bitcoin money? and what that means. *The Quarterly Review of Economics and Finance*, *77*, 144–149. https://doi.org/10.1016/j.qref.2019.10.003

Hoechle, D. 2007. Robust standard errors for panel regressions with cross-sectional dependence. *The Stata Journal,* Vol. 7, No. 3, 281-312.

Hogan, T. L., & Luther, W. J. (2019). Endogenous matching and money with random consumption preferences. *The B.E. Journal of Theoretical Economics*, *19*(2). https://doi.org/10.1515/bejte-2017-0170

Kiyotaki, N., & Wright, R. (1989). On Money as a Medium of Exchange. *Journal of Political Economy*, *97*, 927–954.

Kiyotaki, Nobuhiro, & Wright, R. (1991). A contribution to the pure theory of money. *Journal of Economic Theory*, *53*(2), 215–235. https://doi.org/10.1016/0022-0531(91)90154-v

Kiyotaki, N., and Wright, R. (1993), "A Search-Theoretic Approach to Monetary Economics," *American Economic Review*, Vol. 83(1), 63–77.

Luther, W. J. (2016). Cryptocurrencies, network effects, and switching costs. *Contemporary Economic Policy*, *34*(3), 553–571. https://doi.org/10.1111/coep.12151

Luther, W. J., & White, L. H. (2014). Can bitcoin become a major currency? *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2446604

Murphy, R. P., Richardson, C. J., Schuler, J. M. and J., Hummel, J. R., & Charles L. Hooper and David R. Henderson. (2018, June 25). *The economics of Bitcoin*. Econlib. https://www.econlib.org/library/Columns/y2013/Murphybitcoin.html

Salop, S. C. (1979). Monopolistic competition with outside goods. *The Bell Journal of Economics*, *10*(1), 141–156. https://doi.org/10.2307/3003323

Seater, J. J. (2008). The demand for currency substitution. *Economics*, *2*(1). https://doi.org/10.5018/economics-ejournal.ja.2008-35

White, L. H. (2002). Does a superior monetary standard spontaneously emerge? *Journal Des Economistes et Des Etudes Humaines*, *12*(2). https://doi.org/10.2202/1145-6396.1062

Appendix

Net Foreign Assets (NFA) is defined by the World Bank as "… the sum of foreign assets held by monetary authorities and deposit money banks, less their foreign liabilities." As the World Bank reports this number in current terms of the local currency, the data is transformed first by dividing by the "local currency per USD" exchange rate that aligns with the year in question (also provided by the World Bank), and then put in constant 1995 USD by dividing by an index of the accumulated rates of yearly US inflation. (For reference, all figures in constant 1995 USD use this index.) This figure is reported in millions of constant 1995 USD.

Private Net Foreign Assets (PNFA) is calculated by subtracting "foreign currency reserves held by monetary authorities net of gold" (that is, Total Reserves net of Gold) from the Net Foreign Assets figure described above. This is done to mitigate actions taken by government entities and focus attention on private entities. This number is also reported in millions of constant 1995 USD.

The variables "NFA/GDP" and "PNFA/GDP" are Net Foreign Assets and Private Net Foreign Assets reported as a percentage of Gross Domestic Product. That is, $\left(\frac{NFA}{GDP}\right) * 100$; $\left(\frac{PNFA}{GDP}\right) * 100$; respectively. Gross Domestic Product is also expressed in millions of constant 1995 USD.

Per capita Private Net Foreign Assets (per capita PNFA) is simply the previously described PNFA multiplied by one million and then divided by population.

Common Independent Variables

The variables in this section are used consistently across all specifications. Per capita income in 1995 USD, as the name implies, is the per capita income expressed in constant 1995 U.S. dollars. U.S. Recession Dummy is a dummy variable equal to one in years which contained at least one quarter of a recession in the United States as determined by National Bureau of Economic Research, and otherwise is zero. The years that include a recession are 2001, 2008, and 2009. The variable "Inflation Difference" is given by the inflation experienced in a country during a given year minus the inflation experienced in the U.S. during the same year, in percentage terms. Both figures were taken from the World Bank.

Measures of Trade

"Tourism as a percent of GDP" is the percent of Gross Domestic Product of a country coming from in-bound international travelers, including any pre-payments. This figure is derived by $\left(\frac{\text{Tourism}}{\text{GDP}}\right) * 100$, where both tourism and GDP are expressed in millions of constant 1995 USD.

"Trade as a percent of GDP" is the summation of a country's imports and exports expressed as a percentage of Gross Domestic Product, given by $\left(\frac{\text{Imports+Exports}}{\text{GDP}}\right) * 100$. "Percentage point change in trade" is the change in "Trade as a percent of GDP" from the

previous year. For clarity, a change in a country's trade as a percent of GDP from, say, 50% to 55% would be reported as 5, not 10.

Measures of Freedom

"Total Freedom" is the unweighted average of 12 components of economic freedom measured on a scale of 0-100, as reported by the Heritage Foundation, for a specified country and year.

"Economic Freedom" is the unweighted average of 4 components of economic freedom: Investment, Trade, Financial, and Monetary. In the rare event that one of these measures was not available, the unweighted average of the remaining three was used.

The four components of "Economic Freedom" are also considered individually. A full explanation of these indices of freedom can be found in the appendix of the report from the Heritage Foundation: (http://www.heritage.org/index/pdf/2021/book/02_2021_IndexOfEconomicFreedom_METHODOLOGY.pdf)

For the Fraser Institute specifications, "Overall Freedom" is the unweighted average of five components: Size of Government, Legal System and Security of Property Rights, Sound Money, Freedom to Trade Internationally, and Regulation. An explanation of these indices can be found at the Fraser Institutes website: (https://www.fraserinstitute.org/economic-freedom/approach)

The index for "Sound Money" used in this article was adjusted to consider the sub-index "Freedom to own foreign currency bank accounts" separately, as described in the text.