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Bästa läsare,

Årets första utgåva av Penning- och valutapolitik innehåller fyra artiklar av lite olika karaktär. I den första artikeln resonerar riksbankschef Stefan Ingves om Sveriges roll i det internationella ekonomiska samarbetet, och i den andra artikeln diskuterar förste vice riksbankschef Cecilia Skingsley och Björn Segendorf förändringar i den finansiella infrastrukturen. Därefter följer en artikel som ger en översikt av valutamarknaden för svenska kronor, och en sista mer teknisk artikel om olika aspekter av valutasäkring.

- **Sveriges roll i det internationella ekonomiska samarbetet – i går, i dag, i morgon**

  Riksbankschef *Stefan Ingves* ger sin syn på förutsättningarna för Sverige att göra sin röst hörd i det internationella ekonomiska samarbetet, och hur dessa förutsättningar påverkas av pågående skiftande globala styrkeförhållanden och omvälvande förändringar inom EU. Artikeln är en ombearbetning och utveckling av material från olika seminarier och presentationer som Stefan Ingves har gett under senare år.

- **Ombyggnad pågår av de finansiella strukturerna**

  Förste vice riksbankschef *Cecilia Skingsley* och *Björn Segendorf* diskuterar hur den tekniska utvecklingen påverkar utbudet och efterfrågan på finansiella tjänster och vilka utmaningar dessa förändringar ger upphov till. Dessutom beskriver de hur Riksbanken arbetar för att framtidssäkra de delar av den finansiella infrastrukturen som Riksbanken tillhandahåller.

- **Understanding the foreign exchange market**

  Amanda Nordström beskriver de förändringar som valutamarknaden har genomgått under de senaste decennierna, och fokuserar särskilt på marknaden för svenska kronor. Hon presenterar också ett mått på marknadslikviditet för svenska kronor, och resonerar kring hur likviditeten har varierat över tiden.

  Artikeln finns endast på engelska.

- **Hedging against exchange rate risk – maturity choice and roll-over risk**

  Christoph Bertsch analyserar olika aspekter som är relevanta för svenska finansiella företag som valutasäkrar sina finansiella investeringar i utländsk valuta. I synnerhet jämför han vilka för- och nackdelar som finns med att valutasäkra på kort eller lång sikt, och presenterar en tankeram som kan användas för att analysera frågeställningarna.

  Artikeln finns endast på engelska.

Trevlig läsning!
Marianne Nessén och Ulf Söderström

Innehållsförteckning

Sveriges roll i det internationella ekonomiska samarbetet – i går, i dag, i morgon

Stefan Ingves [*]
Stefan Ingves är riksbankschef sedan 2006.

Sverige har under lång tid haft en relativt stark röst i det internationella ekonomiska samarbetet. Härigenom har vi kunnat medverka till att utforma gemensamma regler och ramverk och sluppit vara hänvisade till att passivt acceptera vad omvärlden har bestämt. Förutsättningarna för ett litet land som Sverige att göra sin röst hörd i detta samarbete håller nu på att förändras kraftigt, bland annat till följd av skiftande globala styrkeförhållanden och omvälvande förändringar inom EU. Det behövs därför en diskussion om Sveriges framtida roll inom exempelvis EU-samarbetet som bygger på insikten att saker och ting förändras snabbt och att vi, som ett litet utrikeshandelsberoende land, måste förhålla oss till dessa nya förutsättningar.

1 Introduktion

Sverige har under det senaste århundradet varit starkt engagerat i internationellt samarbete, ett samarbete som har varit mycket gynnsamt för den svenska ekonomiska utvecklingen. Förutsättningarna för detta ekonomiska samarbete håller nu på att förändras kraftigt. Det beror bland annat på att den globala maktbalansen håller på att förändras. Den mest aktuella illustrationen av detta ligger förstås inte på det ekonomiska utan på det säkerhetspolitiska planet, i form av Rysslands invasion av Ukraina – en handling vars konsekvenser på kort och lång sikt är omöjliga att idag överblicka och går utöver vad som kommer att behandlas i den här artikeln. Helt klart är dock att det kommer att ha djupgående följder för det multilaterala samarbetet, också på det ekonomiska planet, även om det är svårt att säga hur. Ett annat tecken på den förändrade maktbalansen är att Kina och andra tillväxtekonomier växer i styrka och politiskt inflytande, medan det motsatta gäller för Europa. Inom Europa sker också snabba förändringar, utöver Ukrainakrisen. Å ena sidan har vi euroländerna som strävar efter att valutaunionen ska fungera bättre och vill fördjupa sitt

[*] Den här artikeln är en bearbetning och utveckling av idéer och tankar som jag har framfört vid olika seminarier och presentationer under senare år, bland annat vid Utrikespolitiska föreningen i Uppsala 2019 och Utrikespolitiska föreningen i Lund 2020. Jag vill tacka Mattias Hector för hjälp med att omforma föreläsningarna till en artikel. Jag vill även tacka Mira Barkå, Emma Bylund, José Camacho, Åsa Ekelund, Frida Fallan, Anders Lindström, Marianne Nessén, Jonas Niemeyer, Christina Nordh-Berntsson, Lena Strömberg, Ulf Söderström och Katarina Werder för kommentarer och hjälp med statistik och figurer.

samarbete, inte minst på det finansiella området. Å andra sidan har vi Storbritannien som nyligen tog steget ut ur EU för att man tror att man står starkare utanför.

I den här artikeln reflekterar jag över Sveriges hållning till internationellt samarbete, hur förutsättningarna har förändrats och vilka utmaningar Sverige står inför framöver. De reflektioner jag gör baseras på mina erfarenheter från internationella sammanhang där jag har verkat i olika egenskaper under nära 40 år, i något jag menar är en form av ekonomisk diplomati.

2 En historisk tillbakablick

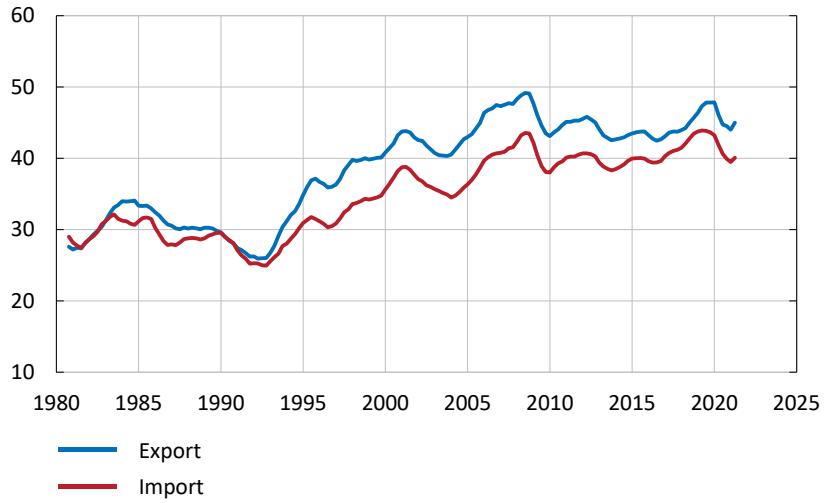
2.1 Ett litet land är beroende av sin omvärld

Den svenska ekonomins utveckling under 1900-talet är anmärkningsvärd. Från att i slutet av 1800-talet ha klassats som ett av Europas fattigaste länder rankas Sverige i dag som världens tionde rikaste land – under delar av 1970-talet låg vi till och med så högt som på fjärde plats – räknat som BNP per capita, se Bergh (2008) samt OECD (2021).

Det går inte att förklara den här ekonomiska framgången med bara en enskild faktor, men en viktig förklaring kan nog vara att svenska beslutsfattare, såväl privata som folkvalda, tidigt verkar ha insett vilka särskilda utmaningar det innebär att Sverige är ett litet land. Som ett litet land kan vi till exempel inte nå verkligt välstånd genom att förlita oss enbart på våra egna marknader, vilket ett större land i någon mån kan. Inte heller kan vi driva igenom vår vilja gentemot andra länder i kraft av vår storlek, utan vi måste använda andra medel.

Figur 1. Svensk export och import

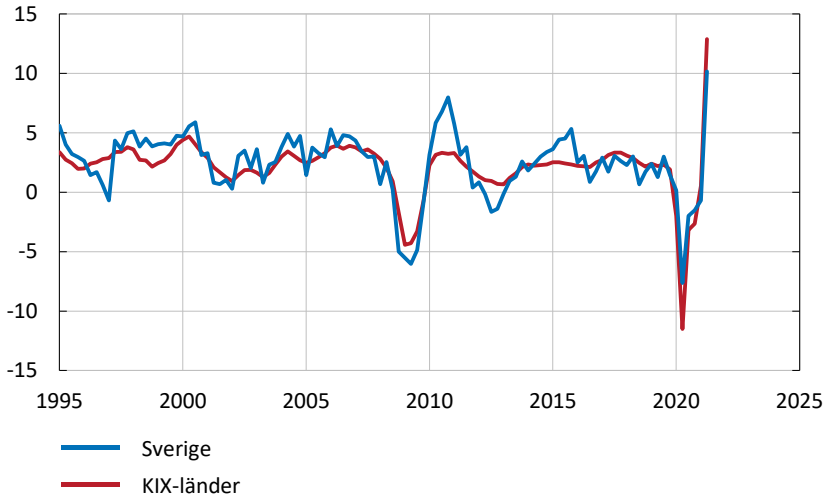
Löpande priser, procent av BNP



Källa: Statistiska centralbyrån

För att ett litet land ska nå ekonomiskt välstånd är det istället helt nödvändigt med öppenhet och samverkan med omvärlden – något som blir väldigt tydligt när man tittar på några nyckelfakta för svensk ekonomi. Utrikeshandelns betydelse har till exempel vuxit trendmässigt och värdet av både export och import motsvarar nu mellan 40 och 50 procent av BNP, se figur 1, som visar utvecklingen av svensk export och import från 1980 och framåt. Det är därför inte förvånande att vår BNP-tillväxt är så nära kopplad till utvecklingen i vår omvärld, något som framkommer i figur 2 som visar hur nära BNP-tillväxten i Sverige samvarierar med tillväxten i ett vägt genomsnitt av våra viktigaste handelspartner. Vi är dock inte bara beroende av omvärlden för handel med varor och tjänster – det blir tydligt om vi tittar på kapitalströmmar och den finansiella sektorn. Stocken av svenska direktinvesteringar i utlandet är den tolfte största i världen, satt i relation till vår BNP, se Kommerskollegium (2021). Motsvarande siffra för utländska direktinvesteringar i Sverige är den artonde högsta.[1] De svenska bankerna är vidare inte bara stora relativt Sveriges BNP, de har också en omfattande internationell verksamhet, i synnerhet i den nordisk-baltiska regionen, se figur 3. Fri rörlighet för kapital är därmed en viktig förutsättning för att svenska företag, såväl finansiella som icke-finansiella, ska kunna växa sig starka. Att även svenska myndigheter är beroende av omvärlden illustreras i figur 4. Här framgår de begränsade möjligheter nationella centralbanker har att föra en självständig räntepolitik i och med att realräntorna i olika länder tenderar att samvariera i väldigt hög grad.

Figur 2. BNP-tillväxt i Sverige och omvärlden
Årlig procentuell förändring



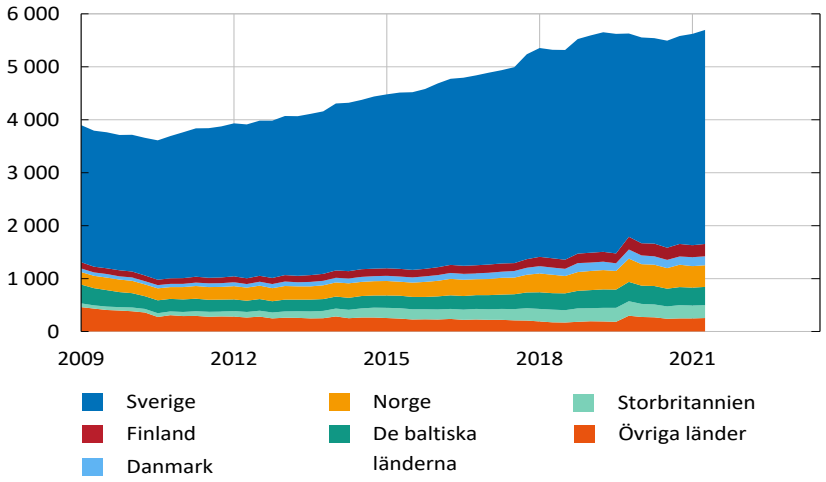
Anmärkning: KIX är ett viktat geometriskt kedjeindex där vikterna bygger på totala flöden av bearbetade varor och råvaror för drygt 30 länder. Vikterna uppdateras varje år, och baseras på data med några års tidsfördröjning.

Källa: Statistiska centralbyrån och Sveriges riksbank

[1] Här bör noteras att några av de länder som ligger högre upp i listan är så kallade skatteparadis där direktinvesteringar inte alltid är kopplade till någon real ekonomisk aktivitet. Istället motiveras de av skattemässiga fördelar av att använda bolag registrerade i dessa länder för transaktioner av olika slag.

Figur 3. De svenska storbankernas utlåning i olika länder och regioner

Miljarder kronor

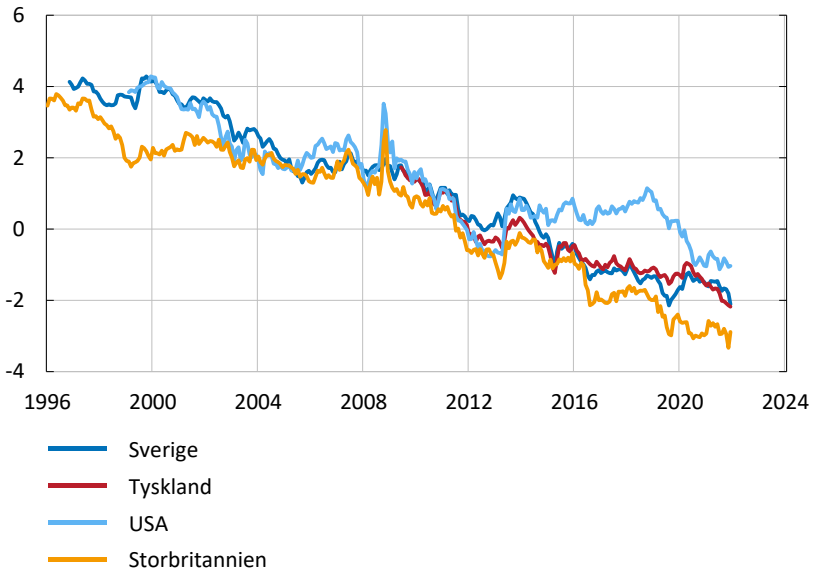


Anmärkning: Avser utlåning till allmänheten i Handelsbanken, SEB och Swedbank.

Källa: Bankernas delårsrapporter samt Sveriges riksbank.

Figur 4. Realräntor i olika länder

Procent



Anm. 10-årig real statsobligationsränta. Data för Tyskland från 2009.

Källa: Nationella centralbanker och Sveriges riksbank.

Det säger sig självt att ett land som Sverige, med detta starka omvärldsberoende, har ett egenintresse av internationella samtal och förhandlingar där man försöker enas om gemensamma regler och institutioner, eftersom vi gynnas av att den internationella integrationen kan ske på ett säkert och rättvist sätt. Sådana förhandlingar kan äga rum bilateralt, det vill säga mellan två enskilda länder, men för

ett litet land är det en stor fördel om det sker multilateralt, mellan flera länder samtidigt. Dels säkerställer det en mer enhetlig spelplan, eftersom överenskommelserna omfattar flera länder, dels minskar det möjligheterna för stora aktörer att dominera de mindre.

Om vi vill dra nytta av de fördelar som kommer av att handla med omvärlden är det viktigt att vi gör vår stämma hörd. I det multilaterala samtalet, där flera länder deltar, kan vi göra det på ett sätt som inte är möjligt i en värld där varje land förhandlar för sig och där störst tenderar att gå först. Insikten om den här krassa verkligheten har säkert bidragit till att Sveriges riksdag, regering och myndigheter har fäst så stor vikt vid det multilaterala samarbetet, inom organisationer som till exempel Förenta Nationerna, Världshandelsorganisationen, Internationella valutafonden (International Monetary Fund, IMF), Världsbanken, Organisation for Economic Cooperation and Development (OECD), Bank for International Settlements (BIS) och diverse regionala utvecklingsbanker.[2] Vägen in i olika organisationer har förvisso inte alltid varit okomplicerad och ibland kantad av försiktighet och tveksamhet (se bland annat avsnitt 2.3), men i slutändan har ändå fördelarna av ett deltagande bedömts väga tyngst.

2.2 Vår tidiga plats i BIS styrelse har varit viktig för vårt inflytande

Sveriges multilaterala engagemang började sålunda tidigt och det är en bidragande orsak till att det har blivit så framgångsrikt, inte minst för Riksbanken. Genom internationell lobbying och en hel del tur lyckades till exempel Riksbanken bli delägare i världens första multilaterala finansiella institution, Bank for International Settlements (BIS) redan vid starten 1930, och sedan 1931 har Riksbanken varit representerad i styrelsen, se Rooth (1930) och Sveriges Riksbank (1930). Som vi kommer att se går det knappast att överskatta värdet av detta, vare sig för Riksbanken eller för Sverige.

BIS brukar kallas för centralbankernas centralbank och erbjuder, möjligen i konkurrens med IMF, det viktigaste forat för internationellt centralbankssamarbete. Det är ingen överdrift att påstå att allt av vikt som sker inom centralbanksvärlden på något sätt dryftas i någon av BIS olika grupper. Men det är inte alla BIS-medlemmar som får delta i de olika grupperna och kommittéerna – våra nordiska grannar deltar till exempel i ett väldigt begränsat antal grupper, något som för övrigt gäller det stora flertalet av världens länder. Som medlem av styrelsen har emellertid dörren stått öppen för Riksbanken att delta i princip överallt. Som exempel har riksbankschefer sedan 1930-talet åkt till Basel varannan månad för att träffa cheferna för världens ledande centralbanker och diskutera aktuella frågor i grupper med mycket begränsat deltagande.[3] Vi har också kunnat påverka utformningen av globala riktlinjer för både banker och infrastrukturföretag, eftersom vi är medlemmar i den så kallade Baselkommittén för banktillsyn (Basel Committee for Banking Supervision, BCBS) och Kommittén för betalningar och marknadsinfrastruktur (Committee on Payments and

[2] För en beskrivning av olika internationella organisationer, se appendix.

[3] Från början ägde dessa möten rum varje månad. Sedan 2002 äger mötena rum varannan månad, se Toniolo (2005).

Market Infrastructures, CPMI).[4] Baselkommittén hade jag för övrigt förmånen att få leda under två mandatperioder, mellan 2011 och 2018. Det var en mycket intressant tid då kommittén hade en viktig roll i att reformera bankregelverket utifrån erfarenheterna från den globala finanskrisen. Att ha tillgång till den här exklusiva plattformen, som alltså är en direkt följd av att vi lyckades komma med i styrelsen så tidigt, är något som få europeiska länder, och inget annat nordiskt land, har lyckats med.[5]

2.3 Chefskap för IMF och FN

Sverige var inte riktigt lika snabbt med att gå med i de så kallade Bretton Woods-institutionerna: Internationella valutafonden (IMF) och Världsbanken. Det verkar bland annat ha bottnat i en viss svensk tvekan om ett medlemskap i Bretton Woods-institutionerna var lämpligt ur ett stabiliseringspolitiskt perspektiv. Det svenska utrikeshandelsberoendet förefaller emellertid ha varit en viktig förklaring till att den svenska inställningen svängde – ett medlemskap i den internationella världshandelsorganisationen (International Trade Organisation, ITO) och GATT-förhandlingarna bedömdes nämligen förutsätta ett IMF-medlemskap. Alternativt hade man kunnat upprätta valutaavtal med IMF:s medlemsländer som grundades på IMF:s stadgar, se Ahlström och Carlsson (2005). Ställda inför detta val ansökte regeringen om medlemskap i IMF – uppenbarligen bedömdes det som bättre för Sverige att då vara med i organisationen, och därmed få ett inflytande, än att stå utanför och ändå behöva följa dess regler.

Senfärdigheten att gå med i IMF berodde dock inte bara på tveksamhet från svensk sida. Vår neutralitet under det andra världskriget verkar ha lett till en viss misstänksamhet från bland annat USA, se Ahlström och Carlsson (2005). Misstron var dock inte större än att riksbankschefen Ivar Rooth blev chef för valutafonden, så snart Sverige hade blivit medlem i början av 1950-talet, bara för att sedan efterträdas av ytterligare en svensk, Per Jacobsson.[6] Att detta skedde samtidigt som Dag Hammarskjöld var chef för FN gjorde ju inte det hela mindre imponerande.[7] Sverige tillhör därmed den lilla skaran länder som har haft chefskapet för Internationella valutafonden, och är det enda landet utöver Frankrike som har haft posten mer än en gång.

[4] För en beskrivning av olika BIS-kommittéer, se BIS hemsida, www.bis.org.

[5] Först 1994 utökades styrelsen med centralbankscheferna i Japan och Kanada. Samma år valde den amerikanska centralbanken att ta sin styrelseplats i anspråk, se Toniolo (2005). Som ett av grundarländerna var Japan representerat i styrelsen från början, men man tappade sin styrelseplats i efterdyningarna av andra världskriget. USA hade sedan 1935 avstått sin styrelseplats av inrikespolitiska skäl, se Toniolo (2005).

[6] Ivar Rooth var IMF-chef från 1951 till 1956 och Per Jacobsson från 1956 till 1963.

[7] Dag Hammarskjöld var FN:s generalsekreterare från 1953 till 1961. Under större delen av 1940-talet ledde Ivar Rooth och Dag Hammarskjöld Riksbanken, Rooth som riksbankschef, Hammarskjöld som ordförande i Riksbankens fullmäktige, se Barvèll m.fl. (2019).

2.4 Framgångsfaktorer bakom internationellt inflytande

Små länder måste vara konstruktiva

Att som litet land utöva verkligt inflytande i internationella sammanhang är svårt. I förhandlingar med enskilda, stora länder menar jag att det är mer eller mindre omöjligt, men även i ett multilateralt sammanhang finns det vissa faktorer som jag betraktar som avgörande för om ett land ska nå inflytande eller inte.

Att delta och befinna sig vid bordet när internationella frågor förhandlas är förstås en förutsättning för att kunna vinna inflytande, men det är lika viktigt att vara engagerad och konstruktiv, i synnerhet om man kommer från ett litet land. Det gäller att visa att man bidrar till att föra frågor framåt, och inte bara agerar bromskloss genom att ta hänsyn till inhemska särintressen. Jag menar att vi i Sverige länge har haft en tjänstemannakår som har just den inställningen, såväl inom regeringskansli som myndigheter. Vi kanske inte alltid är så belevade och eleganta som fransmän och britter, men vi är flitiga och fokuserade på att hitta effektiva samförståndslösningar som är bra för alla – inte bara enskilda intressegrupper. Min erfarenhet är att omvärlden också vet att svenska tjänstemän är drillade i hur man agerar för att komma framåt och få jobbet gjort. Det här har bidragit till att svenska representanter ibland har lyckats få ett inflytande som är större än vad som kan motiveras av Sveriges ekonomiska och politiska vikt. Det finns undersökningar som bekräftar den här bilden. Forskare vid Göteborgs universitet har till exempel mätt vilket så kallat nätverkskapital olika EU-länder har. Där ligger Sverige på en hedrande fjärdeplats, se Johansson m.fl. (2019). Det är också talande att den tidigare förste vice riksbankschefen Kerstin af Jochnick blev utsedd att ingå i bankunionens tillsynsnämnd som en av fyra representanter för Europeiska centralbanken (ECB) – trots att Sverige inte ens är med i bankunionen. Jag är också säker på att den här konstruktiva grundsynen hos mina medarbetare på olika nivåer i hög grad kan förklara det faktum att jag har fått förmånen att bli förste vice ordförande i Europeiska systemrisknämnden (European Systemic Risk Board, ESRB) och vice ordförande i BIS styrelse.

Sverige har ställt upp när det behövts

En annan viktig förutsättning för att ett land ska få verkligt inflytande är att andra länder förstår att landet är att räkna med om det blir problem. I klartext innebär det att man är beredd att lägga plånboken på bordet och ställa upp med lån när andra tvekar. Och det har vi i Sverige genom åren visat att vi är. Riksdagen beslöt till exempel att vi skulle vara ett av de länder som 1962 bildade General Arrangements to Borrow (GAB), den ”reservkassa” som IMF kunde använda sig av om de reguljära finansieringskällorna inte skulle räcka till. Sverige har också ställt upp med bilaterala lån till IMF vid olika tillfällen och vi deltar även i den så kallade New Arrangements to Borrow (NAB) som har ersatt GAB som IMF:s reservfinansiering. Härutöver ställde riksdagen upp med bilaterala lån till Island, Lettland och Irland i samband med den

senaste finansiella krisen.[8] I den vevan ställde Riksbanken också upp med swap-linor till andra centralbanker för att hantera de akuta behoven innan stöd från regeringar och IMF/EU hade hunnit komma på plats, se Leung (2020). 2015 ingick Riksbanken också ett swap-avtal med den ukrainska centralbanken, se Sveriges riksbank (2015). Till detta ska förstås också hela det svenska biståndet läggas. En del av detta utgörs av Riksbankens engagemang i så kallad teknisk assistans, finansierad av Sida. Riksbanken har för närvarande projekt igång med centralbankerna i Namibia, Palestina, Rwanda och Ukraina. Relativt storleken på den svenska ekonomin är Sverige en av de största biståndsgivarna i världen – så man kan nog säga att vi har dragit vårt strå till stacken.

Den här beredvilligheten att ställa upp med resurser, i Riksbankens fall genom lån, har varit viktig för vårt internationella inflytande.[9] Som exempel vill jag lyfta fram Sveriges medlemskap i den så kallade G10-gruppen som består av de länder som var med och skapade GAB, nämligen G7-länderna plus Nederländerna, Belgien och Sverige. Efter två år anslöt även Schweiz, så antalet länder uppgick till elva, men man behöll namnet G10. Att Sverige kom att tillhöra den här gruppen har varit oerhört viktigt för vårt internationella inflytande. Det har erbjudit en direkt ingång till G7-länderna och underlättat för våra beslutsfattare att bygga relationer med sina motsvarigheter i världens mäktigaste länder. Svenska representanter har härmed tillhört en krets betrodda som har fått tillgång till information som vi annars inte hade fått. Det är ett intressant faktum att samma grupp av länder är de som under lång tid har bildat BIS styrelse. Att vi, genom tur och skicklighet, lyckades komma med i BIS styrelse 1931 har därmed, enligt min uppfattning, varit en mycket viktig förklaring till vårt relativt starka internationella inflytande under resten av 1900-talet.

2.5 Vi tjänar på att vår omvärld mår bra

Att ställa upp för andra har dock inte bara gett Sverige inflytande i olika organisationer. Lika mycket handlar det om den enkla sanningen att instabilitet riskerar att smitta från ett land till ett annat, något som blir smärtsamt tydligt i fallet Ukraina, även om det i det fallet primärt handlar om säkerhetspolitisk instabilitet, snarare än ekonomisk. Som ett litet land har vi ett särskilt intresse av att förhindra instabilitet i vår omvärld, eftersom vi är helt beroende av vår omvärld för att kunna exportera och behålla vår finansiella stabilitet. Det innebär att ”det som är bra för dig är bra för mig”. Det här är ett annat sätt att säga att internationell handel och tillväxt inte är ett nollsummespel, utan istället ett exempel på en klassisk vinn-vinn-situation. Ur det här perspektivet är det till exempel lovvärt att man inom EU har lyckats enas om ekonomiskt stöd, såväl till Ukraina som till länder som har drabbats relativt hårt av pandemin.

[8] För information om de olika krediterna, se Finansutskottet (2009, 2010, 2012). Till följd av den ryska invasionen av Ukraina beslöt riksdagen den 28 februari 2022 att inte bara ge humanitärt stöd, utan även stöd i form av finansiering, vapen och skyddsmateriel till de ukrainska väpnade styrkorna.

[9] Det är värt att notera att Riksbanken aldrig har gjort några kreditförluster på sina krediter till IMF eller andra centralbanker.

3 Utmaningar för Sverige

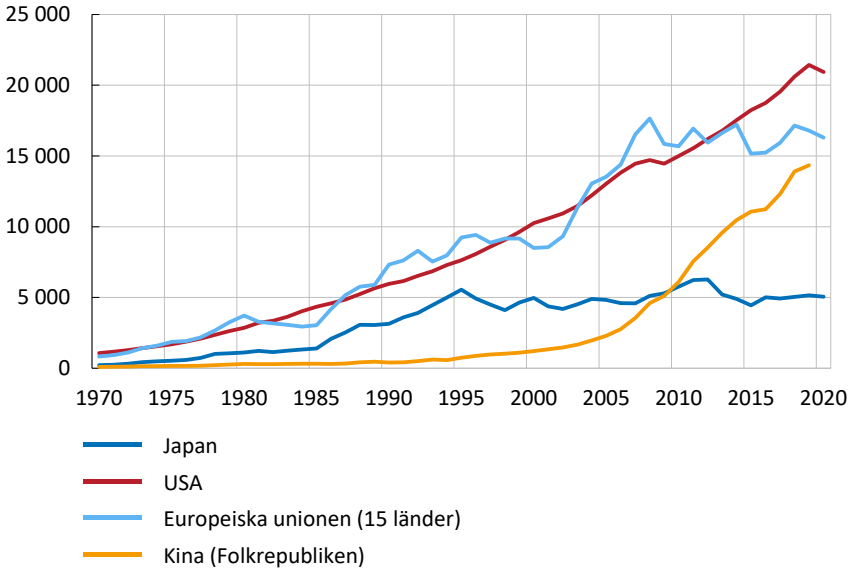
Sveriges möjligheter att delta i, och utöva inflytande över, det internationella samarbetet är dock inte utan utmaningar. Till följd av globaliseringen förändras nämligen den internationella miljö som Sverige agerar i snabbt och påtagligt.

3.1 Förändrade globala styrkeförhållanden pressar Sverige

Det mest direkta resultatet av globaliseringen är att de ekonomiska styrkeförhållandena har förändrats. Det här är en process som har pågått under en lång tid och resultatet är framför allt att så kallade tillväxtekonomier i Asien och Latinamerika har vuxit i styrka jämfört med Europa och USA. Särskilt anmärkningsvärd har förstås den kinesiska utvecklingen varit, se figur 5. Att de här länderna växer snabbare än vi är i sig ingenting att beklaga, även om det hade varit trevligt om framför allt vissa europeiska länder hade kunnat prestera bättre. I själva verket hade världsekonomin utvecklats betydligt svagare utan draghjälpen från dessa framväxande marknader. Inte minst hade det varit kännbart för Europa under de senaste tio åren. Som jag tidigare nämnde så är det här en illustration av att ekonomisk tillväxt inte är ett nollsummespel – i absoluta tal går det bättre för oss om det går bättre för vår omvärld.

Figur 5. Produktion i olika länder och regioner

BNP i löpande priser, miljarder USD



Källa: OECD

Sverige har inte kommit med i G20 och FSB

Baksidan av den här utvecklingen ligger för Sverige istället på det politiska planet och våra möjligheter att bedriva ekonomisk diplomati. Tillväxtekonomierna har nämligen legitima förväntningar på att få en politisk representation i det internationella samfundet som speglar deras växande ekonomiska styrka. Och i hög grad är det

Europa som förväntas maka på sig. Den tydligaste illustrationen är kanske framväxten av G20 och Financial Stability Board (FSB). De här grupperna bildades eftersom de stora länderna såg ett behov av att skapa forum som bättre återspeglade de förändrade globala ekonomiska styrkeförhållandena än vad existerande organisationer gjorde. På initiativ av G7-länderna skapades därför G20 år 1999. Gruppen är inte någon formell organisation utan mer ett organiserat samarbete. Den består av G7-länderna och ett antal av de största och mest snabbväxande tillväxtekonomierna, varav ingen är europeisk. Samma år skapade G7 också Financial Stability Forum (FSF) som då inte omfattade tillväxtekonomier. Det ändrades dock i samband med den globala finanskrisen, och 2009 omvandlades FSF till FSB där samtliga G20-länder deltar plus Nederländerna, Schweiz och Spanien.

Genom att se på hur G20 och FSB är sammansatta kan vi på ett tydligt sätt se den särskilt utsatta position som Sverige befinner sig i: Istället för att låta dessa grupper bestå av G10 plus starka tillväxtländer valde man att låta FSB bestå av G10 minus Sverige och Belgien, men plus Spanien och en rad tillväxtländer.

Det här är den hittills tydligaste illustrationen av att Europa i allmänhet, och Sverige i synnerhet, inte längre har samma priviligierade ställning i det internationella samarbetet som tidigare. Riksbanken har argumenterat för att Sverige borde vara medlem i FSB som representant för den nordiska regionen, men utan större framgång. Vi lyckades visserligen få med Riksbanken och Finansinspektionen i vissa kommittéer där vi bedömdes som särskilt relevanta, men svenska myndigheter blev inte fullvärdiga medlemmar. Riksbanken har sedan överlåtit till Riksgäldskontoret att delta som ansvarig myndighet för resolution av banker. Huvudanledningen till att Sverige lyckades få en viss representation var att vi var hemland för Nordens enda globalt systemviktiga bank, Nordea – skulle Nordea hamna i blåsväder var det praktiskt att ha de ansvariga myndigheterna i närheten. I och med att Nordea nu har flyttat till Finland har dock det svenska deltagandet i FSB:s kommittéer redan börjat minska.[10]

En annan illustration av Sveriges minskande roll internationellt är hur vår tillgång till så kallade swap-linor med andra centralbanker har förändrats. Så sent som under finanskrisen 2008–09 tillhörde Sverige de länder som i första omgången erbjöds en swap-lina med den amerikanska centralbanken, Federal Reserve. Riksbanken var då bland annat i sällskap med centralbankerna i länder som Kanada, Japan, Schweiz och Storbritannien samt ECB. Centralbankerna i dessa andra länder har sedan 2013 en stående swap-lina med Federal Reserve. När Federal Reserve i början av pandemin erbjöd tillfälliga swap-linor till andra centralbanker var Riksbanken en av nio centralbanker som erbjöds en sådan. För övriga centralbanker som var i behov av amerikanska dollar inrättades en ny lånefacilitet.[11] Federal Reserve har därefter avslutat de tillfälliga swap-linorna och Riksbanken har anslutit sig till lånefaciliteten.

[10] 2018 övertog Finland deltagandet i FSB:s grupp för att identifiera databehov för globalt systemviktiga banker.

[11] Faciliteten som kallas Foreign and International Monetary Authorities (FIMA) Repo Facility innebär lite förenklat att en centralbank ingår ett avtal om att sälja amerikanska statsobligationer till Federal Reserve och samtidigt förbinder sig att dagen efter köpa tillbaka dessa. Till skillnad från en swap-lina, där den

Europa pressas i IMF

Ett annat tydligt exempel på att Europa och Sverige pressas tillbaka på den internationella arenan ser man inom IMF. Här är trycket stort från snabbväxande tillväxtekonomier att deras nya ekonomiska styrka ska avspeglas i deras relativa röststyrka. Det här är förstås ett legitimt krav, men samtidigt är det inte givet hur det ska justeras och beräknas rent tekniskt. Länder som till exempel Kina är inte blyga och passar vi oss inte så riskerar vi att drabbas hårdare än vad som är rimligt. Hur det här ska åstadkommas i praktiken är därför något som tjänstemän i regeringskansliet och på Riksbanken får lägga ganska mycket gemensamt krut på att förhandla internationellt.

Det här globala förhandlingsspelet har bland annat resulterat i ett åtagande från Europas utvecklade ekonomier om att reducera sin representation i IMF:s så kallade exekutivstyrelse.[12] Tanken är att denna representation ska minskas med motsvarande två exekutivdirektörstjänster. Det här har utvecklats till ett kattrakande inom Europa där de större EU-länderna har gjort klart att de inte har något som helst intresse av att bidra.[13] Även här är det nödvändigt för oss att intensivt bevaka våra intressen. Annars riskerar vi att den nordisk-baltiska valkrets som Sverige nu tillhör kommer att upplösas och vi i slutändan får en betydligt sämre nationell representation i IMF.

Sveriges position i BIS är osäker

En ytterligare organisation där Riksbanken, och därmed Sverige, riskerar att tappa inflytande inom en inte alltför avlägsen framtid är BIS. Som jag nämnde tidigare har riksbankschefer varit medlemmar av styrelsen alltsedan 1930-talet, se Toniolo (2005). Fram till nu har varje ny riksbankschef i praktiken blivit invald per automatik. Faktum är att från 1942 fram till 2009 utsågs styrelseordföranden från ett av vad vi i dessa sammanhang ofta kallar knatteländerna, det vill säga Belgien, Nederländerna, Schweiz och Sverige, något som tydliggör vilket starkt inflytande dessa länder hade då. Därefter har modellen för att tillsätta en ordförande ändrats och någon ordförande från dessa fyra länder har inte utsetts. Jag blev förvisso utsedd till vice ordförande i styrelsen så sent som i november 2021, men det är ändå tydligt att de små ländernas ställning i BIS håller på att försvagas. Nyligen genomfördes också en styrelsereform som bland annat innebär att det maximala antalet styrelseledamöter har minskats, och att det inte längre är lika självklart att länder får förnyat förtroende, se BIS (2016). Även här lever Sverige farligt – om en ny ledamot ska väljas in i styrelsen är risken överhängande att en ny svensk riksbankschef inte kommer att få någon plats.

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behövande centralbanken kan skapa den egna valutan för att få dollar, kräver utnyttjande av lånefaciliteten att den berörda centralbanken äger amerikanska statsobligationer.

[12] Exekutivstyrelsen ansvarar för IMF:s dagliga verksamhet och består av en representant för respektive valkrets under ordförandeskap av IMF:s verkställande direktör. Andra viktiga organ i IMF är guvernörsstyrelsen, som ansvarar för IMF:s strategiska styrning, och Internationella monetära och finansiella kommittén (IMFC) som är IMF:s högsta policyskapande organ.

[13] I många fall delar europeiska länder valkrets med länder från andra delar av världen. En minskning av styrelserepresentationen kan då ske genom att justera de rotationsscheman som styr hur ofta och länge respektive valkretsland representeras i exekutivstyrelsen. Andra sätt att uppnå en reduktion är att slå ihop valkretsar eller att skapa mer renodlade europeiska valkretsar.

3.2 Multilateralismen riskerar att tappa mark

Den hårdnande verkligheten märks inte bara i enskilda organisationer utan också i att själva det multilaterala samarbetet blir alltmer tillbakapressat, till förmån för förhandlingar mellan enskilda länder. Det här blev särskilt tydligt under den förra amerikanska administrationen. Förhoppningsvis kommer det att ändras under den nye presidenten, men i någon mån återstår det att se. Kina visar också en allt tydligare tendens att använda sin ekonomiska styrka för att sätta press på enskilda länder, inte minst i politiska sammanhang. En sådan press kan vara mycket svår att hantera om det inte finns internationella regelverk och institutioner att falla tillbaka på. För en frihandelsberoende nation som Sverige vore det därför mycket allvarligt om världens länder rörde sig bort från multilaterala samarbeten. Försvagade multilaterala organisationer innebär ofrånkomligen en direkt försvagning av Sveriges möjligheter att hävda sina intressen i det internationella förhandlingsspelet. Det gäller inte bara på det ekonomiska planet – de politiska effekterna är minst lika oroande, inte minst kopplade till Kinas ökande internationella självförtroende och Rysslands aggressiva expansionspolitik.

3.3 Eurons stärkta roll och brexit gör vårt utanförskap tydligare

Även inom EU sker det förändringar som påverkar Sveriges förmåga att utöva inflytande.

En effekt av den ekonomiska och finansiella krisen 2008–2009, som utvecklades till en kris för hela eurosamarbetet, har till exempel varit att euroländerna har intensifierat och fördjupat sitt ekonomisk-politiska samarbete, i syfte att valutaunionen ska fungera bättre. Det fördjupade eurosamarbetet illustreras bland annat av den tydligare roll den så kallade eurogruppen, det vill säga euroländernas finansministrar, har fått. De träffas regelmässigt kvällen före Ekofinmötena och har därmed möjlighet att koordinera positioner inför de formella besluten i Ekofinrådet. Euroländerna möts också inför stats- och regeringschefernas möten i Europeiska rådet, i så kallade euro summits, där man ger politisk vägledning i frågor med särskild betydelse för euroländerna, se Euro Summit Statement (2011).

Särskilt intensivt har arbetet varit med att ta fram ett ramverk för att hantera det djupt sammanlänkade europeiska banksystemet. Med den så kallade bankunionen har man inom EU skapat ett system med gemensam tillsyn av de stora europeiska bankerna genom ECB och gemensam resolution av fallerande banker genom Single Resolution Board.[14] Det pågår också ett arbete med att skapa det så kallade tredje benet i bankunionen – ett system för en gemensam insättningsgaranti – men här har man inte kommit ända fram ännu.[15] Bankunionen utgör ett svar på det så kallade finansiella trilemmat som går ut på att man inte samtidigt kan ha 1) integrerade finansmarknader och 2) finansiell stabilitet med 3) nationellt ansvar för tillsyn och resolution. Länderna i bankunionen har sålunda lämnat ifrån sig ett visst nationellt självstyre i utbyte mot ett mer integrerat och stabilare banksystem. Genom

[14] För information om bankunionen, se www.consilium.europa.eu/en/policies/banking-union/.

[15] För information om arbetet med en gemensam insättningsgaranti, se www.consilium.europa.eu/en/policies/banking-union/risk-reduction-european-deposit-insurance-scheme/.

bankunionen har euroländerna ytterligare anledning att samverka för att påverka utformningen av EU-regelverk så att de passar de egna intressena. Sammantaget innebär det här att det blir svårare för länder som står utanför euroområdet respektive bankunionen att påverka utformningen av de regler som kommer att gälla för oss.

Den andra viktiga förändringen i Sveriges möjligheter att utöva inflytande inom EU är kopplad till Storbritanniens utträde ur EU. Brexit är på många sätt en tragedi för Europa och kommer att leda till att såväl EU som Storbritannien tappar i ekonomisk och politisk styrka. De ekonomiska konsekvenserna kommer att bli allvarligare för Storbritannien, men även EU kommer att påverkas. Det gäller inte minst på det finansiella området där London är ett globalt finansiellt centrum. Hur EU väljer att hantera att detta finansiella centrum numera ligger utanför EU är något som kommer att få stor betydelse för den finansiella sektorn inom EU.

Före det brittiska utträdet var Storbritannien en mycket viktigt samarbetspartner för Sverige i EU-arbetet. Gruppen av icke-euroländer hade genom Storbritanniens medverkan en politisk och ekonomisk tyngd som gjorde det svårt för euroländerna att köra över gruppen, i synnerhet i frågor med bäring på de finansiella marknaderna.[16] I och med det brittiska utträdet har dock den situationen förändrats radikalt, med en tydlig maktförskjutning från icke-euroländer till euroländerna när det gäller inflytande över finansmarknadsfrågor. Det är särskilt olyckligt för ett land som Sverige med sin relativt stora finansiella sektor och internationaliserade näringsliv. Efter brexit tillhör vi en klart mindre inflytelserik grupp av länder, en grupp som vi dessutom har mycket mindre gemensamt med än med Storbritannien. Vi vet också att vissa av dessa länder har en tydlig ambition att gå med i eurosamarbetet i närtid. I takt med att gruppen av icke-euroländer krymper kommer den att bli alltmer perifer i ett EU-perspektiv.

4 Hur ser framtiden ut?

4.1 Internationaliseringen kan inte stoppas – vi måste göra vad som behövs för att klara kraven

I min analys av hur vi i Sverige bör hantera de utmaningar vi står inför tar jag avstamp i två grundläggande omständigheter, varav den ena är den jag nämnde inledningsvis: Sverige är fortfarande ett litet land. Och i relativa termer är det ännu mer sant nu än det var för 40–50 år sedan. Den andra omständigheten är att den fortsatta internationaliseringen inte kan stoppas och att vårt välstånd faktiskt är beroende av internationaliseringen. Visst finns det protektionistiska krafter som verkar åt andra hållet, men i det långa loppet har jag svårt att se att internationaliseringen inte ska fortsätta. Om inte annat kommer det att bli en ofrånkomlig följd av den teknologiska utvecklingen.

[16] Gruppen med icke-euroländer består av Bulgarien, Danmark, Kroatien, Polen, Rumänien, Sverige, Tjeckien och Ungern.

Som jag har noterat har svenska beslutsfattare länge visat en förståelse för de krav det här ställer. Den svenska, eller nordiska, modellen bygger inte på att skydda enskilda sektorer och företag, som i vissa andra länder. Istället handlar det om att underlätta produktionsomställningar genom att till exempel tillhandahålla sociala skyddsnät för individer. Den här osentimentala inställningen till att enskilda branscher ersätts av nya menar jag är fundamental för att vi ska kunna klara oss i en allt mer internationaliserad värld. Att ha en välskött, stark ekonomi är också något som ger behövlig tyngd i en europeisk diskussion som i allt högre grad kommer att domineras av euroländerna.

4.2 Nordisk-baltiskt samarbete kan värna inflytandet

Det faktum att Sverige tillhör en region som på många sätt är ekonomiskt och teknologiskt framgångsrik är också något som skulle kunna utnyttjas mer som argument i diskussionen om representation i internationella organisationer. De fyra största nordiska länderna befinner sig var för sig ungefär mellan plats 40 och 60 i världen räknat i total BNP. Ser man till Norden-Baltikum som en region har vi dock den sjuttonde högsta BNP:n i världen. Regionen är dessutom ekonomiskt och finansiellt välintegrerad med en mycket framskjuten position när det gäller innovation. Som en illustration har Sverige sedan 2006 legat bland de tre högst rankade nationerna i Network Readiness Index, som mäter hur väl olika länder förmår dra nytta av digitaliseringens möjligheter.[17] I den senaste mätningen 2021 var fyra av de nio högst rankade länderna från Norden, med Sverige och Danmark som tvåa och trea. Skulle vi därför kunna få in mer av ”valkretstänk” i olika organisationer skulle vi kanske kunna behålla mer av vårt internationella inflytande. Det skulle kunna vara relevant i flera organisationer, till exempel G20, FSB och BIS.

I det här sammanhanget kan jag med tillfredställelse konstatera att centralbankerna i Danmark, Island, Norge och Sverige i en gemensam kandidatur har lyckats bli värd för en så kallad BIS Innovation Hub (BISIH), med placering i Stockholm. Detta nordiska innovationscentrum, som invigdes den 16 juni 2021, har till uppgift att fördjupa analysen av tekniska finansiella innovationer som är relevanta för centralbanker. Centret kommer att fungera som ett nav för ett nätverk av experter inom innovation, för forskning om viktiga trender inom finansiell teknik av betydelse för centralbanker och för att främja internationellt samarbete i syfte att förbättra det globala finansiella systemets funktion. Tanken är att dra nytta av att Sverige och den nordisk-baltiska regionen i många stycken är världsledande inom innovationer relaterade till IT och finansiella tjänster. Hubben är en av totalt sju BISIH fördelade över hela världen.[18]

4.3 Självbestämmande är en chimär

Det faktum att Sverige över tiden tappar i relativ ekonomisk styrka och absolut politiskt inflytande menar jag ökar kostnaden av att stå utanför de samarbeten som står till buds. Dessutom vill jag hävda att den självständighet och det

[17] Network Readiness Index har tidigare tagits fram av World Economic Forum. Från 2019 tas det fram av den oberoende tankesmedjan Portulans Institute i Washington.

[18] BIS har också öppnat hubbar i Singapore, Hongkong, Schweiz, Kanada, Storbritannien och euroområdet (Frankfurt/Paris).

självbestämmande vi i Sverige tror oss vinna av att inte tillhöra det ena eller andra samarbetet i allt högre grad är en chimär. Låt mig ta några exempel: När riksdagen ska besluta om svensk lagstiftning på finansmarknadsområdet finns det inte många beslut de kan ta där det inte finns mer eller mindre begränsande lagstiftning på EU-nivå som man måste förhålla sig till. EU-lagstiftningen måste i sin tur förhålla sig till globala överenskommelser, eftersom inte heller EU agerar helt isolerat från omvärlden. Uppgörelser inom till exempel G20, FSB och Baselkommittén för banktillsyn binder EU, om inte legalt så dock politiskt, eftersom EU och enskilda EU-länder är representerade i dessa grupper.

Det här är till exempel en viktig aspekt när man diskuterar om Sverige bör delta i bankunionen. Det så kallade bankpaketet som nu håller på att genomföras i svensk lagstiftning begränsar nämligen svängrummet för både Finansinspektionen och Riksgälden ganska ordentligt, och gör att den självständighet vi tror oss behålla vid ett utanförskap naggas i kanten ytterligare – och den här utvecklingen lär inte avta i styrka.

Talar vi om behovet av nationella lösningar på till exempel betalningsområdet så ska vi vara medvetna om att den finansiella infrastrukturen redan är väldigt internationaliserad, se Segendorf och Skingsley (2022). Som exempel kan nämnas att en betalning mellan två svenska banker som avvecklas i Riksbankens RIX-system typiskt sett kräver utnyttjande av teknisk infrastruktur i 4–5 länder. Detta talar för att det är betydligt bättre att sitta med vid bordet och utöva det lilla inflytande vi har, än att stå ensamma och behöva anta regler utan att ha något inflytande över beslutsprocessen. I och med Storbritanniens utträde ur EU riskerar därmed Sveriges situation att bli mer och mer lik Norges, om vi inte har modet att närma oss kärnan i EU-samarbetet.

Vän av ordning kan invända att vissa EU-länder minsann har betydande strukturella problem och att eurosamarbetet stundtals har förefallit vara nära att kollapsa – är ett närmare samarbete med dessa länder verkligen bra för Sverige? Det är sant att det finns mycket att förbättra, både i hur enskilda ekonomier fungerar och hur samarbetet fungerar. Exempelvis har EU:s ansträngningar för att förbättra medlemsländernas potentiella tillväxt och funktion gått trögt. Det speglar delvis att medlemsländerna i unionen i många fall fokuserar på kortsiktiga kostnader med reformer och inte ser de långsiktiga vinsterna eftersom dessa ofta kommer framtida generationer till godo, och det är ju en grupp som har svårt att göra sin röst hörd i debatten. En starkare svensk röst i det här samarbetet skulle dock bidra till ett större fokus på öppenhet och frihandel och till att EU på marginalen blev bättre på att hantera de utmaningar som internationaliseringen inbegriper.

Utifrån mitt sätt att se på detta måste vi i Sverige fundera över vilka alternativ vi faktiskt har, givet de förändrade globala förhållanden som jag har redogjort för. Vi måste acceptera att Sverige är ett litet land och att vår ekonomiska välgång är beroende av frihandel och öppenhet. Att i ett sådant perspektiv värna ett nationellt självbestämmande som i många stycken är en chimär blir kontraproduktivt, gränsande till ologiskt. Vill man vara lite drastisk kan man uttrycka det som att man kan välja att backa sig in i framtiden i förhoppningen att vi står starkare vid sidan om. Eller så kan vi

acceptera att världen blir mindre och mer konkurrensutsatt för varje dag, och att den här processen ställer nya krav på oss som ett litet land. Grundfrågan som jag menar att vi i Sverige måste förhålla oss till är om det är bättre att sitta med vid bordet än att stå själva utanför – på engelska uttrycks det här ofta som att vara ”rule maker” eller ”rule taker”. Även om vårt inflytande vid bordet fortfarande kommer att vara begränsat så är jag övertygad om att vi successivt kommer att bli mer av det senare om vi inte aktivt verkar för att ytterligare fördjupa vårt internationella engagemang. Det gäller även om det i vissa stycken innebär att vi får ett minskat nominellt självbestämmande, vilket till exempel skulle vara fallet både om vi gick med i bankunionen och om vi övergick till euron.

5 Slutord

I den här artikeln har jag försökt ge mitt perspektiv på Sveriges roll i det internationella samarbetet: hur det har utvecklats historiskt, vilka faktorer som förklarar vår prioritering av det multilaterala samarbetet och det relativt stora inflytande som vi har haft under lång tid, men också de utmaningar vi möter i form av globala, och regionala, förskjutningar i olika maktförhållanden. Om man inte är medveten om de här förändrade förutsättningarna är det lätt att förledas att tro att vårt internationella inflytande är större än vad det i realiteten är, och att vi kommer att behålla vårt självbestämmande och inflytande om vi bara ”sitter still i båten”. Jag menar att det är en allvarlig missuppfattning. Vi måste ha en seriös diskussion om Sveriges framtida roll inom exempelvis EU-samarbetet som bygger på insikten att saker och ting förändras snabbt och att vi, som ett litet utrikeshandelsberoende land, måste förhålla oss till dessa nya förutsättningar. Den senaste utvecklingen i Östeuropa sätter de här utmaningarna i blixtbelysning och visar hur snabbt och oväntat förändringar kan ske och hur viktigt det är att ha beredskap och ett institutionellt kunnande för att hantera oförutsedda situationer.

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APPENDIX A – Ordlista

BIS – Bank for International Settlements: Banken grundades år 1930 och är därmed den äldsta internationella finansiella institutionen. En tidig uppgift för banken var att medverka i avvecklingen av det tyska krigsskadeståndet efter första världskriget. Banken ägs av 63 centralbanker världen över och har som syfte att stödja centralbankers strävan efter monetär och finansiell stabilitet genom internationellt samarbete. För detta ändamål bedrivs ett omfattande analys- och forskningsarbete, bland annat genom ett antal kommittéer och arbetsgrupper. Man fungerar också som värd åt vissa grupper, som bland annat Baselkommittén för banktillsyn som tar fram globala standarder för banktillsyn, och Financial Stability Board (FSB). BIS fungerar också som bank åt centralbanker. Banken har sitt säte i Basel, Schweiz.

FSB – Financial Stability Board: En organisation med representanter från centralbanker, tillsynsmyndigheter och finansdepartement, som grundades av G20 år 2009, med syfte att främja finansiell stabilitet genom att koordinera nationella finansiella myndigheter och internationella standardsättande gruppers arbete med att stärka reglering och tillsyn av den finansiella sektorn. FSB:s företrädare, Financial Stability Forum (FSF) grundades av G7-länderna år 1999. FSB:s sekretariat är beläget i Basel och finansieras av BIS. Medlemmar är myndigheter från Argentina, Australien, Brasilien, EU, Frankrike, Indien, Indonesien, Italien, Japan, Kanada, Kina, Mexiko, Nederländerna, Ryssland, Saudiarabien, Schweiz, Spanien, Storbritannien, Sydafrika, Sydkorea, Turkiet, Tyskland och USA.

G20: En informell sammanslutning av länder utan någon fast organisation och med ett roterande ordförandeskap. Gruppen utropade sig år 2009 som det primära forumet för ekonomiskt samarbete. Medlemmar i gruppen är Argentina, Australien, Brasilien, EU, Frankrike, Indien, Indonesien, Italien, Japan, Kanada, Kina, Mexiko, Ryssland, Saudiarabien, Storbritannien, Sydafrika, Sydkorea, Turkiet, Tyskland, USA. Spanien har en plats som permanent inbjuden gäst.

OECD – Organisation for Economic Cooperation and Development: Skapades 1961 ur den tidigare OEEC (Organisation for European Economic Cooperation), som i sin tur var en produkt av den så kallade Marshallplanen för Europas återuppbyggnad. Organisationen utgör ett samarbetsforum för medlemsländernas regeringar och syftar bl.a. till att främja ekonomisk tillväxt och sysselsättning och en högre levnadsstandard i medlemsländerna.

IMF – International Monetary Fund: Grundades år 1944 som en av de två så kallade Bretton-Woods institutionerna (den andra är Världsbanken). IMF verkar för att det globala finansiella systemet ska vara stabilt och att det inte ska uppstå internationella finansiella kriser. IMF övervakar och analyserar utvecklingen i de 190 länder som är medlemmar. Organisationen ger också teknisk assistans och lånar ut pengar till länder som genomför ekonomiska anpassningsprogram. IMF:s styrelse består av representanter för IMF:s 24 valkretsar, där varje valkrets innefattar ett land eller en grupp av länder.

Ombyggnad pågår av de finansiella strukturerna

Björn Segendorf och Cecilia Skingsley [*]
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Den digitala teknologin utvecklas snabbt och påverkar utbudet och efterfrågan på betaltjänster och finansiella tjänster. Men även hur den finansiella sektorn producerar dessa tjänster förändras. Den finansiella infrastrukturen är den ”fabrik” som den finansiella sektorn använder i denna produktion. Riksbanken tillhandahåller viktiga delar av den finansiella infrastrukturen. Det är alltså av yttersta vikt att Riksbankens utbud av infrastrukturtjänster möter de behov som finns på marknaden.

I den här artikeln beskriver vi de förändringar som drivs av den tekniska utvecklingen, vilka utmaningar de ger upphov till och vad Riksbanken gör för att framtidssäkra de tjänster som Riksbanken tillhandahåller den svenska marknaden.

1 Inledning

Den tekniska utvecklingen är snabb, inte minst inom kommunikation. På 100 år har vi rört oss från postgång, telegraf och radio till television, e-post och streaming. Vi kan lägga ut bilder som blir tillgängliga omedelbart på sociala medier och skicka sms som når mottagaren inom ett par sekunder. Det här är något som vi tar för givet, och vi förväntar oss samma snabbhet oberoende av landsgränser överallt i samhället.

Betalningar, värdepappershandel och andra finansiella tjänster är i grund och botten också en fråga om att överföra information mellan olika parter. Men inom dessa områden tycks utvecklingen inte ha givit upphov till samma realtidsupplevelse som inom annan kommunikation, med betalappen Swish som ett stort och viktigt undantag. Vill du betala räkningar tar det oftast en dag innan betalningsordern utförs. Vill du köpa eller sälja värdepapper på en marknadsplats kan du förvisso göra det online med en knapptryckning men själva utbytet av pengar och värdepapper sker först två dagar efter att affären gjorts upp.

Finansiella tjänster är inte bara långsammare än kommunikationstjänster. Fysiskt avstånd spelar också större roll. Kommunikationstjänsterna är numera i princip

[*] Vi vill tacka Marianne Nessén och Ulf Söderström för värdefulla kommentarer på tidigare versioner av artikeln.

oberoende av geografiska avstånd medan finansiella tjänster dras med hinder som ökar med avstånd och geografiska gränser.

Vill du ringa någon i Frankrike eller Spanien är det bara att slå telefonnumret, och ett mail går lika fort till Paris och Madrid som till Perstorp och Malung. Det spelar heller ingen roll var du befinner dig om du vill följa någon eller vara vän med någon på de olika sociala medier som finns. Som konstrast är betalningar till länder i eurozonen förvisso förhållandevis enkla och snabba jämfört med tidigare, men det tar fortfarande en dag för dem att nå fram. Vill du köpa aktier i Frankrike eller Spanien finns det få enkla sätt att göra det på. Det tar längre tid än att köpa svenska aktier och det är dyrare. När det gäller att flytta ekonomiska värden verkar det finnas en enkel tumregel: Ju längre värdet ska färdas, desto krångligare, dyrare och längre tid tar det.

2 Varför finansiella tjänster är så långsamma

För att förklara varför finansiella tjänster fortfarande fungerar så långsamt som de gör behöver vi först översiktligt beskriva den finansiella infrastrukturen. Kort sagt består den av de tekniska system som hanterar betalningar och transaktioner med finansiella instrument. Pengar och värdepapper bokförs och registreras nu för tiden i huvudsak digitalt. Allmänhetens avista-inlåning hos bankerna och staten, det vill säga pengar som omedelbart eller med kort varsel kan tas ut, uppgick till nästan fyra tusen miljarder kronor i november 2021 medan allmänhetens innehav av kontanter var lite över 60 miljarder.[1] Liksom avista-inlåningen är alla värdepapper också utgivna och registrerade digitalt. En betalning eller en värdepapperstransaktion är därför numera i all väsentlighet en fråga om att utbyta information mellan köpare, säljare och deras mellanhänder som vanligtvis är banker.

Låt oss ta två exempel, det första om vad som sker när en betalning ska utföras, det andra när ett värdepapper ska köpas.

2.1 Hur fungerar en betalning?

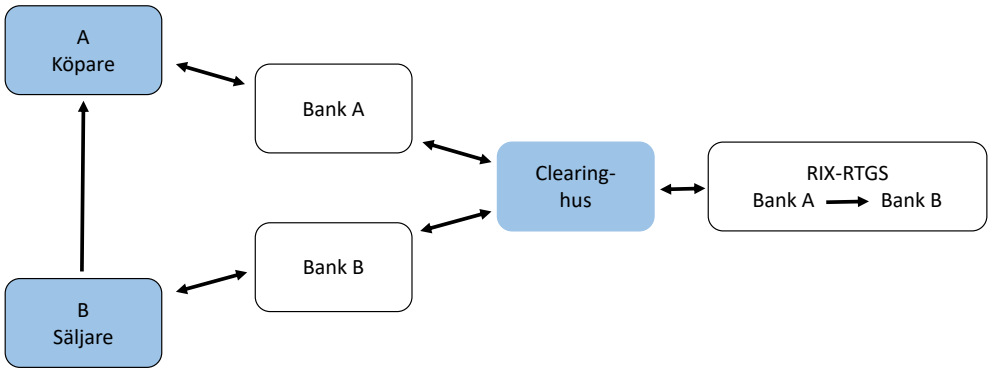
Låt oss börja med pengar och en betalning som ska göras digitalt. Pengar bokförs i allmänhet på konton hos en bank. Vid en betalning måste det vara möjligt för den betalande parten och mottagaren att ha konton i olika banker. Mottagarens och avsändarens banker behöver därför kommunicera, bokföra och utbyta pengar med varandra. Det sistnämnda steget kallas avveckling, vilket betyder att betalningen är slutgiltigt reglerad mellan de inblandade bankerna. Avveckling sker nästan alltid genom att bankerna har konton hos Riksbanken som de använder för att överföra pengar mellan varandra. Detta sker i Riksbankens betalningssystem RIX-RTGS där det genomförs runt 531 000 betalningar i månaden, med ett genomsnittsvärde på cirka 35 miljoner kronor. Årsomsättningen i RIX-RTGS är cirka 130 000 miljarder kronor, det vill säga nära 26 gånger Sveriges årliga BNP.

RIX-RTGS är byggt för att genomföra ganska få men stora betalningar mellan banker och inte för att hantera stora mängder betalningar eller den information som följer

[1] SCB, Finansmarknadsstatistik, november 2021, tabell 5.1.

med allmänhetens betalningar, som referensnummer, fakturanummer, kundnummer och annan liknande information. Eftersom antalet betalningar i ekonomin är mycket stort kan alltså inte bankerna sända alla betalningsinstruktioner mellan varandra en och en via RIX-RTGS utan de använder en central knutpunkt som kallas clearinghus, och som bakar samman betalningsinformationen från många små betalningar till stora filer och ser till att varje bank får rätt information vid rätt tillfälle.[2] Clearinghusen står alltså för den kommunikation, sammanslagning av betalningar inklusive beräkning av de belopp som bankerna ska betala till varandra vid avvecklingstillfället och underlag för den bokföring som behövs före och efter avvecklingen.[3] Clearinghusen kan också hjälpa bankerna att genomföra avvecklingen genom att skicka instruktioner till avvecklingssystemet. Tack vare clearinghuset behöver varje bank bara hantera ett fåtal informationsutbyten istället för många tusen per tidsintervall. Vilket clearinghus en bank använder beror på vilken typ av betalningar den gör. Exempelvis används Bankgirot för bankgirobetalningar och oftast Visa eller Mastercard för kortbetalningar.[4] Se Figur 1 för illustration av en betalning mellan en köpare och säljare med olika banker.

Figur 1. Betalning mellan köpare och säljare med olika banker där betalningsinformationen går via ett clearinghus



2.2 Hur fungerar köp av värdepapper?

Vårt nästa exempel handlar om handel med värdepapper som sker på en handelsplats, det vill säga en börs, där man kommer överens om pris och kvantitet. Köpare och säljare använder en bank eller en annan finansiell institution som mellanhand för att lägga in köp- eller säljordern på börsen. Ägarbytet registreras dock inte där utan hos en så kallad värdepapperscentral. I Sveriges fall är det Euroclear

[2] Följande anekdot kan illustrera det praktiska värdet av att använda en central knutpunkt. I 1770-talets London fanns det så kallade walk clerks som gick mellan bankerna för att lösa in och betala checkar. Det sägs att två av dem åt lunch på värdshuset Five Bells på Lombard Street. Under den välförtjänta vilan föreslog en av dem att alla walking clerks skulle träffas på Five Bells för att byta checkar istället för att gå runt som de gjorde nu. Det blev födelsen av det moderna clearinghuset. Se Shafik (2016).

[3] Dessa belopp som bankerna ska betala till varandra kan beräknas på två sätt: netto eller brutto. Nästan alla betalningsflöden som går via Bankgirot är bruttobelopp medan kortbetalningar är nettobelopp.

[4] Kortbetalningar via Visa och Mastercard är dock undantag från tumregeln att alla betalningar inom Sverige avvecklas i RIX-RTGS. Dessa betalningar avvecklas hos utvalda banker utomlands.

Sweden AB, där värdepapperna ges ut och ägarskap registreras.[5] Informationen om ägarskap ligger sedan till grund för aktieutdelningar, räntebetalningar och så vidare.[6] För vissa typer av transaktioner används också clearinghus för värdepappersaffärer.[7]

Värdepappersköpet är inte komplett förrän säljaren har fått pengar för värdepappret. Helst ska pengar och värdepapper byta hand samtidigt för att minska riskerna att någon av parterna inte får det de kommit överens om (kreditrisk) eller att de får det för sent (likviditetsrisk).[8] Ett sådant byte underlättas om konton för både värdepapper och pengar finns på samma ställe, vilket de gör i Sverige. Euroclear genomför överlåtelsen av värdepappret samtidigt som de överför pengar mellan köparen och säljaren, eller i deras ombuds konton hos Euroclear. Dessa konton kan ses som en del av RIX-RTGS genom att Riksbanken låter Euroclear administrera speciella RIX-konton i Euroclears egna system.

2.3 Säker infrastruktur viktig för att kronan ska fungera

Varför låter Riksbanken Euroclear administrera speciella RIX-konton? Jo, centralbanker har ett särskilt ansvar för att de finansiella infrastrukturerna fungerar väl, se figur 2.[9] Riksbankens uppdrag om prisstabilitet och ett säkert och effektivt betalningsväsende förutsätter nämligen att den finansiella infrastrukturen är säker och effektiv. Det finns ett ömsesidigt beroende mellan dessa uppdrag. Prisstabilitet och en säker och effektiv infrastruktur bidrar till att göra den svenska kronan attraktiv för betalningar inom Sverige. Att den svenska kronan används är i sin tur en förutsättning för att Riksbanken ska kunna bedriva penningpolitik och för att den betalningsinfrastruktur som Riksbanken tillhandahåller ska användas, inklusive kontanter. Om inte den svenska kronan används för ekonomiska transaktioner förlorar Riksbanken de verktyg som behövs för att Riksbanken ska kunna fullgöra sitt uppdrag.

[5] En värdepapperscentral är ett företag som tillhandahåller konton för värdepapper, förvaring och utgivning av värdepapper och ofta tillhörande tjänster som röstlängder vid bolagsstämmor, aktieutdelningar, ränteutbetalningar och så vidare. När värdepapper ges ut registreras de hos värdepappersförvararen som registrerar ägandeskap och överlåtelser samt säkerställer att informationen är korrekt och fullständig. En värdepappersförvarare driver vanligtvis ett avvecklingssystem för värdepapper och ibland också, som i fallet med Euroclear Sweden AB, ett system för avveckling av den tillhörande betalningen.

[6] I vår genomgång bortser vi för enkelhetens skull från så kallade custodians som är företag, vanligtvis en bank, som förvarar och administrerar värdepapper eller andra tillgångar för sina kunders räkning och som även kan tillhandahålla andra kringliggande tjänster som clearing och avveckling, likviditetshantering, valutaväxling och gränsöverskridande betalningar, kredit och pantsättning.

[7] Dessa clearinghus är ofta så kallade centrala motparter (Central Counter Party, CCP). På den svenska marknaden erbjuder två sådana clearinghus sina tjänster: Nasdaq för derivathandel och Euro CCP för aktier.

[8] Ett samtidigt byte av värdepapper och pengar betecknas ofta DvP som står för Delivery-versus-Payment.

[9] I de flesta länder ser det ut ungefär som i Sverige; man har ett eller två clearinghus för betalningar, en värdepapperscentral och en central motpart. Avvecklingen av betalningarna sker hos centralbanken. Dessa likheter har gjort det möjligt att utveckla gemensamma och globala standarder som den finansiella infrastrukturen ska leva upp till, se CPMI och IOSCO (2012) och CPMI (2005).

Figur 2. Hur en säker och effektiv finansiell infrastruktur bidrar till ett stabilt penningvärde och finansiell stabilitet

2.4 Länder har redan utformat sina egna infrastrukturer

Finansiella infrastrukturer är nästan alltid byggda för att fungera i endast ett land eller valutaområde. Det finns flera orsaker till detta. En är att olika länder har olika lagar som infrastrukturerna behöver bygga på och följa. Lagarna kan skilja sig mellan olika jurisdiktioner och ofta finns det historiska orsaker till detta. Även om man inom EU strävar efter att ha en gemensam lagstiftning och konvergens i nationella lagstiftningar finns det fortfarande skillnader. Exempelvis finns det krav på att betalningar i euro ska följa vissa standarder och regler som kallas SEPA (Single Euro Payment Area), vilket det inte gör för betalningar i svenska kronor.

Dessa legala och historiska skillnader gör att finansiella tjänster och betalningsprodukter ofta ser olika ut i olika länder**.** Exempelvis använder vi i Sverige vanligtvis kort från Visa och Mastercard medan Danmark har ett eget nationellt kort, Dankortet. En svensk hushållsräkning eller faktura har ett bank- eller plusgironummer och ett speciellt referensnummer för betalningen som följer en specifikt svensk standard.[10] De flesta betalningar och transaktioner sker dessutom inom landet. Hushåll betalar räkningar för till exempel el och vatten till lokala leverantörer, de arbetar lokalt och får betalt i lokal valuta. På samma sätt har företag ofta en stor andel betalningar lokalt. Också värdepapper handlas företrädelsevis på den inhemska marknaden. Därutöver finns det i allmänhet etablerade leverantörskedjor för export och import och upparbetade bankrelationer som gör det möjligt för företagen att göra betalningar mellan länder.

Sedan finns det ekonomiska faktorer som bidrar till att de nationella strukturerna har förblivit nationella. Finansiell infrastruktur är komplicerad och dyr att bygga. När man väl har investerat i IT-system, utformat processer, rutiner och regelverk har infrastrukturen en lång ekonomisk livslängd. Det är därför ofta billigare att fortsätta använda den infrastruktur som redan finns än att bygga en ny. Banker, företag, myndigheter och andra aktörer har dessutom redan investerat i utrustning, mjukvara

[10] Referensnumret kallas OCR-nummer där OCR står för Optical Character Recognition. Numret innehåller vanligen uppgift om fakturanummer, kundnummer eller båda, och syftar till att betalningsmottagaren ska kunna automatisera registrering och bokföring av inbetalningar.

och interna processer utifrån den existerande standarden. Även här finns en inlåsningseffekt. Att den större delen av transaktionerna är inhemska gör också att de ekonomiska drivkrafterna för att ändra i en befintlig infrastruktur är små. Ska större förändringar göras krävs ett övertygat åtagande från de som tillhandahåller infrastrukturtjänsterna och de som använder dem, och bestämda deadlines för att saker ska hända. Ta exempelvis införandet av den nya standarden ISO 20022 för finansiella meddelanden. Standarden publicerades ursprungligen 2004 och är en öppen internationell standard som är tänkt att användas över hela världen. Först 16 år senare beslöt SWIFT, som är en global leverantör av kommunikation- och meddelandetjänster till den finansiella sektorn, att övergå till den nya standarden.[11] Riksbanken och den svenska marknaden planerar att övergå till den under en övergångsperiod med slutdatum under 2025 för RIX-systemet. En omställning till någonting nytt tenderar med andra ord att ta lång tid, kräva noggrann planering och ta betydande resurser i anspråk.

3 Hur kan det bli annorlunda?

Ett monetärt system består av en valuta och de institutioner och ramverk som behövs för att pengarna ska kunna användas i ekonomin. Det svenska monetära systemet består till exempel av den svenska kronan, Riksbanken, Riksgälden, de svenska bankerna, den finansiella infrastrukturen och det legala ramverket. Historien visar också att det behövs en växelverkan mellan den offentliga och den privata sidan för att utveckla och värna väl fungerande monetära system. Vi menar att historien har gett oss åtminstone fyra lärdomar:

- För det första: För att ett monetärt system ska fungera behöver det finnas *förtroende för pengarna*. Det säkerställer man genom att ha en trovärdig utgivare som garanterar pengarnas värde. Att enas om en monetär enhet i ett land – det ekonomer brukar kalla *pengars enhetlighet* – gör också att systemet fungerar enklare och smidigare.
- För det andra: *Den tekniska utvecklingen*, som ofta är kopplad till något helt annat än betalningar, är en viktig drivkraft för förändring. Detta går hand i hand med *uppfinningsrikedom*, människans förmåga att reagera kreativt på behov som uppstår. Ibland kan det också leda till att det uppstår nya former av affärsverksamheter.
- För det tredje: *Den privata och den offentliga sektorn* kompletterar varandra eftersom de har olika uppgifter. Där den offentliga sektorn står för förtroende och stabilitet erbjuder den privata sektorn innovation. Genom historien har

[11] SWIFT (Society for Worldwide Interbank Financial Telecommunication) är ett kooperativt företag registrerat i Belgien. I början av 2022 tillhandahöll SWIFT säkra meddelandetjänster i 202 länder och till mer än 7 500 finansiella institutioner såsom banker, finansiella mäklare, förvaltare och mer än 100 finansiella infrastrukturer för betalningar, statspapper, värdepapper och handel med mera. SWIFT-meddelanden används för betalningar i betalningssystem för stora betalningar såsom RIX-RTGS. Huvuddelen av SWIFT-trafiken härrör dock från meddelanden mellan banker som ingår i olika korrespondentbanksarrangemang. Att ha tillgång till SWIFT:s nätverk är således nödvändigt för banker när det gäller att genomföra gränsöverskridande betalningar.

den offentliga sektorn ibland också behövt ta ledningen för att förändringar ska ske på ett sätt som gynnar oss alla i samhället.

- För det fjärde: *Nätverkseffekter och stordriftsfördelar* är viktiga faktorer att beakta när det handlar om betalningar. De hindrar nya aktörer från att ta sig in på marknaden, men ger också utrymme för effektivitetsvinster. Dessa båda effekter är i och för sig inget nytt, men de har fått större betydelse när betalningarna har digitaliserats.

Staten har en viktig roll när det gäller den finansiella infrastrukturen. Det är staten som stiftar de lagar som ska säkerställa att den finansiella verksamheten fungerar på ett sunt sätt. Det är också staten som ska säkerställa att den finansiella infrastrukturen och dess deltagare följer de lagar och förordningar som finns, har en sund finansiell ställning och lever upp till internationella standarder och andra krav. I Sverige har den privata sektorn ofta kunnat samordna sig och själv bygga mycket av den finansiella infrastrukturen. Men så är inte alltid fallet, vare sig i Sverige eller i andra länder. Centralbanken behöver då ofta gripa in och antingen försöka förmå marknaden att koordinera sig, det vill säga centralbanken antar en katalysatorroll, eller själv bygga och tillhandahålla infrastrukturen.

I så gott som alla länder är det centralbanken som tillhandahåller avveckling för stora betalningar på samma sätt som Riksbanken gör genom RIX-RTGS. De pengar som används för avvecklingen är en fordran på centralbanken och kallas för centralbankspengar. Avveckling på detta sätt minimerar kredit- och likviditetsrisker eftersom pengarna är en fordran på centralbanken och inte på någon privat aktör som kan hamna på obestånd. Centralbanken är också konkurrensneutral för deltagarna. Historiskt har staten emellanåt varit missnöjd med den privata sektorns utbud på betalningsmarknaden och tillhandahållit tjänster på andra sätt. Ett sådant exempel är Postgirot som bildades 1925 som en del av Postsparbanken för att bankernas tjänster för långdistansbetalningar i Sverige ansågs undermåliga.[12] Att skicka kontanter och checkar i kuvert, vilket var den då rådande tekniken, dög inte.

För att kunna gå från en situation med nationellt avgränsad infrastruktur till en situation med mer gränsöverskridande infrastruktur kommer staten att behöva ta en ledande roll men i nära samarbete med den privata sektorn. Och den svenska staten behöver också samarbeta med stater i andra länder. För Sveriges del sker det här framför allt på två nivåer: i EU och i globala regelverk.

3.1 Samarbetet intensifieras mellan länder

Både marknadsaktörer och beslutsfattare på den offentliga sidan börjar inse allt mer att nationellt definierade infrastrukturer inte fullt ut kan tillhandahålla de tjänster som efterfrågas i en allt mer ekonomiskt integrerad och digitaliserad värld. Denna

[12] Systemet med checkar och postväxlar var förknippat med stora kostnader för företag och banker, och 1917 tillsattes Postcheckskommittén. Syftet var att utreda behovet av en postcheckrörelse som antogs i hög grad kunna förenkla betalningar, underlätta bokföring och samtidigt ha låga avgifter eftersom det skulle vara relativt billigt att administrera. Posten skulle också slippa det tungrodda förfarandet med postanvisningar. Avsikten var också att minska hanteringen av kontanter. En proposition lades fram till riksdagen 1922 men avslogs. 1924 var det dags igen efter påtryckningar av Riksräkenskapsverket och Generalpoststyrelsen. Postgirot inrättades som en del av Postsparbanken, se SOU 1979:35.

insikt har vuxit fram under en längre tid men har speciellt aktualiserats under de senaste åren.[13]

De svenska storbankerna gick 2017 samman med sina danska och finska motsvarigheter för att bygga en nordisk clearingplattform för betalningar – det så kallade P27-initiativet.[14] Syftet med detta var både att fortsätta utnyttja stordriftsfördelarna och att underlätta betalningar mellan de nordiska länderna.

Också bland centralbankerna finns ett antal initiativ som vi kommer att berätta om i avsnitt 3.4. Först vill vi dock fokusera specifikt vad Riksbanken gör för att modernisera sitt utbud av tjänster.

3.2 Riksbanken anpassar sitt utbud av tjänster

RIX och dess nuvarande tjänster har bidragit till den finansiella stabiliteten och tjänat de svenska bankerna väl under ett antal år. Men kraven på ett modernt centralbankssystem för betalningar utvecklas efterhand. I och med globaliseringen ökar också behoven av anpassning av svenska tjänster och standarder mot de som används i vår omvärld. Nya funktioner efterfrågas och när deltagarna blir fler följer också högre driftsbelastning och risker. Det uppstår även nya typer av hot, framför allt i fråga om it-attacker, och för att hantera dem krävs specifika säkerhetsåtgärder.

Ovan har vi pratat om avveckling i RIX-RTGS, som har hand om stora belopp, och om clearinghusens roll. För slutkunden innebär det att transaktionen tar en dag eller mer. Men sedan 2012 finns Swish som ett alternativ för mindre transaktioner som kan utföras omedelbart.

Swishbetalningarna avvecklas i BiR, Betalningar i Realtid, ett avvecklingssystem som ägs och drivs av Bankgirot. I BiR avvecklas betalningarna mellan bankerna och inte i centralbankspengar utan i privata pengar som inte är riskfria fordringar på Riksbanken. För att minska den kredit- och likviditetsrisk som uppstår i och med det har Riksbanken och bankerna utarbetat en lösning där bankerna gör särskilda BiR-avsättningar i RIX-RTGS som fungerar som en garanti för betalningarna i BiR. Men i framtiden, när en stor andel av alla betalningar kommer att ske omedelbart, är detta arrangemang inte tillräckligt. Det beror delvis på att beloppen kommer att vara mycket större än i dag vilket återigen aktualiserar de kredit- och likviditetsrisker som uppstår vid avveckling i privata pengar. Bankernas behov av likviditet och att kunna justera sin likviditet i systemet kommer att vara större. Att som idag avsätta medel i RIX-RTGS är inte det enklaste sättet att möta dessa behov, och det har också vissa nackdelar för prognoser av likviditeten i RIX. Sammantaget skulle den nuvarande lösningen på sikt kunna medföra risker för den finansiella stabiliteten.

Efter en ingående analys har Riksbanken därför beslutat att utveckla en ny tjänst för omedelbara betalningar. RIX-INST, som vi kallar den, bygger på den Europeiska centralbankens (ECB) TIPS-plattform (Target Instant Payment Settlement) som

[13] En analogi är när Ernest Hemingway i boken *The Sun Also Rises* skriver: ”How did you go bankrupt?” Bill asked. “Two ways,” Mike said. “Gradually, then suddenly.”

[14] Se P27 Nordic Payments.

lanserades i november 2018 för att avveckla omedelbara betalningar i euro *och eventuellt andra valutor*. Med den här tjänsten kommer bankerna att kunna avveckla betalningar i centralbankspengar mellan sig, dygnet runt under årets alla dagar. Med utgångspunkt i RIX-INST kan bankerna sedan utveckla tjänster för omedelbara betalningar gentemot sina kunder.

RIX-INST innebär också att Riksbanken kommer att dela TIPS-plattformen med andra centralbanker, vilket har flera olika fördelar. För det första ger det effektivitetsvinster på grund av de stordriftsfördelar som vi talade om tidigare. Det är inte bara är de fasta utvecklings- och driftskostnaderna som fördelas på större volymer, utan även de framtida kostnaderna för skydd mot it-attacker och liknande. Det är en av de få saker som vi säkert vet om framtidens betalningar: Dessa kostnader kommer att öka framöver.

För det andra hjälper en gemensam plattform den svenska marknaden att harmoniseras till europeisk standard. Den bygger ju redan på de standarder som tillämpas i eurozonen och alltmer på hela den europeiska betalningsmarknaden som helhet. Det gynnar de svenska bankerna och deras kunder som har verksamhet i andra europeiska länder om de kan hantera sina betalningar på ett enhetligt sätt oavsett valuta. En sådan effektivisering av betalningsprocesserna både i Sverige och utomlands kommer att främja konkurrens på betalningsmarknaden.

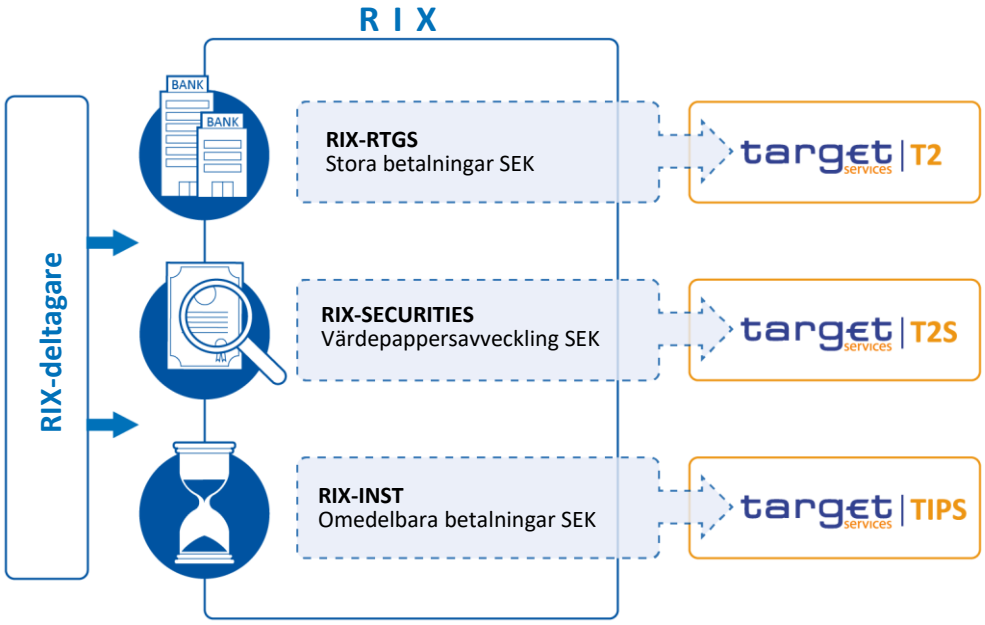
För det tredje kommer konkurrensen att stärkas ytterligare av att RIX-INST tillhandahålls på ett konkurrensneutralt sätt. Riksbanken kommer att besluta om åtkomst och priser utan hänsyn till kommersiella intressen som privata system skulle kunna ha. Det är särskilt viktigt med tanke på de hinder som nätverkseffekter och stordriftsfördelar skapar, framför allt om man beaktar att den här typen av betalningar blir allt vanligare.

Den här nya tjänsten öppnas för den privata sektor våren 2022 och kommer vara tillgänglig för de som är deltagare i RIX (se nedan).[15] Riksbanken och ECB undersöker samtidigt möjligheten att använda TIPS-plattformen för omedelbara betalningar mellan valutor som kronan och euron. Det kan vara ännu en fördel med att dela den här plattformen. Norge och Danmark avser också att använda TIPS för omedelbara betalningar i sina nationella valutor, se Danmarks Nationalbank (2020) och Norges Bank (2021). Det är även troligt att fler länder kommer att vilja ansluta sig till TIPS. Den kan då fungera som en knutpunkt för omedelbara betalningar mellan ett antal valutor.

Tjänsten RIX-INST kommer att erbjudas som en del av RIX, Riksbankens betalningssystem. Riksbanken undersöker även möjligheterna att använda andra av ECB:s plattformar för stora betalningar mellan banker (RIX-RTGS) och för värdepappersavveckling i svenska kronor, se figur 3. För de senare tjänsterna, se avsnitt 3.3.

[15] De aktörer som kan delta i RIX är kreditinstitut, värdepappersföretag, clearingorganisationer, värdepapperscentraler, centrala motparter och Riksgäldskontoret, se Villkor och anvisningar | Sveriges Riksbank.

Figur 3. Hur RIX kan komma att övergå till Eurosystements plattformar.



3.3 Ett helhetsgrepp på RIX

Riksbanken kommer att använda ECB:s TIPS-plattform för tjänsten RIX-INST medan den befintliga tjänsten RIX-RTGS tillhandahålls sedan 2009 genom Riksbankens egna system. Den tjänsten behöver dock förnyas. Därför beslutade Riksbanken i september 2021 att man skulle börja förbereda sig för att kunna använda Eurosystemets framtida plattform T2 för nästa generation av RIX-RTGS, se Sveriges riksbank (2021). T2 kommer att ersätta TARGET2, som är Eurosystemets nuvarande system för bruttoavveckling i realtid. Det kommer att innehålla ett antal tjänster som har förbättrats i förhållande till TARGET2 och baseras på den globala meddelandestandarden ISO 20022. Precis som TIPS kommer T2 dessutom att kunna underlätta betalningar i flera olika valutor – däribland eventuellt den svenska kronan. T2 ska tas i drift i november 2022.

Riksbankens direktion beslutade samtidigt att också inleda en liknande process för TARGET2-Securities, T2S, som är en plattform för simultan avveckling av värdepapper och pengar. I dag har bara en värdepapperscentral, Euroclear Sweden AB, tillgång till centralbankspengar i svenska kronor för värdepappersavveckling. Genom att ansluta sig till T2S skulle även andra värdepapperscentraler få tillgång till svenska kronor. De skulle då kunna bjuda ut tjänster på den svenska marknaden vilket skulle förbättra konkurrensen på den svenska marknaden. T2S inledde sin verksamhet 2015 och har utvecklats till att bli en plattform för flera olika valutor. Till exempel är den danska kronan tillgänglig för avveckling sedan oktober 2018.

På samma sätt som med TIPS som gemensam plattform skulle det ge Sverige betydande stordriftsfördelar att använda plattformarna T2 och T2S gemensamt med Eurosystemet. Det innebär att Sverige via Riksbanken får tillgång till Eurosystemets resurser och expertis. Det kommer i sin tur att bidra till att tjänsten framöver kan utvecklas i linje med bästa praxis. Att ansluta sig till de båda plattformarna skulle

dessutom bidra till att harmonisera den svenska finansmarknaden med den europeiska. Det ser Riksbanken som den bästa strategin för att både svenska och utländska banker och investerare ska kunna genomföra betalningar och handla värdepapper på ett effektivt sätt.

Eftersom detta är plattformar för stora betalningar kommer effekterna av att ansluta sig till T2 och T2S i första hand att ha betydelse för deltagarna i Riksbankens nuvarande avvecklingstjänst RIX-RTGS. Men i förlängningen bör det även spara kostnader för slutanvändarna av finansiella tjänster. Ett exempel kan vara företag som vill ge ut obligationer för att finansiera sin verksamhet. Det blir då en klar fördel för dem om de kan göra det inom en infrastruktur som harmoniserar med större europeiska marknader.

De förberedelser som Riksbanken har beslutat att inleda kommer att fungera som underlag när direktionen beslutar om vi ska inleda avtalsförhandlingar med Eurosystemet. Riksbanken behöver analysera ett antal viktiga punkter noggrannare. De rör allt från vilka konsekvenser besluten får för penningpolitiken och den finansiella stabiliteten till möjliga reservlösningar. Vi måste också ytterligare undersöka vilka eventuella krav som måste vara uppfyllda enligt den svenska säkerhetsskyddslagstiftningen.

Detta är inget som sker över en natt. Beslutet att gå vidare följs av arbete som tar flera år – förhandlingar med Eurosystemet, implementering, testning och så vidare. Den första transaktionen med svenska kronor på T2 eller T2S sker sannolikt först om kanske sju eller åtta år.

3.4 Det globala arbetet rör sig fort

Världen stannar som bekant inte vid EU:s gränser, utan allmänheten behöver kunna flytta ekonomiska värden runt hela jordklotet. Därför har G20-länderna utvecklat ett omfattande program för att förbättra betalningar mellan länder. Arbetet är uppbyggt som en färdplan med 19 olika delar, där 16 delar inriktas på att förbättra de nuvarande systemen. Inom del 17, 18 och 19 ser man istället på olika möjligheter att utforska framtida ännu inte helt operativa metoder för att förbättra betalningarna.[16]

Man skulle kunna säga att det arbete som G20 nu genomför är en modern och mer omfattande version av när den svenska staten införde Postgirot. På samma sätt som då är den offentliga sektorn missnöjd med hur det ser ut i nuläget, och ser ett behov av att både vägleda och driva på den privata sektorn. Men även här måste den offentliga och privata sektorn samarbeta. Betalningar mellan länder fungerar bara bra om det finns harmonisering, standarder och tillförlitliga rättsliga ramar. Detta är områden där den offentliga sektorn på global nivå har utlovat bättring, men i slutändan är det den privata sektorn som måste leverera slutprodukterna. Nu är det dock den offentliga sektorn som har stakat ut kursen och inom några år kommer

[16] Delarna 17, 18 och 19 omfattar multilaterala plattformar, stablecoins (se avsnitt 3.5) och digitala centralbanksvalutor. För mer information om detta arbete se CPMI Cross-border payments programme.

förhoppningsvis betalningar mellan länder att kunna genomföras nästan lika friktionsfritt som inom landet.

3.5 Kryptotillgångar skapar både hot och möjligheter

Samtidigt som den offentliga sektorn har tagit initiativet till att förbättra infrastrukturen för betalningar på en global nivå händer det mycket inom den privata sektorn. Vi har tidigare nämnt P27 men vill i det här avsnittet redogöra för en mer svårbedömd utveckling: kryptotillgångar. Kryptotillgångar skapas genom att utgivaren skapar en digital representation av sin tillgång, en så kallat token. De idag mest kända kryptotillgångarna är kryptovalutor som exempelvis bitcoin.[17] Kryptovalutor är överlag inte reglerade på det sätt som traditionella tillgångar som aktier och penningmarknadsfonder är, vilket gör att de saknar konsumentskydd och därmed är mer riskfyllda investeringar. Inte heller är de reglerade för att fungera som pålitliga pengar. För att pengar ska fungera som betalningsmedel måste de vara säkra och allmänt accepterade. Kryptovalutor har ingen bakomliggande stat som säkerställer finansiella infrastrukturer, välfungerande banker, sunda offentliga finanser eller ankare för pengarnas värde. Därför varierar också värdet på dem mycket.

En undergrupp inom kryptotillgångar kallas stablecoins. Deras värde är vanligtvis knutet till värdet på andra tillgångar, till exempel en nationell valuta.[18] Stablecoinutgivaren säger sig hålla en reserv i till exempel dollar. Stablecoins har likheter med penningmarknadsfonder eftersom reserven för vissa stablecoins till stor del är investerad i korta tillgångar som kommersiella papper. Men de lyder inte under samma regleringar och krav som dessa fonder gör. Vid finansiella kriser är det vanligt att marknadsaktörer flyttar sina innehav till säkrare tillgångar och att värdet på vissa andra tillgångar sjunker. Om tillgångarna i reserverna för stablecoins sjunker i värde kan det leda till att deras utgivare får likviditetsproblem. Om det i sin tur leder till att efterfrågan på stablecoins minskar kan utgivarna behöva sälja av sina underliggande tillgångar snabbt, vilket kan bidra till att priset på dem minskar ytterligare och förstärker en redan pågående spiral neråt.

Ett omfattande samarbete sker nu på global nivå för att dessa stablecoins ska regleras och övervakas på ett sätt som gör att de inte blir en källa till finansiella kriser. Rätt utformade och övervakade ska det inte uteslutas att stablecoins kan bidra till att betalningar mellan länder fungerar bättre.

Inom EU har Europeiska kommissionen presenterat förslag till en förordning om marknader för kryptotillgångar, den så kallade MiCA-förordningen. Den är tänkt att reglera utgivare och tillhandahållare av tjänster för kryptotillgångar.[19] I dagsläget

[17] Pseudonymen Satoshi Nakamotis webbartikel om bitcoin 2009 brukar räknas som startskottet för tillkomsten av kryptotillgångar, se Söderberg (2018) och Segendorf (2014).

[18] I juni 2019 tog Libra Association, ett konsortium lett av Facebook, ett initiativ till ett globalt stablecoin, se Cicović m.fl. (2019). Ett argument var att främja finansiell inkludering. Världsbanken uppskattar att mer än mer än 1,5 miljarder människor befinner sig utanför det finansiella systemet. För dessa har det hittills varit för svårt och för kostsamt att använda tjänster som vi i Sverige gärna tar som självklara: att ha ett bankkonto, kunna betala och vid behov ta lån. Detta initiativ bytte sedan namn till Diem och lades ner i januari 2022.

[19] MiCA står för Markets in Crypto Assets. För mer information om MiCA, se MiCA-förordningen.

omfattas inte kryptotillgångar av EU:s regelverk för finansiella tjänster – förutom regelverket för bekämpning av penningtvätt och finansiering av terrorism. Förslaget, som kan förväntas börja tillämpas i sin helhet någon gång under 2023 eller 2024, innehåller bland annat större krav på den som levererar tjänster kopplade till kryptotillgångar. Ett syfte är att stärka konsumentskyddet och minska riskerna för marknadsmissbruk. Förslaget syftar också till att hantera de hot mot den finansiella stabiliteten och de nationella valutorna som kan uppkomma om stablecoins skulle bli vanligare.

4 Slutsatser

Infrastrukturerna för finansiella tjänster är under hårt förvandlingstryck. Konsumenter, företag och myndigheter förväntar sig snabbare, billigare och smidigare tjänster. Den privata sektorn driver på för att olika marknadsägda infrastrukturer ska konsolideras, något som vi redan nu ser på nordisk nivå. Likaså strävar centralbankerna i eurozonen mot att konsolidera sin infrastruktur och andra länder har börjat använda dessa system. Vi ser även att lagstiftning och standarder fortsätter att harmoniseras mellan länder. Starka krafter pressar även på för att skapa globala betalningssystem eller åtminstone länka ihop de nationella till en helhet som fungerar bättre. Allt talar för att denna utveckling kommer att fortsätta.

Sverige, som är en liten och öppen ekonomi, har mycket att vinna på detta om det görs på rätt sätt. Billigare, snabbare och smidigare betaltjänster gör marknaderna för tjänster och varor effektivare. Samtidigt innebär en sådan utveckling nya investerings- och anpassningskostnader som kan vara omfattande. Det gäller att hitta en bra arbetsfördelning mellan privat och offentlig sektor. Riksbanken, som svarar för en del av infrastrukturen, kommer att använda ECB:s plattform TIPS för att erbjuda omedelbar avveckling av betalningar i svenska kronor. Riksbanken har också påbörjat ett arbete där man förbereder sig för att använda ECB:s plattformar till avvecklingstjänster för stora betalningar mellan finansiella institut och för värdepapperstransaktioner. Avsikten med det är att de svenska betalningsmarknaderna och de finansiella marknaderna ska fungera bättre. Den långsiktiga målsättningen är att det ska vara lika enkelt och snabbt att göra en betalning till utlandet som att skicka e-post eller följa någon på sociala medier.

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Understanding the foreign exchange market

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The foreign exchange market is an essential part of the global financial system and plays an important role in the economy. Over the last four decades, it has undergone large structural changes, from an opaque and slow-moving, clearly two-tiered market to today's fast-paced, interconnected yet fragmented market. Trading is becoming increasingly electronic and automated, and new participants, tools and strategies have entered the market. These structural changes have had considerable impact on the way foreign exchange is traded, priced and monitored. In this article I survey how the structure of the market has evolved over the last few decades, with a particular focus on the market for Swedish krona (SEK). I also discuss important mechanisms and features of the FX market; price discovery, liquidity and market functioning, and I present a measure of liquidity of the Swedish krona market.

1 Introduction

The foreign exchange (FX) market is an essential part of the global financial system and plays an important role in the economy. It is crucial in sustaining efficiency and arbitrage conditions in most other international financial markets, including the bond, stock and derivatives markets. The pricing mechanisms of the FX market affect financial conditions, resource utilisation and inflation, and so a proper understanding of these mechanisms is at the heart of central bank mandates and operations in many countries around the world. For the Riksbank, an inflation targeting central bank in a small open economy, understanding the drivers and fundamentals of the krona exchange rate, and how the FX market structure is evolving, is important to monetary policy and financial stability.

Over the last four decades, the FX market has undergone large structural changes. Beginning with the introduction of floating exchange rate regimes in the 1970s, currency trading has gone from an opaque and slow-moving, clearly two-tiered

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market to today's fast-paced and interconnected, yet fragmented, market with a growing number of participants and trading venues. Both price discovery and execution of trade, that is, the process by which trades are finalised, are to an increasing degree taking place electronically and automatically. As a result, new market participants, trading strategies and tools have emerged, affecting exchange rate determination and market functioning. In addition, the technological advances and increased competition between trading venues have resulted in enormous amounts of data being available to researchers and practitioners, albeit non-uniform in access and dispersed across multiple platforms.

Above and beyond changes to the structure of the FX market, exchange rate movements themselves are often difficult to explain, and even harder to predict. Conventional macroeconomic theory often assumes that exchange rates are determined as a price that equilibrates the returns to investing in foreign and domestic assets. In particular, these models rely on the so-called *uncovered interest rate parity (UIP)* condition*,* stating that the expected change in the exchange rate is determined by the interest rate differential between the two currencies in question. More specifically, the currency with the higher interest rate is expected to depreciate by the amount of the interest rate differential.

However, in reality, the empirical evidence of UIP remains elusive. Research offers many different explanations to this puzzling empirical fact, often related to the assumptions on which the UIP condition relies (for a survey of related research, see for example, Engel 2016). First, the UIP is based on the assumption of risk neutrality and, most often, empirical tests of UIP assume rational expectations among investors. Second, it assumes symmetric information among participants and that market prices immediately incorporate all available information. Since all participants have the same information set, which at any given point in time reflects the latest available information, only one price exists at any given point in time. Third, it requires a lack of trading costs or barriers and equal liquidity, maturity and default risk of the assets traded, see Engel (2014).

Few, if any, of these assumptions of market efficiency hold in the FX market and there is an extensive literature studying modified models that better capture exchange rate dynamics (see for example Fama 1984, Lyons 2001, Bacchetta and van Wincoop 2010 and Lustig and Verdelhan 2019). In fact, as this article will show in more detail, FX market participants are heterogeneous, transparency is limited and information is asymmetric. As a consequence, there are arbitrage opportunities that market participants are unable, or unwilling, to exploit because of the features of the FX market.

The structural changes to the FX market since the 1970s have had considerable impact on the way FX is traded, priced and monitored. Technological advances have made markets more efficient, reduced operational risks and lowered trading costs. Barriers to entering the FX market have been lowered, with new participants, trading venues and tools active in the market. The FX market of today is complex, fast-paced and highly fragmented; liquidity is deep but dispersed over a large number of venues that are to various extent interconnected to each other. Price formation is to an

increasing degree taking place outside of the conventional bank sphere, and as a consequence, agents or organisations wanting to monitor the market have had to turn to new venues and tools for information. The use of computers, algorithms and the ever-increasing speed of the FX market has also given rise to new challenges and risks. For instance, algorithms may amplify and intensify market movements, causing disorderly price movements even in the most traded and liquid instruments.

In sum, the lack of empirical support for traditional modelling of exchange rates and the rapid evolution of the FX market motivates a better understanding of the structure and functioning of this unique and complex market. Moreover, the FX market is integral to the international financial network and affects financial conditions. Therefore, in this article I survey the structure of the FX market: its current state and how it has evolved over the last few decades, with a particular focus on the market for Swedish krona (SEK). I also discuss important mechanisms and features of the FX market; price discovery, liquidity and market functioning, and present a measure of liquidity of the Swedish krona market.

The rest of this paper is structured as follows: the next two sections explore the evolution of the FX market structure from the 1970s to today. The fourth section discusses the implications of these developments for market monitoring, efficiency and market conditions. In addition, it covers the concept of market liquidity and presents an index for systematic measuring of liquidity in the SEK. The last section presents my conclusions.

2 FX market turnover and instruments

With a daily average turnover in 2019 of approximately USD 6.6 trillion, the global FX market is by far the largest and deepest of all financial markets.[1] It consists of several submarkets; the spot market, the FX swap market, the forwards market, the currency swap market and the options market being the largest five, see BIS (2019).[2] Every third year, the Bank for International Settlements (BIS) publishes statistical information on turnover in the FX market sorted by region, counterpart and instrument in the BIS Triennial Survey. It is the most comprehensive source of information on the size and structure of the global FX market, with data collections starting in 1986.[3] From this survey, we know that the Swedish krona, being one of the smallest of the ten most traded currencies (*G10 currencies*), has a daily turnover of around USD 134 billion. To put these numbers into perspective, daily global FX market

[1] Turnover is defined as the gross value of all new deals entered into during a given period, and is measured in terms of the nominal or notional amount of the contracts adjusted for double-counting, see BIS (2019).

[2] These five submarkets make up the majority of the total market in terms of turnover, although the list is not exhaustive. In addition, each submarket is divided into many additional markets depending on where and how contracts are traded.

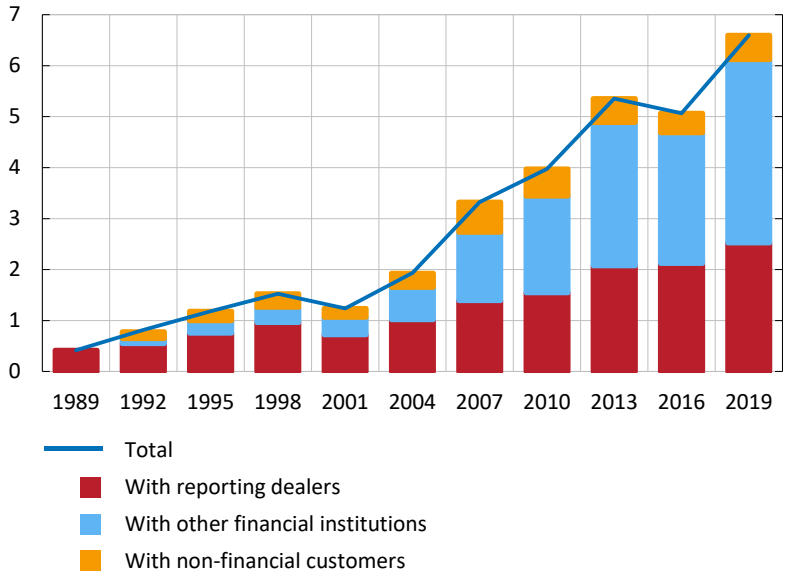
[3] The most recent edition, published in December 2019, took place in April 2019 and involved central banks and other authorities in 53 jurisdictions. These actors collected data from close to 1,300 banks and other dealers in their jurisdictions and reported national aggregates to the BIS, which then calculated global aggregates. Turnover data are reported by the sales desks of reporting dealers, regardless of where a trade is booked, and are reported on an unconsolidated basis, that is, including trades between related entities that are part of the same group, see BIS (2019).

turnover is approximately 27 times as large as daily world GDP, and turnover in SEK is over 90 times larger than the daily Swedish GDP.[4]

Non-financial customers, which is the client segment most closely linked to real economic activity, are counterparties in only a fraction of all FX trading. SEK turnover is, like the FX market in general, dominated by financial flows (see Figure 1 and 2). Financial institutions are counterparties in nearly 90 per cent of the turnover of all trades involving SEK.

Figure 1. Daily global turnover by counterpart

USD trillion

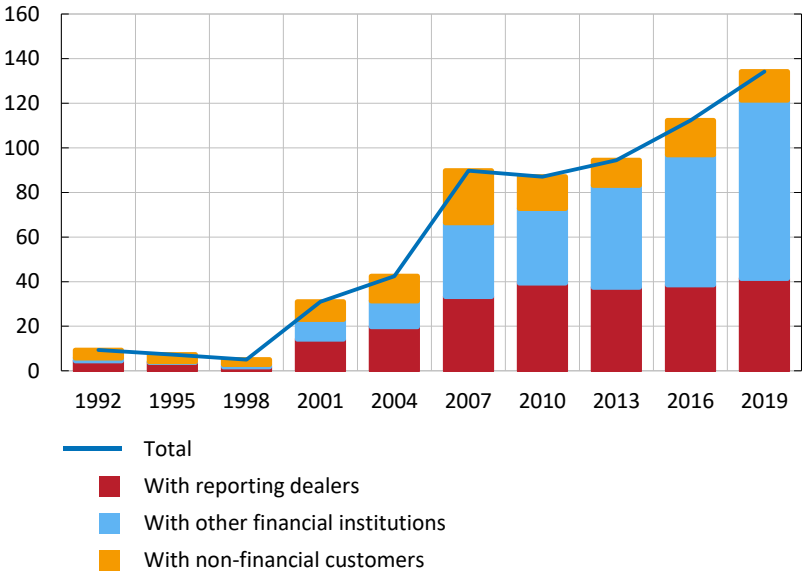


Source: BIS Triennial Survey (2019).

[4] The average daily global GDP in 2019 was approximately USD 240 billion while the Swedish daily average was around USD 1.45 billion per day. Daily GDP is calculated using the gross domestic product of 2019 in current USD, as reported by the World Bank, for the World and Sweden respectively, divided by the number of days in 2019 (365).

Figure 2. Daily SEK turnover by counterpart

USD billion



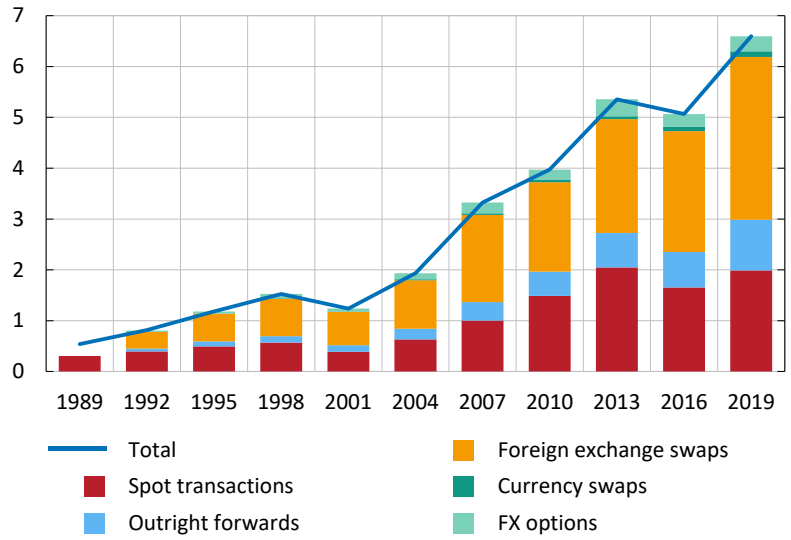
Source: BIS Triennial Survey (2019).

The most direct form of FX trading is the *spot market*, which covers around 30 per cent of the total global turnover, thereby making it the second largest of the submarkets (see Figure 3). Spot transactions involve the exchange of two currencies at a rate agreed on the date of the contract for value or delivery in two business days or less. The FX *forward market* is the third largest, covering around 15 per cent of reported turnover.[5] Forward transactions are defined as contracts between two parties for the delayed exchange of two currencies in which the buyer agrees to purchase and the seller agrees to deliver, at an agreed future date at an agreed price, see BIS (2016).

[5] FX forward transactions should not be confused with *FX futures*, which are exchange-traded, standardised contracts. *Forward* contracts are traded OTC (over-the-counter) and are privately agreed upon between two parties. *Futures contracts* are traded on an exchange and have standardised terms. Futures contract prices are settled daily until expiry of the contract. With the exception of the futures for the Mexican peso and the South African rand, FX futures are physically delivered on the four International Money Market dates (the third Wednesday of March, June, September and December). Futures are not reported as part of the foreign exchange market in the BIS Triennial Survey, nor are they considered in this article.

Figure 3. Daily global turnover by instrument

USD trillion



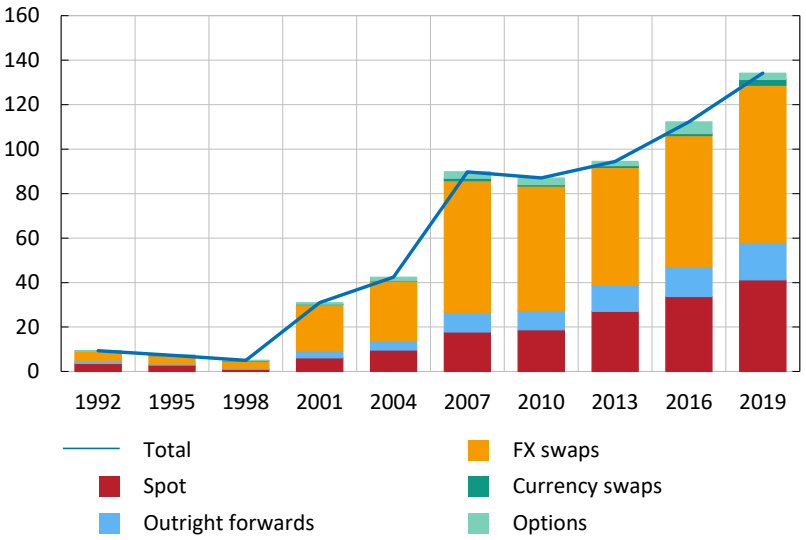
Source: BIS Triennial Survey (2019).

The largest FX submarket in terms of turnover is the FX *swap market*, which with its USD 3.2 trillion comprises almost half of the total turnover of the global FX market. An FX swap is a transaction involving the exchange of two currencies on a specific date at a rate agreed upon at the time of the start of the contract (the near leg), and a reverse exchange of the same two currencies at a date further in the future at a rate agreed at the time of the contract (the far leg), see Baba et al. (2008). The near leg may be a spot transaction or a forward transaction, while the far leg is a forward transaction. FX swaps are used to raise foreign currency, both for financial institutions and their customers, including exporters and importers, as well as institutional investors who wish to hedge their holdings of foreign assets. Swedish banks are frequent users of FX swaps, using them to swap foreign currency denominated financing (typically USD or EUR) into SEK. Swedish pension and investment funds and corporates are typical counterparts in the swaps, having an interest in obtaining foreign currency in exchange for SEK to invest abroad, at very little currency risk. Swedish banks, on the other hand, obtain relatively cheap financing in SEK through such swap agreements.[6] FX swaps comprise more than half of total SEK turnover (see Figure 4).

[6] See for example Sveriges Riksbank (2020) and Bertsch (2022).

Figure 4. Daily SEK turnover by instrument

USD billion



Source: BIS Triennial Survey (2019).

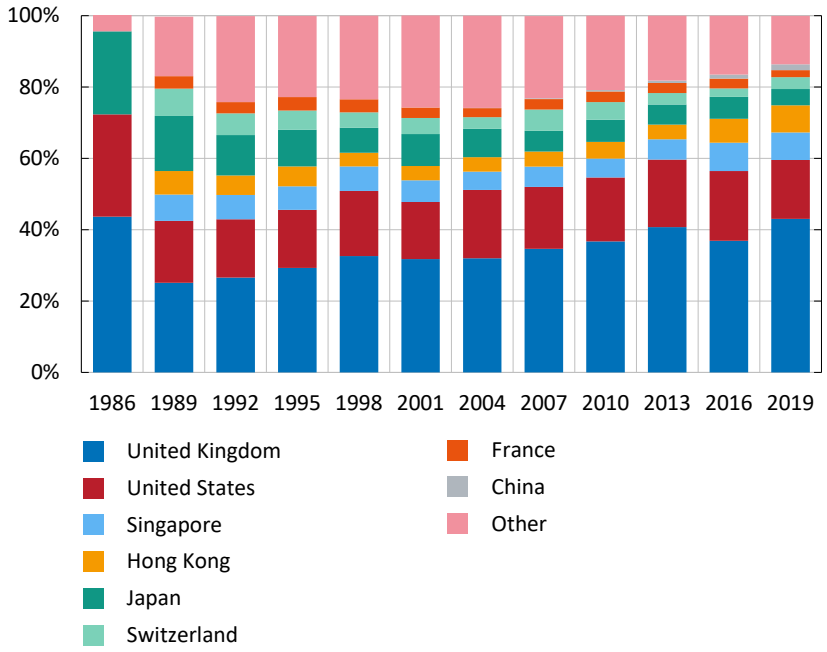
FX swaps should not be confused with *currency swaps*, known also as *cross-currency swaps,* which are contracts which commit two counterparties to exchange streams of interest payments in different currencies for an agreed period of time and/or to exchange principal amounts in different currencies at a pre-agreed exchange rate at maturity, see Baba et al. (2008). Hence, FX swaps and currency swaps are technically similar, but differ in that currency swaps also include the exchange of interest payments and principal amounts. In general, currency swaps also tend to have longer duration than FX swaps.

Finally, *options* are contracts that confer on the owner the right to buy or sell one currency for another currency at a specified exchange rate at a specified point in time. Currency swaps and options make up only a small part of the market as a whole and are normally traded separately from spot and forward contracts and for different purposes, see King et al. (2012).

Historically, most FX trading has been located in London and New York. In 2019, sales desks in these two locations intermediated around 60 per cent of all FX trading; 43 and 17 per cent, respectively, according to the BIS Triennial Survey. Indeed, trading has remained highly concentrated to a handful of trading hubs throughout the last four decades, with the United Kingdom, the United States, Singapore, Hong Kong SAR and Japan accounting for almost 80 per cent of all trading activity (see Figure 5). The internal distribution between these has varied over time, but the United Kingdom share has always been the largest.

Figure 5. Geographic distribution of global FX turnover

Percentage of total, all instruments

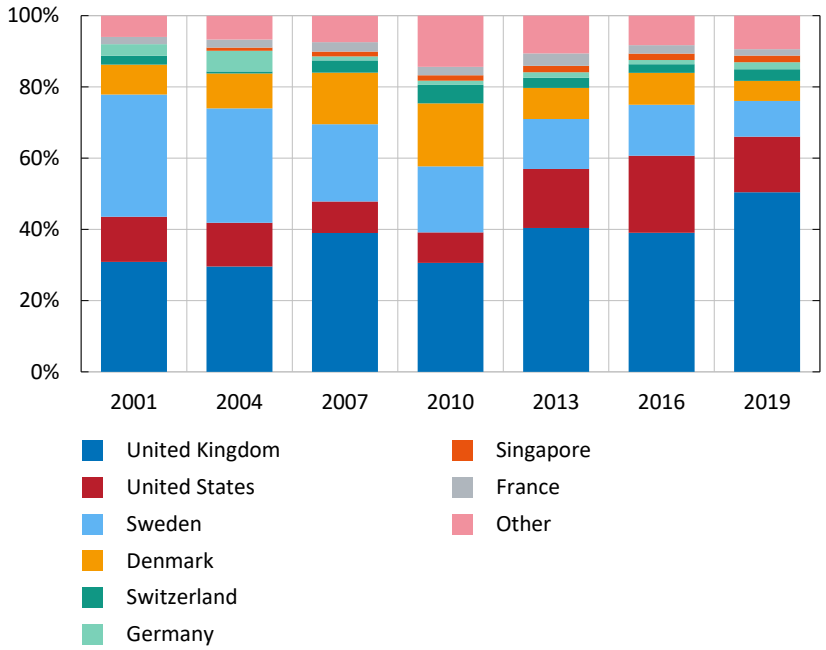


Source: BIS Triennial Survey 1986-2019. Author's own calculations.

Data on the geographical distribution of SEK turnover have been collected since 2001. The share of Sweden-based trading has decreased markedly since the beginning of the survey sample. In 2019, only 10 per cent of the SEK trading flows were intermediated by sales desks located in Sweden, compared to around 35 per cent in 2001 (see Figure 6). Similar to the situation globally, trading activity in SEK is highly concentrated to the United Kingdom and the United States. Contrastingly, the three remaining large trading hubs – Singapore, Hong Kong SAR and Japan – account for only a small share of all trades; around 4 per cent in total in 2019. Instead, the third largest geographical trading hub for the SEK is Sweden, followed by Denmark. However, only approximately 3 per cent of spot trading in SEK takes place in Sweden; the vast majority of spot SEK trading flows is done in the UK.

Figure 6. Geographic distribution of SEK turnover

Percentage of total, all instruments



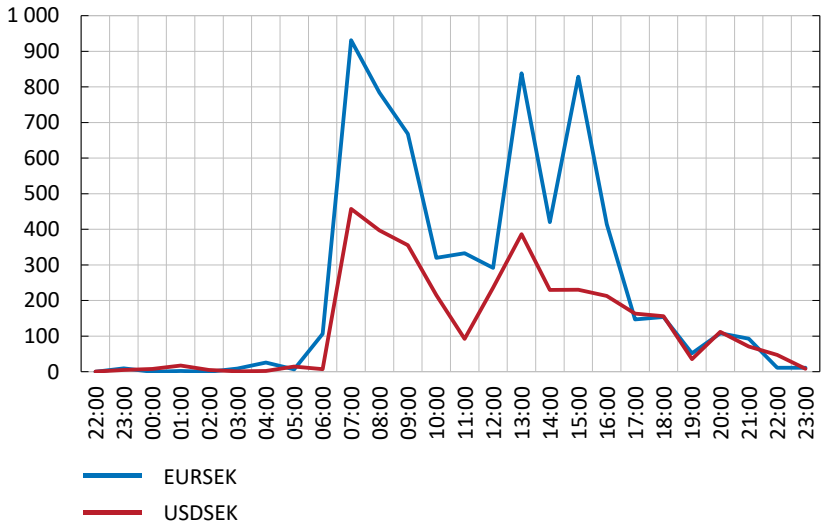
Source: BIS Triennial Survey 2001-2019. Author's own calculations.

Many of the floating exchange rate currencies can be traded 24 hours a day, every day of the year. However, although the FX market is always open to some extent, trading mainly starts when markets open in Sydney and ends when markets close in New York, with the bulk of traded volumes passing through markets from London opening to New York closing. This pattern is highly visible in the two most actively traded currency pairs with SEK on one side, EURSEK (the exchange of euro against SEK and vice versa) and USDSEK (the exchange of US dollars against SEK and vice versa), see Figure 7. Trading flows for individual currency pairs are typically consistent with UK and US trading hours, with the European currencies being traded most actively during London opening hours and the North American currencies during New York hours (King et al., 2011).[7]

[7] It should be noted that global intraday turnover exhibits three "peaks" rather than only two; Asian trading hours are typically associated with heightened activity as well. However, the UK and US trading hours dominate intraday trading activity.

Figure 7. Intraday spot trade volume

USD million



Note: Intraday spot trade volumes in EURSEK and USDSEK submitted to the settlement firm CLS on 2019-01-01 to 2019-02-02.[8] London local time.

Source: CLS.

Technological advances in FX trading have generally begun within the spot, and to some extent the forwards markets, and have also been most pronounced within these segments. The more complex instruments, such as swaps and options, are following the developments in spot and forwards, albeit with a slower uptake of the new technologies. Given this, the rest of this article will focus mainly on the spot and forward markets.

3 Structural developments of the FX market[9]

3.1 1970s to 1980s

Since the introduction of floating exchange rate regimes in many advanced economies in the early 1970s, the global FX market has undergone large structural changes. Far from today's volumes, the global daily average turnover in 1989, the farthest the BIS Triennial Survey goes back in time, was approximately USD 540 billion. The SEK, at that time a managed exchange rate fixed to a basket of currencies, recorded an average turnover of USD 6 billion per day.

During the 1970s and the 1980s, currencies were almost exclusively traded directly via telephone, in an over-the-counter (OTC) market. The OTC market structure refers to

[8] CLS is the world's largest FX settlement firm, providing settlement for around USD 460 billion in daily spot volumes globally (November 2021). Their data are adjusted to equate to the same reporting convention used by the Bank for International Settlements (BIS).

[9] Sections 3.1–3.2 are largely based on the extensive *Handbook on Foreign Exchange*, in particular King et al. (2013). More on the evolution of the FX market structure may also be found in Lyons (2001), Sager and Taylor (2006), King et al. (2012), Moore et al. (2016) and Schrimpf and Sushko (2019a,b).

bilateral transactions not conducted on a formal exchange. A small number of major *dealer banks* were the main *liquidity providers*, financial institutions which intermediate in the FX market by selling and buying the same currency. [10] In the FX market, these dealers emerged to solve the search problem among market participants to match opposing exchange flows. Non-bank financial institutions and large corporations constituted the major part of the client base, the *liquidity consumers.*[11] Their motives for currency trading stemmed primarily from the exchange of currencies due to international trade of goods and services, including financial services, and hedging of FX exposures owing to foreign-currency assets and liabilities.

The FX market consisted of a clearly delineated two-tiered system where dealers constituted the *primary* market tier, called the *interbank* or *interdealer market*, and dealer-to-client trades took place in the *secondary* market tier. In the interbank market, dealer banks managed their currency flows between each other (dealer-to-dealer trading). Interbank prices are the prices banks quote to each other. Trades in both tiers took place directly and predominantly via phone, so called "voice trades". In the interbank market, dealers could also choose to trade indirectly, using a *voice broker* as an intermediary.

Voice brokers are human intermediaries active in the interbank market, matching dealer trades with each other. They receive quotes and orders via telephone from a set of dealer banks connected to the brokerage, and then match corresponding orders into trades without disclosing the identity of parties pre-trade, that is, before the parties have agreed upon transaction. This type of brokering is referred to as *direct dealing*, see Melvin and Wen (2013). Upon receiving an order to, for example, sell US dollars against the Swedish krona, voice brokers would shout out the current best bid and ask prices into all open telephone lines connected to dealers. The *bid price* in this example is the price at which a dealer is willing to buy US dollars in exchange for Swedish krona. Vice versa, the *ask price (offer)* is the price at which a dealer is willing to sell US dollars in exchange for Swedish krona.

Since currency trading always involves the purchase of one currency and the sale of another, the concept of a buyer and a seller might be somewhat confusing, especially when both counterparts are dealers. In this article, and as is conventional in FX trading, it will depend on who initiates the trade. If dealer A posts a bid price with the voice broker, she wants to purchase the base currency (she is the price *maker*). If dealer B accepts dealer A's bid price, she sells the base currency to dealer A (she is the price *taker*). Market practice is to always express the *base currency* first in labelling currency pairs, that is, the units of a given currency to purchase one unit of the base

[10] Dealers are financial intermediaries whose primary business is to enter both buy and sell transactions and which seek profit by taking the associated inventory risk, see Committee on the Global Financial System (2001). Liquidity provision is a term used to describe the practice of continually trading in and out of relatively short-term positions. Liquidity providers are essentially market-makers of the FX market: they sell and buy the same currency pairs, acting as intermediaries for other participants by entering and holding currency positions, normally to make a profit on the difference between the purchasing (bid) price and the selling (ask) price.

[11] Liquidity consumers are clients of the liquidity providers. They typically buy *or* sell currencies for reasons such as international trade or hedging by entering one side of a trading agreement.

currency. Most exchange rates are expressed as units of a currency in order to purchase one US dollar (USD), with the exception of the euro (EUR), the British pound (GBP), the Australian dollar (AUD) and the New Zealand dollar (NZD).[12] For example, the exchange rate of the Swedish krona (SEK) against the US dollar is conventionally expressed as USDSEK, meaning SEK per USD. In this example, the US dollar is the base currency. A buyer of USDSEK purchases USD using SEK as payment; a seller of USDSEK sells USD and receives SEK as payment.

The FX market of the 1970s and the 1980s was characterised by an opaque *price discovery process* (the process through which prices are determined and set) with large discrepancies between the interbank market prices and the prices set to end clients. Information about trades were proprietary to the two counterparties and no market-wide source of information was accessible for end clients. Dealer banks, however, arguably had an information advantage relative to end clients. In addition to small, informal networks among banks, they had access to the voice brokers who would continuously announce the current market prices. Brokers do not enter positions, and could, at least in theory, not trade upon the information they received.[13] End clients would not see the prices traded interbank, only the final price quoted by their dealer bank(s). Post-trade, that is, after the trade had been agreed upon between the counterparties, the parties would exchange physical paperwork to settle the transaction, making the process cumbersome and prone to human error.

3.2 Late 1980s to 2000s

Computers made their first real entrance into FX trading in 1987, when Thomson Reuters Dealing was introduced. This computer system, available only to dealers, offered an alternative to telephone communication, enabling electronic messages to be sent amongst dealers while enhancing operational efficiency by the creation of electronic records of trading. Around the same point in time, Thomson Reuters also released their FXFX product, a proprietary computer site within the Reuters Terminal where dealers' *indicative quotes* for the most commonly traded currencies were shown in real time.[14] Both Reuters Dealing and FXFX quickly became popular and as such, important information hubs for price discovery and trading, see King et al. (2013). The FXFX page contributed to greater transparency in the interbank market, but as indicative quotes are not tradeable per se, the informational content of FXFX quotes as an indicator of the tradeable current exchange rates was questionable, see Martens and Kofman (1998).

[12] In order: euro, British pound, Australian dollar, New Zealand dollar and US dollar. For example, the exchange rate of euros against US dollars is expressed as EURUSD and the exchange rate of British pounds against Australian dollars is expressed as GBPAUD.

[13] Brokers that also act as dealers are called *broker-dealers* or *dealing desk brokers.* When a broker-dealer acts as an *agent*, the trade is on behalf of the client (broker), and when acting as *principal,* the trade is on its own account (dealer).

[14] Indicative prices are prices quoted by dealers that are not necessarily tradable. Dealers submit indicative prices to give clients an indication of the price they are willing to trade at without being committed to trade. For example, if a client requests a quote without specifying the volume, dealers would normally provide an indicative quote. In contrast, tradable quotes are typically attached to a specified volume.

In the early 1990s, FX trading took another crucial step towards electronification when a new type of broker emerged: the *electronic brokering systems*, or *electronic brokerages (EB)*. These electronic systems automatically match orders submitted by dealers to buy and sell currencies. The two main electronic brokerages were run by EBS and Thomson Reuters Matching, both of them available only for interbank trading. These are often referred to as the *primary venues*, see BIS (2019).[15] Similar to stock market exchanges, electronic brokerages are structured so that the *limit orders* (bids to buy and/or offers to sell a given amount of a currency at a given price) with the highest bid price and the lowest ask price are prioritised and matched first with incoming *market orders* (orders to trade a certain amount at the current market price). Dealers submit limit orders in a *centralised limit order book (CLOB).* The brokerage system then automatically matches these offers and bids with incoming orders from other dealers. Both EBS and Reuters Matching operated anonymous limit order books, meaning that the identities of counterparties were unknown prior to the trade. Instead of having to reveal their interest in trading prior to the actual trading, dealers could now post their quotes anonymously on the CLOB. In addition, the CLOB offered not only indicative prices but actual tradeable prices, "firm" liquidity and more reliable information on the price discovery process.

The introduction of electronic brokering made FX trading more efficient; it increased competition between dealer banks and made interbank risk-sharing more effective, requiring fewer trades to distribute a given volume within a given set of constraints, see Evans and Rime (2019). Nevertheless, much of the electronification in the 1980s and 1990s focused on the interbank market and left the dealer-client relationship largely intact. While operational efficiency increased and execution costs decreased in the interbank market, leading to smaller bid-ask spreads in the primary tier, the bid-ask spreads of the secondary tier remained virtually unchanged until the end of the 1990s. Dealers, who profit from the spreads charged on the liquidity they provide, could earn substantial revenue from their informational advantage and the large difference in trading costs between the tiers.

Early examples of electronic solutions for end clients started emerging around the middle of the 1990s (for example FX Connect and Hotspot FX), but the main shift towards electronification of the secondary tier of the FX market began first around 1999, when the electronic *multi-bank trading platform* Currenex was launched. Multi-bank platforms (*MBPs*, also known as *multi-dealer platforms*) are electronic trading venues which connect a set of clients with its dealers and enables electronic negotiation and execution in competition. They facilitate electronic price discovery and execution in a competitive environment as several dealers are connected to the network at the same time. Currenex, and a number of platforms with similar business ideas that followed, gave end clients access to several dealer banks simultaneously

[15] The term primary venue is often used with specific reference to a certain currency pair. Traditionally, Refinitiv (Reuters) Matching is referred to as the primary venue for the Commonwealth currencies and the Scandinavian currencies, while EBS is the primary venue for the euro, the US dollar, the Japanese yen, the Swiss franc and the Chinese renminbi.

through tools such as *request-for-quote* (RFQ) and electronic limit order books directed at end clients rather than dealers alone.[16]

Many of the pioneers of end-client trading platforms were independent *non-bank firms*, often related to the booming tech sector of those years around the turn of the millenium.[17] Spurred by competition for customer business, the number of new, electronic trading venues virtually exploded. To retain some of the information flows and the market dominance that characterised their role in the 1980s, several of the major dealer banks formed a consortium and launched the multi-bank trading platform FXall in 2001, see King et al. (2013). FXall gave members of the platform access to several dealers simultaneously through an RFQ solution. At approximately the same time, dealer banks started introducing their own proprietary electronic platforms, so called *single-bank platforms* (*SBTs,* also *single-dealer platforms*). Single-bank platforms typically offer similar solutions as non-bank and multi-bank platforms, but are owned and run by the dealer bank itself.

Both single- and multi-bank platforms are in different ways and to various extent interconnected with each other and with other trading venues, and dealers typically operate on several platforms simultaneously. They may be disclosed or anonymous, that is, either the counterparty identities are or are not known pre-trade. Trading venues for dealer-to-client transactions are sometimes referred to as *secondary venues*, as opposed to the interbank primary markets. Generally, at least one of the main brokerages is connected to the trading platforms.[18]

Another important impetus for the development of the FX market was *prime brokerage.* The service emerged in the early 1990s, and is offered by banks that allow clients to get access to multiple executing dealers while maintaining a credit relationship and placing collateral and settlement with a single entity, the prime broker, see Federal Reserve Bank of New York (2010). While electronic brokering provides access to dealers, practical aspects of trading such as credit agreements and settlement instructions are needed for each single dealer. Although this is feasible for large clients, it is often too costly for smaller entities. Instead, with prime brokerage accounts clients are given the opportunity to access the primary market through top FX dealers. Clients then trade directly in the bank's name with its established counterparties, subject to credit limits. Prior to the introduction of prime brokerage, dealer banks would charge smaller investors high transaction costs, as their trades were considered too small to be economically interesting. With trade now grouped

[16] When using the RFQ function, clients simultaneously ask several banks to supply them with a price that they are willing to trade on. The dealer banks are required to respond to the request within a few seconds, and the client may then choose which bank to trade with.

[17] The term *non-banks* generally refers to institutions which perform services traditionally associated with banks, but which lack banking licences.

[18] To exemplify, Refinitiv (Reuters) FX Matching is the electronic broker (for interbank trading) on the Refinitiv multi-bank platform FXall (for dealer-to-client trading, or "all-to-all" trading), accessed via the desktop platform FX Trading, all connected to the financial analysis tool Eikon. Although primary venues' market share has decreased since its introduction, EBS (NEX) and Refinitiv FX Matching (Reuters) remain two of the largest brokerages globally, as are their respective platforms, see Euromoney (2019).

together into much larger trade sizes, dealers were willing to trade with prime brokers at more attractive prices.

The effect of these technological changes was to accelerate the pace and increase the volume of FX trading that could be intermediated at a given time. Transparency and trading efficiency increased with access to price streams provided by electronic brokerages and trading platforms. Client-access solutions helped narrow bid-ask spreads faced by clients in the second tier vis-à-vis interbank pricing. New types of intermediaries, particularly the introduction of prime brokerage, gave smaller clients access to more competitive prices and deeper liquidity. Nonetheless, the technological revolution of the FX market had only begun; the 2000s would see a rapid evolution of electronic execution, new participants, the introduction of algorithmic trading and a fragmented, interconnected and fast-paced electronic FX market.

3.3 2000s to today

Today's FX market is complex, consisting of a large number of trading platforms; market participants wanting to trade FX have more than 75 different venues to choose from, see Sinclair (2018). This proliferation has been driven by technological advances as well as competition between both banks and new market participants seeking to capture, or maintain, a share of the FX market. Electronification in FX first took off in interbank trading, but it is the dealer-to-customer segment that has seen the strongest rise in electronification in recent years, see Schrimpf and Sushko (2019b). The resulting market structure is fragmented yet highly interconnected. According to the 2019 BIS Triennial FX survey, 56 per cent of all FX trading, and 70 per cent of all FX spot trading, takes place electronically (BIS, 2019). Or perhaps even more, as according to a study from 2013, some market reporters suggested that as much as 95 per cent of all spot transactions could in fact be electronic, as most voice trades are booked electronically due to the practical benefits from electronic execution, see Rime and Schrimpf (2013).

Modern market participants rely on technologically advanced and sophisticated trading solutions. *Algorithms* became available in FX trading around the early 2000s and grew rapidly with the availability and improvement of data, becoming a tool for navigating an increasingly fragmented market, see Markets Committee (2020). In addition, reporting requirements and regulations have increased the demand for traceable execution, which in turn has contributed to the growth of electronic and automated trading (see below for more details on reporting requirements and regulation). Algorithms are used in many areas of trading, such as the execution of trades, statistical algorithmic trading and high-frequency trading.[19] As executable liquidity is dispersed over a large number of venues, algorithms have also become a tool to source liquidity from many different venues simultaneously.

[19] In statistical algorithmic trading, algorithms are used to collect and analyse large amounts of data to identify favourable trading opportunities and strategies. This type of trading includes, for example, the employment of algorithms to analyse historical time series data to identify whether a currency is suitable for buying, selling or keeping, and portfolios based on mathematical mean-reversion models.

Execution algorithms use mathematical models and automated trading programs to create specific sets of trading rules and models and then automatically execute orders and transactions. For example, traders commonly place limit orders using algorithms. When a pre-defined limit value is reached, the algorithm is programmed to automatically execute or cancel. Since their introduction, they have evolved from simple mechanical forms to highly sophisticated and adaptive types based on machine learning techniques that respond to real-time changes in market conditions. As of 2020, execution algorithms are estimated to account for around 10–20 per cent of global FX spot trading, but are less frequently used in other types of FX trading, see Markets Committee (2020).

Users and usage of algorithms have also evolved during these years, and today, algorithmic solutions are available to a range of market participants. With the advent of *retail trading platforms*, algorithmic trading was also made available for non-bank participants, see King et al. (2013).[20] A Greenwich Associates study from 2021 showed that nearly 40 per cent of financial FX traders used algorithms in 2020 and that approximately as many saw their usage increase in 2021, see Greenwich Associates (2021). Measured since autumn 2018, the Riksbank's Financial Markets Survey shows that approximately 90 per cent of the participants active in the market for SEK often or always use electronic platforms in trading, but only 20 per cent of participants often or always use algorithms.[21]

Algorithms are also the key building blocks of *high-frequency trading (HFT)*. HFT refers to the use of algorithms for the purpose of arbitrage on slower market players by very high speed and high frequency, also called *latency arbitrage*. The nature of HFT is typically speculative and as with algorithmic trading in general, it has its roots in equity markets where it has been common since the late 1990s. Several of the pioneering HFT firms are becoming increasingly important to the FX market in their roles as liquidity providers.

As data quality improves, so do the prospects of using *machine learning* techniques.[22] Algorithms can handle massive amounts of unstructured data; sort, analyse and act upon it in fractions of the time it would take a human trader. The term *artificial intelligence* (AI) is frequently used to describe this human-like intelligence that today is possible to program into electronic systems, making machines trade like humans but without human involvement or intervention. Several major international dealer banks have launched adaptive algorithms; algorithms that self-adapt to the ongoing market conditions, see Greenwich Associates (2021). Still, AI and machine learning

[20] Retail trading platforms are trading solutions, typically software programs, available for retail clients. One example is MetaTrader4, launched in 2005.

[21] See Sveriges Riksbank (2021).

[22] Machine learning is a technique in which a computer processes data and essentially writes its own program based on the statistical relationships it discovers, see Ford (2015). The technique is used in many everyday functions, such as the recommendations of what to watch on streaming platforms or spam filters in emailing software. In finance, one example of machine learning techniques is that used for scraping data, in which a computer program extracts data from human-readable output coming from another program. Noting the entrance of AI and machine learning as separate from algorithms may be slightly precarious. Algorithms have undergone a series of evolutions since their first emergence, with AI and machine learning techniques developing alongside rather than at separate stages in history.

techniques have only recently started to play an important role in transforming electronic FX trading (see for example Refinitiv 2019 and Golden 2021). Despite the rapid evolution of technology, this type of trading is highly resource demanding, both in terms of human skill and computer power.

As trading has become increasingly electronic and automated, it has also gained markedly in speed. The BIS describes the FX market as a *fast-paced electronic market,* a market where the price development predominantly occurs via electronic means, and which is characterized by a sizeable penetration of high-speed, algorithmic-driven order placements. Along with an increase in the use of electronic brokerages, the introduction of *data aggregators* and live *price feeds* has resulted in an increase in the updating frequency of data feeds.[23] As an example, the EBS platform increased its pricing update frequency from every 100 milliseconds to every 20 milliseconds in 2016, and further to every 5 milliseconds for selected platform participants in 2017, see Markets Committee (2018).

3.3.1 Market participants

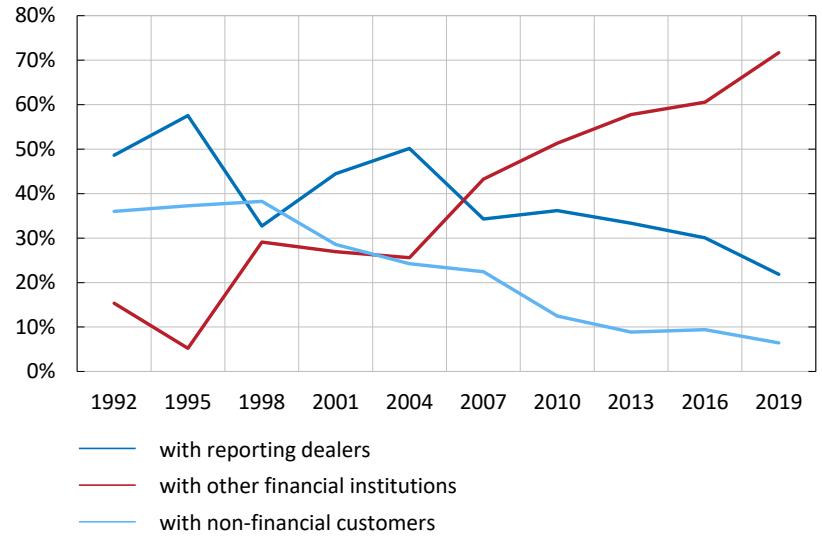
The new, digital infrastructure of the FX market has led to the emergence of new players, functions and possibilities. Nearly half of all reported turnover in spot trading went through prime brokerage accounts in 2019, according to the BIS Triennial Survey, see BIS (2019). For the currencies of small open economies, 56 per cent of all spot turnover of the SEK was prime brokered, which is similar to the Australian, Canadian and New Zealand dollars as well as the Norwegian krone. Higher turnover currencies, such as the British pound, the US dollar, the Japanese yen and the Swiss franc, have a smaller share of transactions conducted through prime brokerage accounts.

Driven by the proliferation of prime brokerage, smaller banks, hedge funds and other players have entered the market to much greater extent than previously. Today, some of the top providers of spot liquidity are non-banks, see Euromoney (2019). The market is no longer centered solely on the dealers; the share of global FX market turnover accounted for by interdealer trading in the BIS Triennial Surveys has declined considerably since the 1990s, from 67 per cent of the total global FX turnover in 1992 to below 40 per cent in 2019, see BIS (2019). They make up even less of the turnover in SEK, their share falling from 48 per cent in 1992 to just above 30 per cent in 2019. In the SEK spot market, only 22 per cent of the turnover have reporting dealers as counterpart (see Figure 8). Interestingly, this is similar to the NOK spot market, but markedly lower than that of the other G10 currencies. Instead, financial institutions other than the dealer banks now represent one side of 60 per cent of all turnover in SEK and over 70 per cent of all SEK spot turnover.

[23] A data aggregator is a technological service where prices are streamed from several liquidity providers and/or platforms simultaneously.

Figure 8. Turnover by counterpart, SEK spot market

Per cent



Source: BIS Triennial Survey (2019).

An increasingly important new group of participants in the FX market are the *principal trading firms (PTFs,* also known as *proprietary trading firms)*. PTFs are firms that invest, hedge or speculate for their own account, not on behalf of clients. They are sophisticated non-banks which provide and consume liquidity primarily through high-frequency and algorithmic trading and typically trade with high speed and frequency to turn over large volumes. This heterogeneous group of players, which includes HFT firms, gains access to the FX market via prime brokers and accounts for roughly a third of total turnover in electronic FX spot markets see BIS (2019). Their share of turnover in the spot market for SEK is lower; around 18 per cent.

In recent decades, several non-bank PTFs have transformed into market-making liquidity providers that have taken over parts of the FX market that were previously exclusive to dealer banks. This subset of PTFs is sometimes referred to as *non-bank electronic liquidity providers*, or *non-bank electronic market-makers.* While banks rely on large balance sheets and client relationships that can generate volumes of flows that may be matched with one another, the non-bank PTFs instead use their speed and technological advantage to intermediate in the markets.

Another reason for dealers' declining share of turnover is that major dealing banks net more trades internally. Typically, dealers would quickly, or even immediately, try to match the opposite side of a client's trade within the interbank market. This is sometimes referred to as "hot-potato trading" or *externalisation*, see Butz and Oomen (2019).[24] On the opposite, *internalisation* refers to the process of warehousing one client's transaction flow until it is offset against an opposing client's flow. Through internalisation, dealers are able to match more client trades directly on their own books, which reduces the need to offload and hedge risk via the traditional interbank

[24] Dealers engage in hot-potato trading when offloading their exposure to open positions onto the interbank market (King et al. 2012).

market, see Schrimpf and Sushko (2019a). With more trades managed internally, hot-potato trading, and thereby also interbank trading, becomes less necessary.

Internalisation ratios are highest within the spot market and have increased along with electronic execution (see Moore et al. 2016 and Schrimpf and Sushko 2019b). Similarly, the use of algorithms has been shown to reinforce the growing trend towards internalisation among dealer banks, see Markets Committee (2020). Internalisation has also coincided with an increase in market concentration: the average number of banks covering 75 per cent of total FX turnover has about halved since first measured in 1989, to a count of 7 in 2019, see Schrimpf and Sushko (2019b).[25] Arguably, internalisation and high market concentration are mutually reinforcing. Dealer banks with large and diverse trading flows can internalise trades more efficiently, allowing them to offer competitive prices and attract even more client flows. Butz and Oomen (2018) show that internalisation is both quicker and less risky among large dealers, who benefit from their size and the possibility of reducing costs doing so. This is in line with the finding that internalisation ratios tend to be higher for large trading centres, as this is typically where the largest dealer banks are located, see Schrimpf and Sushko (2019b).

In addition, the Global Financial Crisis of 2007-2009 brought on a rapid decline in dealer banks' *proprietary trading* (trading for direct market gain, contrary to earning commission on client trades). Increased regulatory scrutiny and greater risk-aversion were important drivers of this development, see King et al. (2011). Banks' balance sheets have become more constrained and costly to deploy in the aftermath of the crisis, which has resulted in a notable reduction in risk appetite and principal risk warehousing, see Debelle (2018).[26]

Nonetheless, the major international banks still constitute an important part of the market as liquidity providers, but are now accompanied by other types of financial institutions that intermediate in the market. This development has dissolved the clearly delineated market structure of the 1980s, and there are no longer two well-defined market tiers with just as well-defined roles of its participants. The distinction between liquidity provider and liquidity consumer is also becoming less clear, both because trading can occur without intermediation and because new types of participants have entered the market.[27]

The BIS Triennial Surveys also illustrate how consumers of liquidity have evolved during the last few decades. Today, FX trading volumes mostly reflect financial motives, as opposed to needs arising directly from real economic activity. As noted earlier, FX trading volumes continue to be dominated mostly by financial institutions, with the share of non-dealer financial institutions growing from below 12 per cent in 1992 to nearly 55 per cent of all trading in 2019. Non-dealer financial institutions

[25] Although interdealer trading, that is, trading with dealer banks as both counterparts, has declined, banks remain one of the counterparts in most FX trading.

[26] Providing algorithms has thus become a tool for banks to transfer the risk bearing onto the end client, as algorithms rely less on liquidity providers' capacity to absorb risk (BIS 2020).

[27] Clients wishing to trade FX no longer *require* a dealer to do so. Today, while clients may access liquidity with various degrees of intermediation: from client-to-client in disclosed or anonymous liquidity pools all the way to the more traditional alternative of using a dealer and a broker.

include market participants such as smaller banks, pension and investment funds, hedge funds and PTFs.

3.3.2 Reporting requirements and regulation

Despite its size and importance, the FX market is subject to relatively little regulation and reporting requirements. There is no central regulatory body, instead, local jurisdictions are set up across the globe. Two influential legislations are the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act) in the US and the MiFID II legislation in the EU.[28] Neither of these applies to the FX spot market.[29]

The Dodd-Frank Act was written in the aftermath of the 2008-2009 financial crisis to reduce risk, increase transparency and provide accountability for market participants. Enacted in July 2010, it is a widely encompassing federal law that applies to US-based financial companies. The Dodd-Frank Act applies to all FX derivatives, although some instruments are mainly subject to reporting requirement. All FX derivatives except FX swaps and outright forwards, are subject to certain mandatory derivatives requirements, including central clearing and exchange trading.

The MiFID II regulation, adopted in January 2018, applies to all financial participants across the EU, including fund managers, banks, exchange trading venues, pension funds and retail investors. MiFID II aims to make markets safer, fairer and more efficient. For instance, the MiFID II legislation requires reporting and record-keeping on transactions of all financial instruments in the EU. It does not apply to the spot market, which is not considered to be a financial instrument according to the European Securities and Markets Authority (ESMA), but to all of the other major FX instruments including forwards and swaps. Firms need to take “all sufficient steps” to obtain the best possible results for their clients when executing orders, referred to as *best execution*. The adaptation of the MiFID II regulation has led to firms taking a more systematic approach to monitoring their trades, increasing the demand for so-called *transaction cost analysis* (TCA). While it is not legally mandatory for the spot FX market, demand for such analysis has increased there, too.

Instead of formal legislation, the FX market has largely been governed by informal rules and codes of conduct, often regional. Following a number of high profile FX misconduct cases in 2013 and 2014, the BIS Markets Committee was commissioned to develop a single, global code of conduct for the wholesale FX market to restore trust and confidence in the market. The Global Code of Conduct was developed through a partnership of central banks and private sector market participants under the auspices of the BIS Markets Committee, and the first complete version was launched in 2017. The code is maintained by the Global FX Committee (GFXC), established in 2017. The GFXC is a forum of central banks and private sector participants that aim to promote a robust, liquid, open and appropriately transparent FX market. The code does not impose any legal or regulatory obligations on market participants, rather it is

[28] The UK implemented the UK MiFID II in December 2020, which essentially mirrors the EU MiFID II framework.

intended to serve as a supplement to any and all local law, rules and regulations by identifying global good practises and processes. Sveriges Riksbank is a member of the GFXC and its local Scandinavian committee, the Scandinavian FX Committee (SFXC), and signed the Terms of Commitment in 2017.

4 A fragmented, fast-paced and electronic FX market

With electronification, barriers to entering the FX market have been lowered and transparency has increased. New players have entered the market, both as providers and consumers of liquidity. Technological advances have made comparable and tradeable prices easily available and updated with high frequency, reduced operational risks and lowered trading costs. Sophisticated tools of trading have become available to an increasingly large and heterogeneous group of FX traders. But as always, development brings new challenges. The FX market is complex, fast-paced and highly fragmented, which has implications for market monitoring and analysis, market efficiency and market conditions.

4.1 Information flows and market monitoring

As a consequence of trading taking place simultaneously on a bilateral basis and at many different trading venues, there is no unique market exchange rate at any given point in time. Rather, the same currency can simultaneously be traded at different exchange rates at different trading venues. The lack of common reference points makes it costly and difficult to obtain a representative overview of the market as a whole, and complicates comparison between venues and providers. The electronic information systems of the primary market venues, EBS and Refinitiv (previously Reuters), are often used by practitioners and researchers as representative references for volume and price data.[30] However, while they remain important sources of information, their market share has dwindled in recent years, and many alternative trading venues and liquidity pools have emerged and taken over market shares, see Schrimpf and Sushko (2019a).[31]

Moreover, the electronification of FX trading results in enormous amounts of data and information being produced and collected. A widespread commoditisation of such data has led to an increased availability via different technological solutions, but this typically entails high costs, advanced quantitative analysis skills and large storage requirements. For those with access, it allows for analysis of order flows, positioning, technical levels, liquidity conditions and trading patterns – information previously exclusive to the interbank dealers. However, the fragmentation of the market causes this information to be dispersed over a large number of trading venues. In this sense, somewhat paradoxically, electronification has increased the amount of information available but made market monitoring and surveillance more difficult. The structure of the FX market, combined with minimal regulation and reporting requirements,

[30] The FX trading unit of Thomson Reuters was renamed Refinitiv in 2018.

[31] Liquidity pools are centralised trading volumes created by orders executed on an exchange or other trading venue.

results in there being no consolidated record of the turnover at any given point in time.

Many central banks, including Sveriges Riksbank, track turnover in their respective FX markets, but relatively few central banks publish this information regularly. In addition, the international nature of the FX market ultimately complicates compilation and consolidation of statistical data. For instance, the data collected by Sveriges Riksbank are reported by the major Swedish banks. Trading of SEK between other market participants, including reporting dealers domiciled abroad, will not be registered in the Riksbank's statistics. This means that trading between non-Swedish dealers and non-bank participants is not captured by the Riksbank statistics, although provided that at least one of two counterparts in a trade report to any of the other central banks participating in the BIS survey, such trading will be captured by the BIS statistics.

Furthermore, the structural changes to the FX market during the last four decades have had an impact on the price discovery process. Fundamentally, the idea is that trading is an integral part of the price discovery process through which information relevant to exchange rate determination becomes embedded in the market price. Information flows, a concept frequently explored in the research fields of market microstructure and order flow analysis, are at the core of the price discovery process (see for example Bacchetta and van Wincoop 2006, Breedon and Vitale 2010). Essentially, informed agents have information about the currency's fundamental value, and this information becomes embedded in the price when the trade is executed.

Early research on information flows focused on consumers of FX liquidity as the most informed, as they would have information on trading flows of foreign and domestic assets, but several empirical studies contradict this (see for example Bjønnes et al. 2005, Evans and Lyons 2006, Nolte and Nolte 2014, Osler and Vandrovych 2009, King et al. 2010, Bjønnes et al. 2014). More recent research instead points to FX market dealers as the most informed participants (see for example Evans and Lyon 2002, Moore and Payne 2011, Chaboud et al. 2020). Information appears to become embedded in the market price through at least three steps. First, end clients reveal their information to dealers by trading. Second, the information becomes embedded in interbank prices, and third, information is dispersed into the general market as dealer-to-client quotes are adjusted to reflect interbank prices, see King et al. (2011).

Dealers' information advantage as central counterparts with large electronic networks of client relationships, their analytical muscles and their ability to quickly act upon new information suggest that dealers are the most well-informed FX market participants. In line with this, market monitors have generally turned to the banks and to the primary electronic venues for information on exchange rate developments. At the same time, even though some of the major dealer-banks have managed to retain some of their information advantage via their own trading platforms, several of the largest trading venues of today belong to non-banks. Trading on primary venues has fallen markedly. As a result, part of these information flows has migrated from the interbank market to external networks.

These structural changes have had implications not only for the monitoring and surveillance of FX trading, but potentially also for the price discovery process itself. As long as central banks and other monitoring agents rely on banks and primary venues as their main source of information, they might overlook information important to exchange rate determination, because banks might not be informed, or because the price discovery process is increasingly taking place outside of the banks' sphere. Central banks have therefore had to diversify their FX monitoring from the usual electronic brokerage screens and voice contact with dealers to monitoring more electronic platforms and obtaining information about market conditions from a broader range of market actors (for a detailed report on how monitoring of the FX market has evolved over time, see Markets Committee 2018).

4.2 Technological advance, market conditions and market efficiency

The use of ever-more advanced financial technology is steadily increasing in a pursuit of more efficient and faster trading. Technological advances and an increase in both the number and variety of participants active in the market have forced the traditional players of the FX market to charge more competitive prices in order to maintain their market shares. To exemplify, the spread between bid and ask prices has in general narrowed as the market has become increasingly electronic, see Rime and Schrimpf (2013). Ding and Hiltrop (2010) demonstrated that the introduction of electronic trading systems narrowed both the immediate and long-term bid-ask spreads. This finding is in line with early studies on the topic, such as Pagano and Roell (1996) and Flood et al. (1999), who suggested that electronic systems should lead to narrower spreads due to lower operation costs, inventory risk and the costs of attaining information. With comparable and tradeable prices easily accessible and updated with high frequency the price discovery process has become less opaque, especially to end clients and even non-active participants. In a more recent study, Geromichalos and Jung (2018) suggested that the introduction of dealer-to-client platforms led to lower spreads by lowering the bargaining power of dealers.

However, quite interestingly, Ding and Hiltrop (2010) also showed that large dealers tended to quote relatively wider spreads on multibank platforms. This, they argued, was indicating that these dealers were compensating for the loss of the information advantage they used to possess in the more opaque market prior to the introduction of electronic trading venues. On the other hand, their research focused on the primary venues, Reuters and EBS, while data indicate that dealers are shifting away from these, see Schrimpf and Sushko (2019a). Instead, dealers are turning to single-bank platforms and direct price streams, a development that is driven principally by the growing trend of internalising trades. The largest dealer banks are reporting internalisation ratios as high as 90 per cent, see Moore et al. (2016).

While internalisation may be beneficial for both dealers and end clients, it is also associated with lower visibility (known as *hidden liquidity*). On the positive side, internalisation may benefit dealers by reducing intermediation costs, while end clients may benefit from a reduction in information leakage and consequently market impact (see for example Butz and Oomen 2019 and Markets Committee 2020). On the negative side, internalisation shifts trading volumes from more transparent venues (so

called *lit* venues) to more opaque internal liquidity pools. Hence, for the same reason that electronic brokerages have had a positive impact on the transparency of price formation, internalisation has the potential of obscuring it.

The growing use of algorithmic execution has been shown to improve overall market functioning by increasing the efficiency of the matching process between liquidity providers and liquidity consumers (see for example Rime and Schrimpf 2013 and Chaboud et al. 2020). Assessing liquidity in a fragmented market is challenging, but with more counterparties connected to each other, search costs have decreased and the velocity of trading has increased, see Rime and Schrimpf (2013).[32] Moreover, studies indicate that algorithmic trading has had a positive impact on *price informativeness* in the FX market (see for example Biais et al. 2015, Roşu 2019 and Chaboud et al. 2014).[33] Simply put, computers are better at finding and exploiting arbitrage opportunities. The increasing use of algorithmic trading has therefore led to a more efficient market by speeding up the price discovery process, thereby improving informational efficiency. Chaboud et al. (2020) find that the price discovery process has become faster during the last decade, consistent with improvements in market efficiency during the same period, potentially a result of the increase in algorithmic trading participation.

Nevertheless, algorithms, machines and the ever-increasing speed of the FX market give rise to new challenges and risks. For instance, algorithms may amplify and intensify market movements, causing disorderly price movements even in the most traded and liquid instruments.

Flash events are perhaps the most dramatic examples of this, with the flash rally of the Japanese yen in January 2019 being one of the most recent.[34] Flash events are unforeseen, abrupt and volatile movements in prices within a very short period of time (typically seconds). Flash events to date have generally proved short-lived and without immediate consequences for financial stability. But even though they may happen rarely, they are important tests of the market's resilience to stress. If reoccurring and with lasting impact on financial market pricing, such events have the

[32] King et al. (2012) suggest that trading, and in extension exchange rates, should be modelled as a search problem. Constraints and costs that are related to this search are in turn affected by the structure of the market.

[33] The term price informativeness is used to describe the ability of the price of an asset to convey all information that is available to all traders at any given time.

[34] On January 3rd 2019, the Japanese yen appreciated sharply during the early Asian trading hours, most notably against the Turkish lira and the Australian and US dollars. Liquidity is generally scarce during these hours, which was further exacerbated by a public holiday in Japan. Previous to the event, Japanese retail investors had been building up currency positions in high-interest yielding currencies, speculating that the Japanese yen would not strengthen above a certain level. After news reports of Apple's profit warning on January 2nd, the yen started appreciating sharply – but orderly – triggering so called *loss-cuts*. Loss-cuts are part of a regulation put on all FX firms in Japan that will be executed if a client's margin deposits falls below a required amount and the client does not deposit the required amount by the deadline (issued in a so-called *margin call*). In this particular case, the appreciation of the yen caused large-enough losses to the retail investors' positions, which were then automatically closed, causing the yen to appreciate even more as the high-yielding currency was sold off and yen bought back. Consequently, more positions had to be closed. In just 5 seconds, the yen appreciated approximately 4 per cent against the US dollar (and approximately 9 and 7 per cent against the Turkish lira and the Australian dollar), before retracing over half of the move within a few seconds. For more details, see Reserve Bank of Australia (2019).

potential to undermine confidence in financial markets and hence impact the real economy. When currencies swing very sharply, a certain depth of liquidity is needed to absorb those moves and allow firms to unwind positions. Hence, it is important to continue to develop a deeper understanding of modern market structure and its associated vulnerabilities, see Markets Committee (2017). Nonetheless, initial observations from the COVID-19 pandemic suggest that the risk of algorithmic execution giving rise to self-reinforcing loops, exacerbating sharp movement in prices, may not be as acute as previously believed, see Markets Committee (2020).

The fragmentation and speed of the market also implicate a risk of *liquidity mirage*: a phenomenon that arises due to the combination of highly fragmented and interconnected market venues and liquidity providers. Typically, several trading venues show the same liquidity providers' interest to trade simultaneously, which in aggregation creates an illusion of deep market liquidity. Combined with high speed, there is a risk that the liquidity suddenly vanishes when an order is executed at the quoted price, as the transacted amount is then withdrawn from several platforms at once. In this new electronic context, the market dynamics of a multitude of liquidity venues need to be taken into consideration.

In addition, trend-driven trading, also known as momentum trading, may exacerbate otherwise small movements. These strategies are typically built on algorithmic programs that identify trends in exchange rates and trade in that direction. Anecdotal evidence from market participants indicate that in periods of low liquidity and in absence of human traders, these trend-driven trades gain momentum as they move markets in their traded direction (see for example Engel 2014).

4.3 Liquidity in the FX market

In general, market liquidity makes transactions smoother and more cost-effective, rendering liquid assets more attractive to investors. Liquid markets improve allocation and information efficiency, allowing for more efficient risk-sharing and thereby permitting financial institutions to accept larger asset-liability mismatches. As such, market liquidity is essential for a well-functioning market, and a sudden disappearance of liquidity from markets may develop into a systemic crisis. For instance, a decline in FX liquidity affects funding costs, impairs hedging strategies and increases rollover risks due to the common practice of using the FX swap market for short-term funding, see Mancini et al. (2013).[35]

Liquidity is a prerequisite for an efficient market that eliminates opportunities for arbitrage, see Shleifer and Vishny (1997). As a result, varying liquidity conditions likely disrupt FX market efficiency and alter exchange rate dynamics. The nature and development of the FX market, which has resulted in limited transparency, a high degree of fragmentation and heterogeneity of agents, have important implications for

[35] Brunnermeier and Pedersen (2009) distinguish between an asset's market liquidity (that is, the ease with which it is traded) and traders' funding liquidity (that is, the ease with which they can obtain funding). This article focuses mainly on what Brunnermeier and Pedersen term market liquidity; costs of trade execution and the ability to trade large volumes without sizeable market impact. Nonetheless, these concepts of liquidity are profoundly linked. Under certain conditions, the two are mutually reinforcing and may lead to liquidity spirals.

both price and liquidity patterns. Several studies suggest that foreign exchange rates contain liquidity premia and that there are noticeable differences in the level of systematic liquidity across currency pairs and time (see for example Engel 1992, Christiansen at al. 2011 and Banti et al. 2012). Furthermore, liquid markets also generally contribute to a more stable and efficient monetary transmission process through the financial system, see Sarr and Lybek (2002). Understanding FX market liquidity and market conditions therefore is important, not only from a financial stability perspective but also for the transmission of monetary policy. Even so, there is no consensus on why and how liquidity in the FX market materialises, not even on what constitutes liquidity, see Karnaukh et al. (2015).

4.3.1 Measuring FX market liquidity

Both theoretically and in practice, market liquidity is a multifaceted concept. A widely recognised definition of market liquidity is the ability to rapidly trade large volumes of a financial instrument at low or no transaction cost without the transaction noticeably and adversely affecting the market price of the instrument, see IMF (2015). In the FX market, this translates into the ability to rapidly trade large volumes of a currency against another at low cost without having a large impact on the effective exchange rate. Kyle (1985) summarised the characteristics of liquid markets as tight, deep and resilient.

There is no universally accepted unequivocal measure of FX market liquidity that captures all of these dimensions, and it is not obvious that each of these characteristics of liquidity remain the same over time. For example, volume-based measures such as the turnover rate may be used as a proxy for market liquidity as more active markets also tend to be more liquid. But while the FX market generally is perceived to be extremely liquid given its massive daily turnover volumes, an increase in turnover may not always be associated with increasing liquidity conditions. As documented in Melvin and Taylor (2009), FX trading activity rose sharply during the financial crisis, which they attribute to the so called “hot-potato trading” rather than an actual increase in liquidity.

Certainly, the turmoil during the onset of the COVID-19 pandemic in spring 2020 was also characterised by large increases in volumes and quite poor liquidity (see for instance Dobrev and Meldrum 2020 and CLS 2020). For example, the NOK, which was heavily affected by the turbulence in financial markets, experienced large but one-sided flows (selling of NOK against foreign currencies) and severely deteriorating liquidity conditions in March 2020, see Alstadheim et al. (2021). Naturally, a volume-based measure such as turnover would provide a false reflection of the actual liquidity situation.

Furthermore, the FX market lack both a consolidated measure of turnover (at least one that is updated more frequently than that of the BIS Triennial Survey) and a proper denominator; there is no measureable stock of foreign exchange or outstanding number of instruments to be turned over.[36] Instead, bid-ask spreads may

[36] However, Sarr and Lybek (2002) suggest that the sum of exports, imports and capital transactions or the level of central bank reserves, potentially including short-term net foreign assets of the banking system,

be better suited as a proxy for market liquidity. Indeed, most liquidity measures for the FX market focuses on bid-ask spreads and exchange rate volatility, see Sarr and Lybek (2002).

Bid-ask spreads provide a simple and easily available measure of liquidity. However, although many of the trading venues provide tradable bid-ask prices, trades are not always executed at the posted bid and ask quotes – some trading is hidden, some is bilateral and once again, dispersed over venues and alternative trading methods, see Mancini (2013).

Electronic brokerages generally also have live and recorded data of order books at any given point of time, which may be used to calculate the *order book depth*; a metric based on the quantity available at any given price level. A thin order book may result in quickly changing prices, while deep order books means more liquidity is available at prices at or close to the top prices in the book. This metric may be useful as a real-time indicator of liquidity conditions or for event studies or short-run analysis of liquidity conditions. For example, microdata from brokerages on order depth were used to analyse the British pound (sterling) flash event in 2016 (see for example Noss et al. 2017 and BIS 2017).

Another measure of liquidity is *price impact on execution*, also called *slippage*. It is defined as the difference between the expected market price when requesting to trade and the actual price that the trade is executed at. The higher the price impact, the more the exchange rate moves following a trade, reflecting lower liquidity. While relatively simple to calculate for any specific transaction post-trade, this metric requires vast amounts of data on millisecond frequency, including the identified direction of single transactions, to use as a systematic measure of liquidity conditions.

Finally, to capture the cost aspect of liquidity, another frequently used measure is the *effective cost* of transactions. Similar to slippage, measuring the effective costs is an attempt to capture the actual trading cost and compare it with the price quoted at the point of execution. As such, the measure can be used as a benchmark measure of (the inverse of) liquidity. Examples are found in Mancini et al. (2013) as well as Karnaukh et al. (2015).

4.3.2 A liquidity index for the Swedish krona

Liquidity is thus a complex and multifaceted concept and no single measure is able to capture all aspects of liquidity. Several measures require vast amounts of detailed and precise high-frequency data, which restricts the analysis to a few of the major currencies and a limited time period historically. In addition, such data are typically expensive and the data handling and filtering techniques necessary are time consuming and cumbersome. Moreover, while the research on FX market liquidity is indeed evolving, it tends to focus heavily on the major currencies: the euro, the US dollar, the British pound and to lesser extent the Japanese yen and the Swiss franc.

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could be used as potential proxies for the outstanding value of FX. As for turnover, transaction data from any of the larger trading venues or settlement institutions could be used as a proxy.

In an attempt to capture systematic liquidity specifically in terms of the SEK, I construct a Krona liquidity index. The index is based on Karnaukh et al. (2015), who offer a method to accurately measure systematic market liquidity using daily and readily available data. Evaluating several low-frequency measures against a high-frequency benchmark capturing the effective cost of transactions, they demonstrate that a low-frequency index based on bid-ask spreads and the Corwin-Schultz (2012) method accurately captures how liquidity changes over time.[37] The Corwin-Schultz estimates combine high and low values over one day with high and low values over two days, assuming that daily high prices are buyer-initiated trades and daily low prices are seller-initiated trades. The ratio of high-to-low prices for a day therefore reflects both the fundamental volatility of the currency pair and its bid-ask spread.

The Krona liquidity index is based on daily prices of bilateral exchange rates of 21 currencies quoted against the SEK.[38] Data are retrieved from Bloomberg, spanning 2001-2021.[39] Bid-ask spreads are relative, computed by averaging the daily bid-ask estimates over time. Corwin-Schultz estimates are calculated using daily high bid prices and daily low ask prices adjusted for overnight returns, see the appendix for more details. The index is constructed by first calculating monthly averages of the relative bid-ask spreads across all daily bid-ask estimates for each individual currency pair. Second, monthly averages across all positive two-day Corwin-Schulz estimates are computed, also for each individual currency pair. Third, all series are standardised by subtracting the mean and dividing it by the standard deviation. Fourth, the two measures are combined by taking a simple average across them for each individual currency pair. The last step is to form an average across all currency pairs. A global liquidity index based on the same 30 currency pairs as Karnaukh et al. (2015) is computed for comparison (see Figure 9).[40]

[37] Karnaukh et al. (2015) use precise intraday data to calculate a high-frequency benchmark measure for evaluating the accuracy of their low-frequency measure. The high-frequency measure is constructed from tradable best bid and ask quotes, transaction prices and volume indicators where the direction of trades is known. Using these, they compute the midpoint of best bid and ask quotes and log return based on the transaction price of deals, which capture the effective cost measure described in section 4.3.1. They conclude that a low-frequency measure based on bid-ask spreads and the Corwin-Schultz model (2012) offer the highest correlation with the high-frequency measure. Their results are robust to several high-frequency measures.

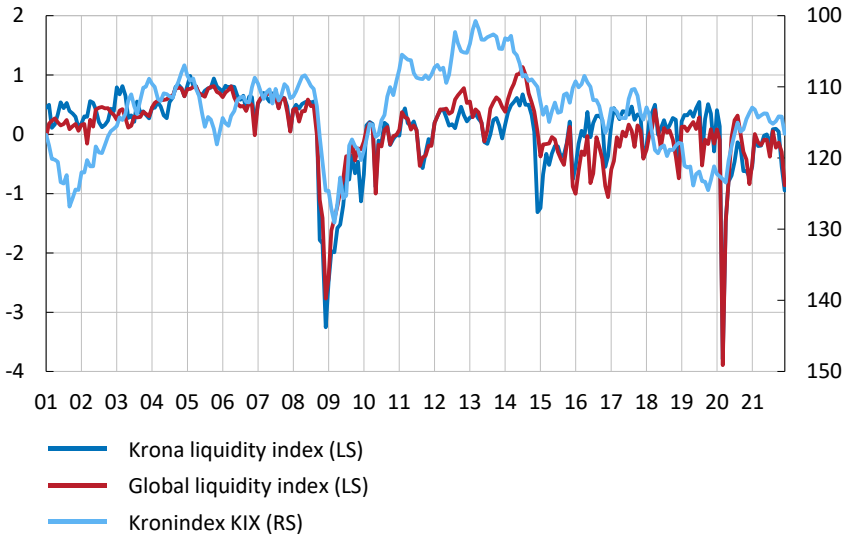
[38] The currencies used are those that are part of KIX ("Kronindex"). KIX is a currency index for the Swedish krona based on currencies from the OECD countries, China, India, Brazil and Russia. The index consists of 32 countries and 21 currencies. For more information on KIX, see Alsterlind (2006).

[39] For some currency pairs, data availability starts already in January 1991. However, due to poor coverage in many other currency pairs, I have chosen to restrict the sample to a period with higher coverage in pricing data in both the SEK currency pairs and the pairs included in the global index.

[40] Currency pairs are listed in the Appendix.

Figure 9. Systematic FX liquidity indices and Kronindex (KIX)

Standard deviation (left) and index units (inverted, right)



Note: Liquidity indices (left hand scale) capture systematic liquidity conditions in a set of currency pairs across time (currency pairs listed in the appendix). Negative values indicate worse liquidity conditions relative to a historical average, and vice versa for positive values. The KIX ("Kronindex") index (right-hand scale) is inverted so that downwards movements illustrate a depreciation of the krona, and vice versa for upwards movements.

Source: Sveriges Riksbank and Bloomberg. Author's own calculations.

Quite interestingly, there is no clear indication of systematic improvements in liquidity conditions across this time period in any of the indices. Given the decrease in bid-ask spreads documented in for example Ding and Hiltrop (2010), this may seem somewhat surprising. Improvements in transparency and efficiency suggest that liquidity should as well have improved systematically during these few decades. On the other hand, Ding and Hiltrop's findings indicate that it was the introduction of electronic trading that significantly caused bid-ask spreads to decrease, which would suggest that the major improvement in liquidity took place during an earlier stage in time than is covered by this sample. In contrast, the 2000s have been characterised by increasing fragmentation and complexity. In addition, Ding and Hiltrop's finding that large dealers actually even quoted larger spreads on multibank platforms may also be part of the explanation of why systematic liquidity seems to be fairly stable in this sample, given that Bloomberg is such as venue.[41]

Both indices show a clear pattern of deteriorating liquidity conditions around periods of financial distress, with the 2008-2009 financial crisis and the COVID-19 pandemic crisis in 2020 by far being the most severe. The European debt crisis that escalated throughout the early 2010s is also associated with negative spikes in liquidity conditions. The link between financial turmoil and deteriorating FX liquidity conditions is related to several different factors. Karnaukh et al. (2015) provide empirical support

[41] In addition, Rime and Schrimpf (2013) showed that the trend towards more narrow bid-ask spreads between 2004 and 2013 was driven solely by emerging markets' currencies; currency pairs of advanced economies were approximately unchanged during the period. The currency sample therefore also affects the dynamics of the liquidity indices across time.

that FX liquidity systematically worsens with more severe funding constraints and global risk. Sudden drops in liquidity have been key in several currency crashes: when liquidity is low, traders become reluctant to take on positions, which in turn contribute to lower liquidity, see Brunnermeier and Pedersen (2009). In addition, lower liquidity leads to higher volatility, which may exacerbate such liquidity spirals even further if it increases the risk of financing a trade, thus increasing the capital requirements of margins. Market-wide systematic liquidity also tend to deteriorate when both global stock and bond markets are more volatile and illiquid, suggesting spillovers from related markets (Mancini et al. 2013).

Moreover, the correlation between the two indices across the time sample is close to 90 per cent, indicating that liquidity conditions in the krona are strongly linked to global liquidity conditions. This is in line with previous research on commonality in liquidity across currencies, suggesting that individual currencies share drivers of liquidity. Brunnermeier and Pedersen (2009) point to shocks to funding constraints of investors as an explanation for commonality across financial markets, suggesting that financial turmoil affect funding constraints of investors across all asset classes. Research also points to general market conditions (risk aversion) and supply- and demand-side factors such as flight-to-quality dynamics, carry trades and the propensity of intermediaries to provide liquidity being such common factors (see for example Karnaukh et al. 2015, Lustig et al. 2011, Mancini et al. 2013 and Menkhoff et al. 2012).

Furthermore, quarter- and year-ends seem to be connected to sharp but short-lived drops in liquidity in both indices, especially since 2014 (see Figure 9). Part of the explanation may be related to regulatory requirements and banks' balance sheet management. In line with previous research, Krohn and Sushko (2022) find additional support of FX funding conditions being correlated with market liquidity and strong indications of co-movement in FX spot and swap market liquidity. They also show that this link has strengthened significantly since mid-2014, which coincides with the introduction of the Basel III framework for global systemically important banks (G-SIBs).[42] They demonstrate that G-SIBs tend to cut back significantly on their quoting activity around quarter- and year-ends, which causes liquidity to deteriorate. Given the strong link between the two, worsening liquidity conditions in the swap market might provide at least a partial explanation to quarter- and year-end drops in liquidity conditions in the spot market.

Given the global and interconnected nature of the FX market, tight links between liquidity conditions are unsurprising. Nonetheless, there are differences between the indices that seem to indicate that liquidity conditions are not only common across

[42] The Basel III framework was introduced in 2011, with the regulation on loss absorbency covering global systemically important banks (the G-SIB buffer) being introduced in 2014. Some regulatory requirements did not become fully binding until 2018, although banks started shifting to the Basel III reporting templates around 2014, see Krohn and Sushko (2022). While liquidity always has tended to deteriorate slightly around quarter-ends, the effect has become several times larger since 2014, when the G-SIB buffer was introduced. FX swaps are counted as more complex assets, which adds on the complexity score component of the G-SIB framework. A higher complexity score might put the bank into a higher G-SIB bucket, which means the bank will be subject to higher loss absorbency requirements via additional capital surcharges. As a result, G-SIBs have an incentive to pull out of the FX swap market around regulatory reporting periods.

currencies; some are idiosyncratic to the Swedish krona. For instance, the Krona index tends to show slightly sharper drops in liquidity during periods of high financial stress, which might imply that the currency pairs used in the Krona index are in general riskier than those in the Global index.[43] Karnaukh et al. (2015) find that such currencies are more likely to suffer larger liquidity drops when global risk, such as global stock and bond volatility, increases.

Furthermore, empirical studies document that the krona tends to depreciate in response to financial stress (see for example Bacchetta and Chikhani 2021 and Ceh 2020). Gardberg (forthcoming) finds that the krona is particularly sensitive to changes in global risk; among all G10 currencies, the krona responds the most.[44] This pattern is visible also in Figure 9, where the above mentioned episodes of elevated financial stress are associated with not only a drop in liquidity but also a weaker krona in terms of the krona currency index KIX. In addition, improvements in liquidity conditions seem to be associated with an appreciation of the krona.

As noted in Markets Committee (2017), sudden shifts in liquidity conditions may exacerbate otherwise orderly movements in exchange rates. In addition, existing research on liquidity risk premia imply that liquidity risk is priced in the FX market; investors demand compensation for holding assets that exhibit low liquidity. This suggests that monitoring the liquidity conditions of the krona might be helpful in understanding krona exchange rate movements, both in short-term and medium-term analysis. Nevertheless, further research is necessary to fully understand the dynamics and relations between liquidity conditions and how liquidity premia might impact price formation. The rapid changes and increasing complexity of the market structure further complicates the question; both depth and ability to trade are important aspects of liquidity, but in today's FX market, tradeable quotes are mixed with indicative ones, all quoted on several platforms simultaneously. With the increasing availability of comprehensive data sets, the effects of such structural aspects particular to the FX market are hopefully to become subject to further research.

In sum, a comparison of the Krona liquidity index and the Global liquidity index indicates that liquidity conditions show a high degree of commonality. Liquidity tends to deteriorate in periods of financial stress, most recently during the onset of the COVID-19 pandemic. The krona tends to be weaker during such periods of financial stress, while improvements in liquidity seem to be associated with the krona appreciating. Interestingly, however, not all movements in the Krona liquidity index can be explained by changes in global liquidity conditions, indicating that some components of liquidity conditions are idiosyncratic to the krona.

[43] Here, riskier currencies refer to currencies bearing larger exposure to systematic risk factors such as carry trade risk and volatility risk (see for example Lustig et al. 2011 and Menkhoff et al. 2012).

[44] Gardberg (forthcoming) show that currencies in countries with large private net external debt, particularly net portfolio debt and other investment liabilities, tend to depreciate during financial turbulence. She uses VIX, an option-implied index of investors' willingness to hedge themselves against large price movements in the American stock market index S&P 500, as a proxy for global risk. All currencies are quoted with USD as the base currency.

5 Conclusion

The FX market has undergone significant structural changes during the last four decades. Both trading and price formation are to an increasing degree taking place electronically and new participants, venues and strategies have emerged. The clear division between the interbank and the end-client tiers that characterised the FX market in the 1970s and 1980s has effectively been dissolved into the fragmented yet interconnected fast-paced electronic market of today. Moreover, the rapid evolution of electronic trading, particularly the use of algorithms, has increased trading efficiency and the speed of trading, but has also had an impact on market liquidity conditions, with potential risks to financial stability and the pricing mechanisms as a consequence. Furthermore, these structural changes have had considerable implications for liquidity distribution and market conditions, and market participants wanting to monitor the market have had to diversify their sources of information. Finally, this article has presented a Krona liquidity index in an attempt to capture changes to the structural liquidity conditions in the krona specifically. Commonality links are strong between global liquidity conditions and those for the krona, although some changes in liquidity appear to be specific to the krona.

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APPENDIX A – Liquidity index calculations

The data used are retrieved from Bloomberg, see field names in Table 1 and currency pairs in Table 2 and Table 3.

Table 1. Bloomberg field names

Ticker	Description
XXXYYY Curncy	Code for currency pair (i.e. EURUSD Curncy)
PR002	Bid price (closing value)
PQ690	High bid price
PQ677	Low bid price
PR004	Ask price (closing value)
PQ678	High ask price
PQ691	Low ask price

Note: As of 3 January, 2022.

Source: Bloomberg.

Table 2. Currency pairs in the Krona liquidity index

Currency pair	Description
AUDSEK	Swedish krona per Australian dollar
BRLSEK	Swedish krona per Brazilian real
DKKSEK	Swedish krona per Danish krone
EURSEK	Swedish krona per Euro
INRSEK	Swedish krona per Indian rupee
ISKSEK	Swedish krona per Icelandic krona
JPYSEK	Swedish krona per Japanese yen
CADSEK	Swedish krona per Canadian dollar
CNYSEK	Swedish krona per Chinese renminbi
MXNSEK	Swedish krona per Mexican peso
NOKSEK	Swedish krona per Norwegian krone
NZDSEK	Swedish krona per New Zealand dollar
PLNSEK	Swedish krona per Polish zloty
RUBSEK	Swedish krona per Russian rubel
CHFSEK	Swedish krona per Swiss franc
GBPSEK	Swedish krona per British pound
KRWSEK	Swedish krona per South Korean won
CZKSEK	Swedish krona per Czech koruna
TRYSEK	Swedish krona per Turkish lira
HUFSEK	Swedish krona per Hungarian forint
USDSEK	Swedish krona per US dollar

Table 3. Currency pairs in the Global liquidity index

Currency pair	Description
EURUSD	US dollar per euro
USDJPY	Japanese yen per US dollar
GBPUSD	US dollar per British pound
AUDUSD	US dollar per Australian dollar
CADUSD	US dollar per Canadian dollar
USDCHF	Swiss franc per US dollar
EURJPY	Japanese yen per Euro
EURGBP	British pound per Euro
EURCHF	Swiss franc per Euro
USDSEK	Swedish krona per US dollar
EURCAD	Canadian dollar per Euro
EURAUD	Australian dollar per Euro
GBPAUD	Australian dollar per British pound
GBPCAD	Canadian dollar per British pound
GBPCHF	Swiss franc per British pound
GBPJPY	Japanese yen per British pound
EURNOK	Norwegian krone per Euro
GBPNOK	Norwegian krone per British pound
USDNOK	Norwegian krone per US dollar
EURNZD	New Zealand dollar per Euro
GBPNZD	New Zealand dollar per British pound
NZDUSD	New Zealand dollar per US dollar
GBPSEK	Swedish krona per British pound
USDINR	Indian rupee per US dollar
USDMXN	Mexican peso per US dollar
EURSGD	Singapore dollar per Euro
GBPDGD	Singapore dollar per British pound
USDSGD	Singapore dollar per US dollar
GBPZAR	South African rand per British pound
USDZAR	South African rand per US dollar

Data are cleaned following Brownlees and Gallo (2006). Observations are removed from the sample if both bid and ask prices are zero or if the price p_{t_i} is such that:

$$\left|p_{t_i} - \bar{p}_i(\alpha, k)\right| > 3s_i(\alpha, k) + \nu$$

Where $\bar{p}_i(\alpha, k)$ and $s_i(\alpha, k)$ denote the α-trimmed sample mean and standard deviation based on k observations in the neighbourhood of t_i, respectively. ν is added on the right side of the inequality to avoid zero variance for a sequence of equal

prices and is set to equal one pip (that is, 0.0001). α is set to 5 percent and k is set to 100.

Bid-ask spread estimates BA_t are calculated according to:

$$BA_t = (ask_t - bid_t) \div \frac{(ask_t + bid_t)}{2}.$$

To calculate the Corwin-Schultz estimates, data are first corrected for overnight returns. If the low value at day $t+1$ is higher than the closing value at day t, both the high and the low values for day $t+1$ are decreased by the amount of the overnight spread. If the high value at day $t+1$ is lower than the closing value at day t, both the high and the low values for day $t+1$ are increased by the amount of the overnight spread.

Corwin-Schultz estimates are thereafter calculated according to:

$$CS_t = \frac{2(e^{\alpha} - 1)}{1 + e^{\alpha}} \approx \alpha$$

for small values of $\alpha \in [-0.25, 0.25]$, where

$$\alpha = \left(1 + \sqrt{2}\right)\left(\sqrt{\beta} - \sqrt{\gamma}\right),$$

$$\beta = \left[ln\left(\frac{H_t}{L_t}\right)\right]^2 + \left[ln\left(\frac{H_{t+1}}{L_t+1}\right)\right]^2 \text{ and } \gamma = \left[ln\left(\frac{H_{t,t+1}}{L_t,t+1}\right)\right]^2,$$

where H_t and L_t denote the observed high and low prices on day t (also for day $t+1$), while $H_{t,t+1}$ and $L_{t,t+1}$ are the high and low over two days (t to $t+1$).

All negative two-day spreads are excluded.

Monthly averages are calculated as simple averages for both estimates.

Both series of estimates are standardised (individually) by subtracting the mean and dividing by the standard deviation. The two standardised series are then combined by taking the simple average across them.

Finally, the index is computed by taking the simple average of the liquidity measure across all currency pairs and taking the negative of the series so that negative values indicate worse conditions and positive values indicate better conditions than the historical average.

Hedging against exchange rate risk – maturity choice and roll-over risk

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The Swedish market for hedging foreign exchange (FX) risk is about double the size of the annual Swedish gross domestic product. Key buyers of FX risk protection are Swedish insurance companies and pension funds who regularly invest in foreign currency assets, which exposes them to exchange rate risk. The dominant sellers of FX risk protection are Swedish banks. The most commonly used financial instruments are FX swaps with a duration of 3 months or less. Since the typical investment horizon of insurance companies or pension funds can span multiple years, shorter-term FX hedging arrangements need to be rolled over repeatedly. In this article, we offer a conceptual framework to discuss the risks and benefits associated with short-term hedging for six risk categories: FX risk, asset price risk, FX market distress, premature liquidation risk, counterparty risk and inflation risk. The focus is on economic considerations that have to do with uncertainty and information.

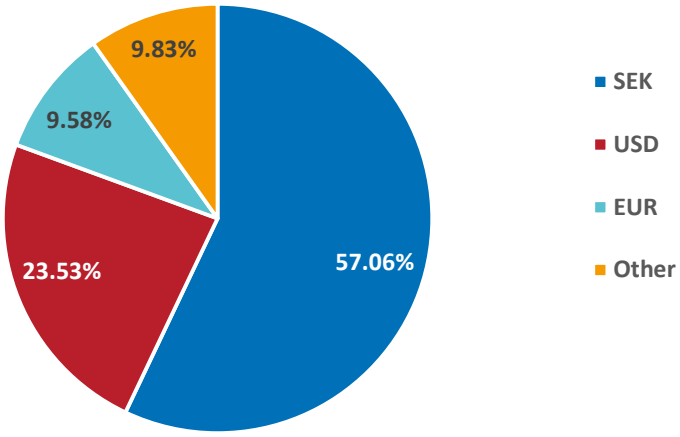
1 Introduction

A substantial part of the assets held by Swedish insurance companies, pension funds and other asset managers are issued by foreign entities and denominated in foreign currency. This is because Swedish investors seek to take advantage of investment opportunities abroad and to diversify their investment returns. Figure 1 shows a currency breakdown of the asset holdings of Swedish insurance companies and national pension funds (AP funds), who are the dominant Swedish asset managers. We can see that in 2020 almost 43% of the assets on their balance sheets were denominated in foreign currency with an important role played by US dollar and euro investments. At the same time, the vast majority of the liabilities of Swedish insurance companies and pension funds are denominated in Swedish krona. Therefore, Swedish asset managers have a “currency mismatch” on their balance sheets. In other words, the currency composition of their assets (domestic and foreign currency) and liabilities (domestic currency) differs markedly.

* I would like to thank Ida Hansson, Daniel Hansson, Thomas Jansson, Kristian Jönsson, Reimo Juks, Mats Levander, Ulf Söderström, Anders Vredin, Stephan Wollert and seminar participants at the Riksbank for valuable discussions and comments. The opinions expressed in this article are the sole responsibility of the author and should not be interpreted as reflecting the views of Sveriges Riksbank.

Figure 1. Currency decomposition of assets held by Swedish insurance companies and national pension funds

Per cent



Note. Currency breakdown of the consolidated asset side of Swedish insurance companies and Swedish national pension funds on December 30, 2020. The total market value of assets held amounted to 5,629 billion Swedish kronor (or 687 billion US dollar).

Source: Sveriges Riksbank.

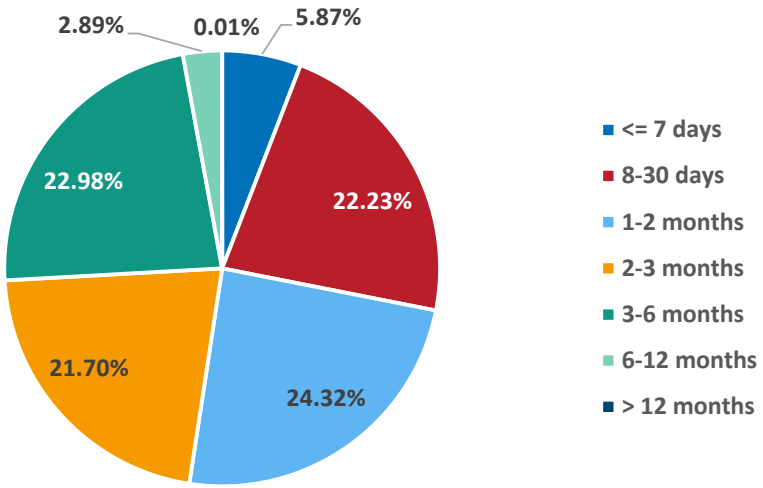
The currency mismatch exposes Swedish investment portfolios to risk due to fluctuations in foreign exchange rates; an unexpected weakening of the US dollar (USD) against the Swedish krona (SEK) will reduce the krona value of assets denominated in dollars and lead to losses on the investment portfolio, and an unexpected strengthening of the dollar will lead to portfolio gains. To reduce such risk, financial market participants use various financial instruments to "hedge" their risk exposure. The most common FX hedging instruments are "FX swaps", which consist of an FX spot transaction and a "forward contract". In essence, FX swaps allow Swedish insurance companies and pension funds to raise foreign currency funding and to protect against exchange rate risk by agreeing to swap cash flows in different currencies at an agreed conversion rate on a future date. For example, a Swedish pension fund (protection buyer) who wants to invest in a US corporate bond can engage in an FX swap contract with a Swedish bank (protection seller) that comprises two parts: (1) the exchange of SEK against USD today through a spot transaction, which the pension fund then uses to purchase a US corporate bond; and (2) a forward contract that specifies a future date when the pension fund has to return USD and receives SEK at a pre-specified conversion rate. In this way, the pension fund can protect the income from its US corporate bond investment from an unexpected weakening or strengthening of the US dollar.

The Swedish market for hedging FX risk is large. In 2020, the total amount of outstanding contracts averaged around 10,000 billion Swedish kronor, roughly twice as large as the annual gross domestic product. The average FX hedging contract had a volume of 80–90 million Swedish kronor (Levander et al. 2021). Figure 2 shows a

decomposition of the maturity profile of these contracts.[1] Importantly, more than 70% of the nominal amount of outstanding FX hedging contracts had a remaining duration of 3 months or shorter. We can see that 5.87% had a duration of less than 7 days, 22.23% had a duration of 8-30 days, 24.32% had a duration of 1-2 months, 21.70% had a duration of 2-3 months and 22.98% had a duration of 3-6 months.

Figure 2. Maturity composition of FX hedging contracts

Per cent



Note. Decomposition of the maturity profile of the nominal outstanding FX hedging contracts in the Swedish market. 2020 averages for the remaining maturity calculated over the end-of-month values. The slice corresponding to maturities exceeding 12 months (0.01% of the outstanding contracts) is not visible.

Source: Sveriges Riksbank.

The short duration of the FX hedging contracts contrasts with the typically longer duration of the foreign currency denominated assets in Swedish investment portfolios. In fact, the expected investment horizon of Swedish asset managers often spans multiple years, meaning that many of the assets in their investment portfolios have long maturities. An example for a popular foreign currency denominated asset is US government bonds with a duration of 5–10 years. Nevertheless, Swedish insurance companies, pension funds and other asset managers often use short-term FX hedging contracts to insure such investments in long-dated US government bonds.

Whenever the expected duration of the foreign currency denominated investments exceeds the duration of the FX hedging arrangements, asset managers have to rely on rolling over short-term hedging contracts. In a given month, around 250 billion Swedish kronor of US dollar FX hedges mature (Sveriges Riksbank 2021). This can pose challenges for asset managers and it can have implications for financial markets and for financial stability. The challenges are especially acute in periods of financial

[1] We thank Mats Levander for sharing the data. More detailed statistics can be found in Levander et al. (2021). While the financial market turmoil in the spring of 2020 following the outbreak of the COVID-19 pandemic had an effect (Sveriges Riksbank 2020a,b), the maturity decomposition for 2019 is similar.

distress such as the financial market turbulence during the spring of 2020, which severely affected the markets for hedging foreign exchange risk around the world.[2]

This article attempts to provide a conceptual framework to discuss the maturity choice and roll-over risk in the market for hedging FX risk. Using a simple theoretical model, we try to provide answers to questions like: What exactly are the risks associated with a duration mismatch between the underlying asset and the FX hedge? What could be potential reasons for why asset managers do not prefer longer-term FX hedging arrangements, for example hedging contracts that match the expected duration of the foreign currency denominated assets? What are the implications for episodes of financial distress?

Our focus is exclusively on aspects related to economic considerations that have to do with uncertainty and information. Therefore, we abstract from certain institutional details and other factors that can be important determinants of the supply and demand for different FX hedging products and their pricing, such as financial regulation and market power. In the article, we describe potential risks and benefits of short- and long-term FX hedging strategies stemming from uncertainty about different payoff-relevant variables (such as the exchange rate, the asset return and interest rates) and from assumptions about the flow of information over time. To this end, we distinguish between six risk categories: FX risk, asset price risk, FX market distress, premature liquidation risk, counterparty risk and inflation risk.

Exactly what risks and considerations are most relevant in relation to FX hedging arrangements is ultimately an empirical question, but we hope that this article can give some guidance by offering a suitable conceptual framework to think about a series of important economic considerations, while being flexible enough to capture additional features. A complete assessment of whether the observed FX hedging strategies are individually and socially optimal crucially hinges on the mandates of asset managers and the nature of the foreign currency denominated assets (bonds, equities, etc.). It is also contingent on expectations about the volatility of exchange rates, the persistence of exchange rate trends, inflation risk and other factors such as the microstructure of financial markets.

Taking a high-level perspective, episodes of financial market distress play a crucial role for FX markets. Severe financial distress can affect both the asset managers who seek FX risk protection and the providers of FX risk protection, who are primarily domestic banks. In normal times, asset managers appreciate the flexibility of short-term FX hedging arrangements, and we describe a number of potential advantages and disadvantages of short-term hedging strategies. However, from a policy viewpoint, an overreliance on short-term FX hedging strategies can have repercussions that are primarily felt in periods of financial distress. This is seen as a potential concern (Sveriges Riksbank 2020a), which resonates with the broader regulatory debate about the build-up of systemic risks. While this article does not intend to make normative

[2] See Sveriges Riksbank (2020a,b) for the Swedish dimension and Avdjiev et al. (2020) for the international dimension.

statements, we hope that it can offer inputs to the discussion of drivers behind the current shape of the market and point at potential policy trade-offs.

The article is organized as follows. In Section 2, we present a simple model framework that we will use for our analysis. In Section 3, we illustrate and evaluate different hedging strategies in situations characterized by different types of risk. In Section 4, we summarize our main findings and discuss how one may think about the trade-offs, the overall risk assessment and potential policy concerns.

For the fast reader, Table 2 in Section 4 offers for each of the six risk categories a summary of the potential advantages and disadvantages associated with short- and long-term FX hedging strategies.

2 Basic model

The formal analysis is based on a stylized theoretical model with two periods. This section describes the basic model used for the analysis in Section 3, where we also consider various extensions to capture different risk categories.

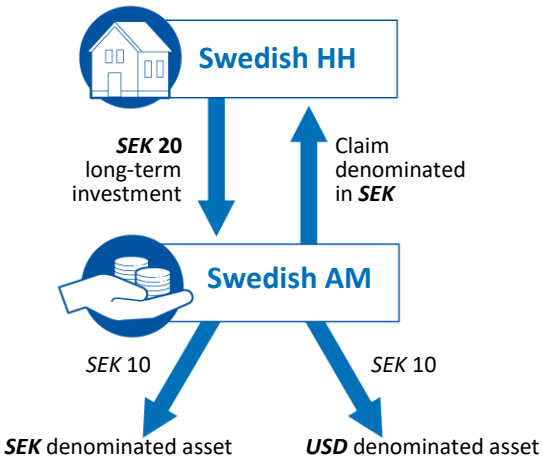
In the model, there are three dates ($t = 0, 1, 2$) and three risk-neutral actors: a Swedish household (henceforth HH), a Swedish asset manager (AM), who is seeking FX risk protection, and a Swedish or international bank (BANK), who sells FX risk protection. The HH has an endowment of $SEK\ 20$ at $t = 0$, which she places with the AM. We consider an investment horizon that spans two periods, that is, from $t = 0$ to $t = 2$. The investment decision is delegated to the AM and we assume that the AM's objective is to seek a balanced (50%–50%) exposure to a domestic SEK-denominated asset and to a foreign USD-denominated asset, as depicted in Figure 3. It shows that the HH invests $SEK\ 20$ with the AM and receives a claim denominated in SEK. The AM, in turn, invests $SEK\ 10$, respectively, in the domestic and foreign assets. The underlying rationale is that Swedish households do not want to rely exclusively on the Swedish financial market. Instead, they want to take advantage of investment opportunities in Sweden and abroad by constructing a portfolio that comprises domestic and foreign assets.[3]

Given the HH's two-period investment horizon, the AM pursues a long-term investment strategy and expects to divest the assets at $t = 2$, thereafter converting the proceeds from the USD denominated asset into SEK. Then the funds are used to serve the SEK denominated claim of the Swedish HH. Crucially, the AM wants to insure against exchange rate risk.[4]

[3] In practice, Swedish asset managers diversify their asset holdings globally. Characteristically, small open economies have a large share of investments in foreign currency denominated assets. Important benefits of such an investment strategy include the possibility to insure against domestic shocks and to take advantage of a wider range of investment opportunities. Our stylized model does not offer micro foundations for the diversification motive and we just assume that HHs want a 50%–50% exposure.

[4] The assumption that the AM wants to insure against FX risk can be justified by the regulation of pension funds and insurance companies who are obliged to hedge certain exchange rate risks. In practice, Swedish asset managers like mutual funds and Swedish households investing directly in foreign currency

Figure 3. Investment in the basic model



We assume that the SEK and USD denominated assets deliver the cash-flows depicted in Table 1. Both investments are "long-term" with a duration of two periods. One USD invested at $t = 0$ delivers a gross return of $USD\ \tilde{r}_2^*$ at $t = 2$ if held to maturity. The investment is potentially risky, meaning that it has a stochastic return (indicated by the tilde ~). In practice, the AM may not always wait until the asset matures but sell it on the financial market at a gain or loss. If the USD denominated asset is divested prematurely at $t = 1$, the return is $USD\ \tilde{p}_1^*$. Similarly, one SEK invested at $t = 0$ delivers a gross return of $SEK\ \tilde{r}_2$ at $t = 2$ if held to maturity and a return of $SEK\ \tilde{p}_1$ if divested at $t = 1$.

Table 1. Asset returns

Returns per unit of USD or SEK invested

Time		t=0	t=1	t=2
Payoff from USD asset	If held to maturity	$-USD\ 1$		$+USD\ \tilde{r}_2^*$
	If sold prematurely	$-USD\ 1$	$+USD\ \tilde{p}_1^*$	
Payoff from SEK asset	If held to maturity	$-SEK\ 1$		$+SEK\ \tilde{r}_2$
	If sold prematurely	$-SEK\ 1$	$+SEK\ \tilde{p}_1$	

There is a foreign exchange market, which is open at dates $t = 0, 1, 2$ for spot transactions and at dates $t = 0, 1$ for forward contracts that can be used to hedge against exchange rate risk.[5] These contracts describe an agreement that stipulates the exchange of currency at a specified future date using a contractually agreed conversion rate, the so-called forward rate. In our model, the BANK offers protection

denominated assets may deliberately refrain from hedging exchange rate risk for speculative reasons, because the cost of hedging FX risk is too high for them or because of risk management considerations.

[5] In practice, FX swaps are more common than forward contracts. As explained in the introduction, FX swap contracts consist of a spot transaction where the AM "borrows" USD at $t = 0$ and "lends" SEK, and a forward transaction with reversed payments of a pre-specified amount.

at $t = 0$ and $t = 1$; the cost of the protection depends on the duration of the forward contract and may be time-varying.

Formally, we denote with S_0 the SEK/USD spot exchange rate at $t = 0$. The future spot exchange rates at $t = 1$ and $t = 2$ are stochastic (indicated by the tilde ~) and denoted by $\tilde{S}_1$ and $\tilde{S}_2$, respectively. Next, let F_{01} be the $t = 1$ forward exchange rate which is agreed upon at $t = 0$. Similarly, F_{02} is the $t = 2$ forward exchange rate agreed at $t = 0$ and F_{12} is the $t = 2$ forward exchange rate agreed at $t = 1$. Finally, let τ_{01} be the insurance premium (or contractual cost) in SEK for a forward contract spanning from $t = 0$ to $t = 1$. The parameters τ_{12} and τ_{02} are defined analogously.[6]

Besides the foreign exchange market, there is a domestic and a foreign credit market at dates $t = 0, 1$. Let i_{01} be the short-term interest rate in the domestic credit market at $t = 0$ and let i_{02} be the long-term interest rate; the future short-term rate at $t = 1$ is potentially stochastic and denoted by $\tilde{\imath}_{12}$. Analogously, we denote with i^*_{01} the short-term interest rate in the foreign credit market at $t = 0$ and with i^*_{02} the long-term interest rate; the potentially stochastic future short-term rate at $t = 1$ is $\tilde{\imath}^*_{12}$.

2.1 No arbitrage

Suppose for now that the insurance premia for forward contracts are zero, so $\tau_{01} = \tau_{12} = \tau_{02} = 0$. In a perfectly competitive risk-neutral environment with no arbitrage opportunities, interest rates and prices are in the following relationship. First, the price of the domestic asset at $t = 1$ has to equal its discounted expected cash flow: $p_1 = E[\tilde{r}_2/(1 + \tilde{\imath}_{12})]$. The same holds for the foreign asset: $p^*_1 = E[\tilde{r}^*_2/(1 + \tilde{\imath}^*_{12})]$. Second, the domestic SEK long-term interest rate has to equal the expected return of the domestic asset, so $i_{02} = (1 + i_{01}) \times E[1 + \tilde{\imath}_{12}] - 1 = E[\tilde{r}_2] - 1$, and the foreign USD long-term interest rate has to equal the expected return of the foreign asset: $i^*_{02} = (1 + i^*_{01}) \times E[1 + \tilde{\imath}^*_{12}] - 1 = E[\tilde{r}^*_2] - 1$.

If one of the above relationships does not hold, there are arbitrage opportunities in the domestic and foreign financial markets, which could be exploited by financial market participants. As an example, consider a situation where $i_{02} < E[\tilde{r}_2] - 1$. Here a risk-neutral arbitrageur could borrow funds cheaply in the domestic credit market and generate vast profits by investing them in the domestic asset, which offers a higher expected return. In practice, competitive financial markets do not offer such opportunities to generate potentially unlimited profits, provided there are no relevant limits to arbitrage (such as tight credit limits) that prevent arbitrageurs from exploiting arbitrage opportunities.

Since we are operating in an environment where there is a domestic and a foreign financial market, the assumption of no arbitrage implies additional conditions that link interest rates, exchange rates and forward rates.

To rule out the possibility that there is an opportunity to earn riskless profits from covered interest arbitrage, the covered interest parity (CIP) demands that $F_{01}/S_0 =$

[6] We can interpret τ as a catch-all that also includes factors like liquidity risk and counterparty risk, which are important determinants of how expensive it is to protect against exchange rate risk.

$(1 + i_{01})/(1 + i_{01}^*)$ and $F_{02}/S_0 = (1 + i_{02})/(1 + i_{02}^*)$ at $t = 0$, and $F_{12}/S_1 = (1 + i_{12})/(1 + i_{12}^*)$ at $t = 1$.[7] These relationships assure that it is not possible to generate a profit by borrowing in the credit market in one currency and investing in the credit market in another currency.

Finally, in our risk-neutral world, the equalization of expected returns (domestic and foreign) demands that $S_0 \times (1 + i_{01}) = E[\tilde{S}_1] \times (1 + i_{01}^*)$ and $S_0 \times (1 + i_{02}) = E[\tilde{S}_2] \times (1 + i_{02}^*)$ at $t = 0$, and $S_1 \times (1 + i_{01}) = E[\tilde{S}_2|S_1] \times (1 + i_{12}^*)$ at $t = 1$. The uncovered interest parity (UIP) conditions imply $E[\tilde{S}_1] = F_{01}$ and $E[\tilde{S}_2|S_1] = F_{12}$.[8]

2.2 Baseline example

To guide our analysis of the basic model, we use an example with some numbers. Figure 4 provides an illustration. As seen in Figure 4, we assume that the spot exchange rate at $t = 0$ is $S_0 = 10\ SEK/USD$ and that the future exchange rates at $t = 1$ and $t = 2$ are unknown. We also assume that the domestic one-period interest rate is $i_{01} = i_{12} = 10\%$, while the foreign one-period interest rate is $i_{01}^* = i_{12}^* = 20\%$. The asset returns follow from the assumption of no arbitrage as specified above. That is, the domestic long-term interest rate is given by $i_{02} = (1 + i_{01})(1 + i_{12}) - 1 = 21\%$, and if the return of the foreign asset is riskless, then it must be given by $r_2^* = 1.44$ to match the foreign long-term rate of $i_{02}^* = (1 + i_{01}^*)(1 + i_{12}^*) - 1 = 44\%$.

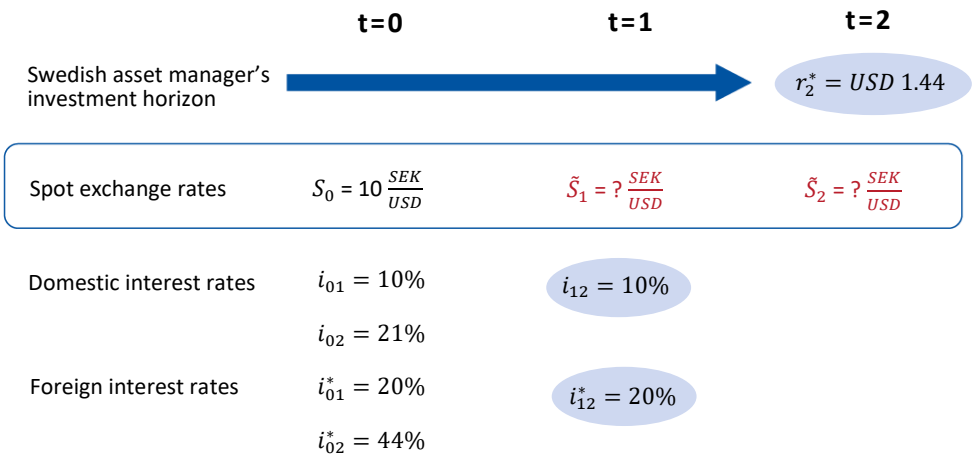
In the baseline environment, we assume that the foreign asset return is known at $t = 0$, as well as the future domestic and foreign interest rates. We will relax these assumptions for the variables marked with blue circles in Figure 4 when considering various extensions.

In our example, the Swedish asset manager then invests SEK 10 in the foreign asset, with a known long-term return of $\tilde{r}_2^* = USD\ 1.44$. To do so, she must first purchase dollar in the spot market at the exchange rate S_0. While the asset return in dollar is known, the future exchange rate is not, and therefore the asset manager does not know how much SEK the investment will generate. Thus, she faces FX risk.

[7] In practice, deviations from the CIP can occur (see, for example, Borio et al. 2016). Through the lens of our model, we can capture deviations from the CIP by manipulating the insurance premia $\tau_{01}, \tau_{12}, \tau_{02}$.

[8] Risk aversion is one reason why the spot price of a foreign currency can deviate from the prevailing forward rate.

Figure 4. Foreign asset return, spot exchange rates and interest rates



Note. The spot exchange rates $\tilde{S}_1$ and $\tilde{S}_2$ in red are stochastic and their realization is not known at $t = 0$. In the baseline example variables marked with blue circles are assumed to be risk-free and known at $t = 0$.

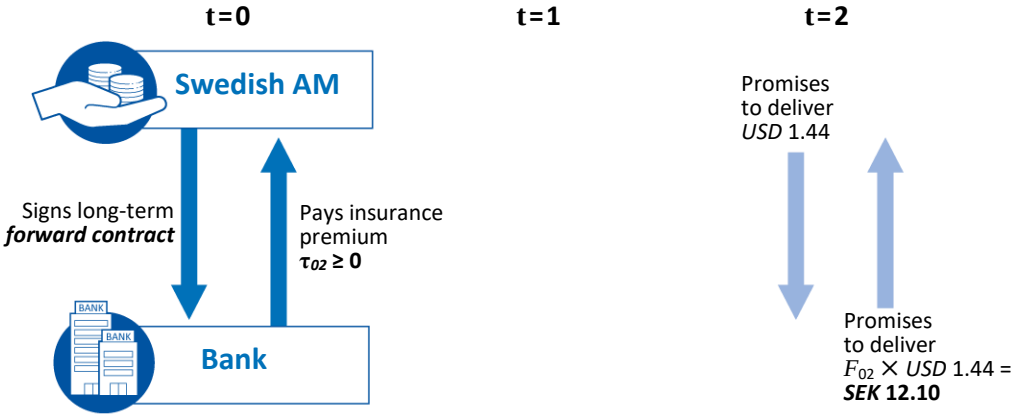
2.2.1 The long-term FX hedging strategy

One way to protect the asset manager from FX risk is to enter a long-term hedging arrangement. Figure 5 illustrates schematically how this works. After the Swedish asset manager places her investment of $SEK\ 10$ in the foreign asset, which requires her to purchase US dollar in the spot market at the rate S_0, she engages in a long-term forward contract with the BANK at $t = 0$. The forward contract stipulates a promise by the AM to deliver $USD\ 1.44$ at $t = 2$, which is the anticipated payoff from the foreign asset, and to receive $F_{02} \times USD\ 1.44$ from the BANK. Provided that covered interest parity holds, the payment received by the AM is $SEK\ 12.1$, which is the same return as investing $SEK\ 10$ in the domestic asset at the interest rate $i_{02} = 21\%$.[9]

In effect, the exchange rate risk associated with the foreign asset return is fully eliminated. Figure 5 also shows that the AM pays an insurance premium at $t = 0$ to the BANK. Since we assume in the baseline that the insurance premium (τ_{02}) charged by the BANK is zero, the long-term FX hedging assures that the rate of return on the foreign asset is identical to that on an investment in the domestic credit market.

[9] The return in SEK from the foreign asset return must satisfy $F_{02} \times USD\ 1.44 = (1 + i_{02})/(1 + i_{02}^*) \times S_0 \times USD\ 1.44 = SEK\ 12.1$.

Figure 5. The long-term FX hedging arrangement



Note. The forward contract spans from $t = 0$ to $t = 2$. The Swedish asset manager (AM) promises to deliver $USD\ 1.44$ at $t = 2$ in return for $SEK\ 12.1$ from the protection seller (BANK).

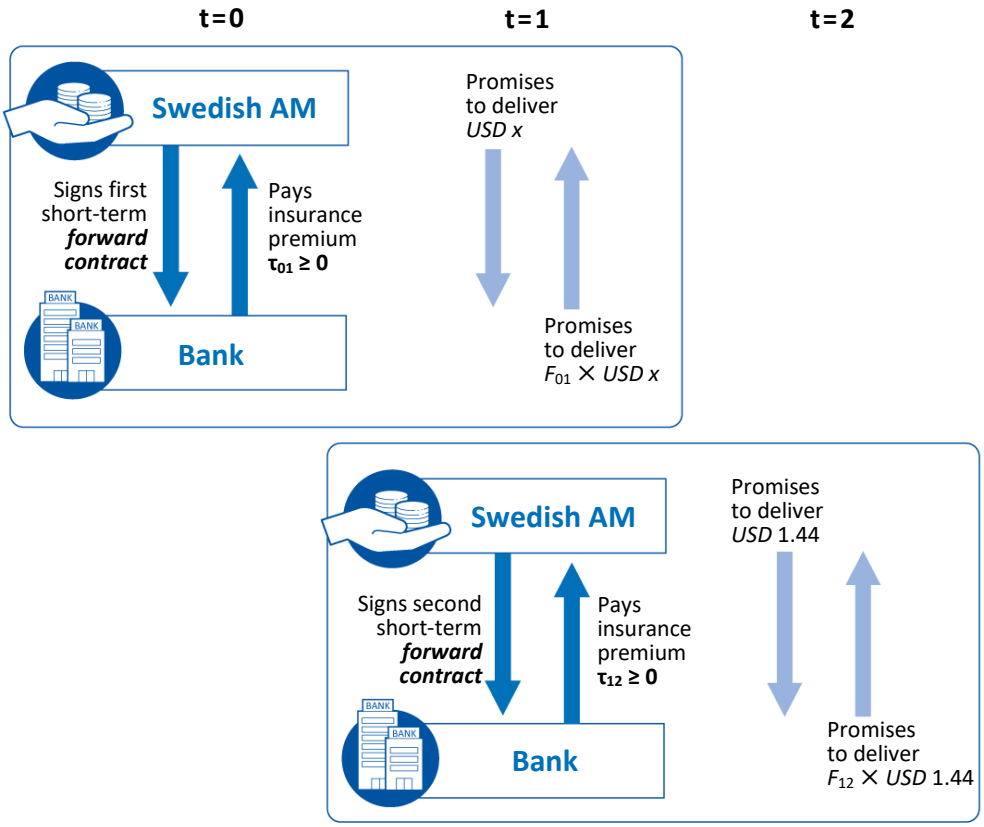
2.2.2 The short-term FX hedging strategy

An alternative to the long-term hedging arrangement is to enter two short-term hedging arrangements. This is illustrated in Figure 6. The first forward contract signed at $t = 0$ foresees a promise by the Swedish asset manager to deliver $USD\ x$ to the protection seller in exchange for $F_{01} \times USD\ x$ at $t = 1$. The second forward contract signed at $t = 1$ foresees a promise by the AM to deliver $USD\ 1.44$ to the BANK in exchange for $F_{12} \times USD\ 1.44$ at $t = 2$. For each forward contract, an insurance premium may have to be paid (τ_{01}, τ_{12}), but we assume for the baseline that insurance premia are zero.

We will discuss the optimally chosen amount x of the first forward contract in more detail below. In essence, the optimal x minimizes payoff risk by tailoring hedging gains and losses to the desired levels, taking into account expected future interest rates.

This concludes the discussion of the model framework. We now use this framework to analyze how the long- and short-term FX hedging strategies perform in different risk scenarios. We discuss, in turn: risk originating from movements in the foreign exchange rate (FX risk); risk from movements in the price of the foreign asset (price risk); risk related to FX market distress; risk related to the need to sell the asset and to unwind the FX hedge in advance; risk related to the counterparty in the FX hedging arrangement; and, finally, risk of increased inflation in the domestic economy. Throughout, our aim is to address two questions: *How does the performance of short- and long-term FX hedging strategies differ? Under what conditions will the two strategies lead to the same outcome?*

Figure 6. The short-term FX hedging arrangements



Note. The first forward contract spans from $t = 0$ to $t = 1$. The Swedish asset manager (AM) promises to deliver $USD\ x$ at $t = 1$ in return for $F_{01} \times USD\ x$ from the protection seller (BANK). The second forward contract spans from $t = 1$ to $t = 2$ and AM promises to deliver $USD\ 1.44$ at $t = 2$ in return for $F_{12} \times USD\ 1.44$.

3 FX hedging strategies under different types of risk

This section considers how different hedging strategies perform under six different risk categories: FX risk, asset price risk, FX market distress, premature liquidation risk, counterparty risk and inflation risk.

3.1 FX risk

We begin by discussing risk originating from movements in the exchange rate, building on the baseline environment described above. The attractiveness of FX hedging depends in general on what types of risk the investor faces. If most of the risk is due to movements in the exchange rate, for instance if the investment return in foreign currency is easy to predict, then the case for FX hedging is most pervasive. This is typically the case for highly rated fixed-income investments. Conversely, an asset manager investing in foreign currency denominated equity may have little

incentive to seek a FX hedge since the risk associated with the equity exposure is likely to dwarf the currency risk.[10]

We first abstract from asset return risk, that is, we consider the simpler baseline model with riskless asset cash flows, $\tilde{r}_2^* = r_2^* = 1.44$ and $\tilde{r}_2 = r_2 = 1.21$. Section 3.1.1 focuses on shocks to spot exchange rates and switches off interest rate risk. In this scenario, a long-term FX hedging strategy and a carefully calibrated short-term FX hedging strategy can lead to identical outcomes. We discuss limitations to the result and present in Section 3.1.2 what happens when we introduce interest rate risk as one of the drivers of exchange rate risk. Thereafter, Section 3.1.3 introduces asset return risk.

3.1.1 Shocks to the spot exchange rates without interest rate risk

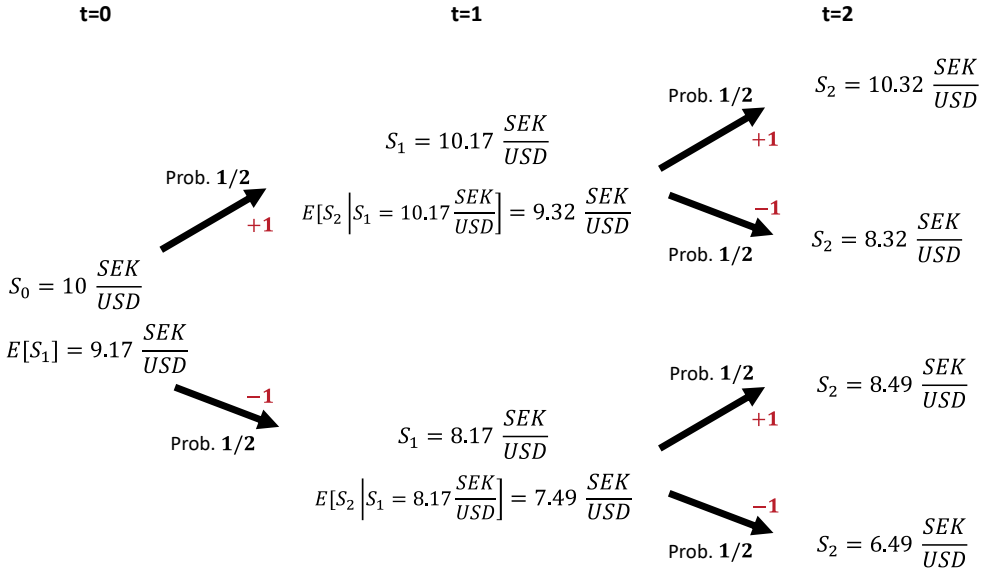
In our first comparison of FX hedging strategies, we assume that there is neither domestic, nor foreign interest rate risk, that is, the domestic and foreign one-period interest rates are known and equal to 10% and 20%, respectively ($\tilde{\imath}_{12} = i_{12} = 10\%$ and $\tilde{\imath}_{12}^* = i_{12}^* = 20\%$). As in the baseline example, this means that the two-period interest rates are $i_{02} = 21\%$ and $i_{02}^* = 44\%$, respectively.

Since the domestic interest rate is below the foreign interest rate, the SEK is on average expected to appreciate against the USD. But the exact realization of the future exchange rate can be both stronger or weaker than in period 0. We will consider an environment where it is equally likely that the exchange rate will appreciate or depreciate, with shocks equal to $+1$ or -1. Assuming that covered interest parity (CIP) holds, the forward exchange rate at $t = 0$ is $9.17\ SEK/USD$ (derived as $F_{01} = (1 + i_{01})/(1 + i_{01}^*) \times S_0$), which equals the expected $t = 1$ spot rate, that is, $E[\tilde{S}_1] = F_{01}$. Given the symmetric shocks of $+1$ or -1, the actual spot exchange rate is either $S_1 = 10.17\ SEK/USD$ or $S_1 = 8.17\ SEK/USD$ with probability one-half each, as illustrated in Figure 7.

The CIP then also demands that the implied forward exchange rate at $t = 1$ depends on the realized spot exchange rate: $\tilde{F}_{12} = (1 + i_{12})/(1 + i_{12}^*) \times \tilde{S}_1\ SEK/USD$. Given that the future exchange rate is either 10.17 or 8.17 with probability one-half each, the implied forward rate is either 9.32 or $7.49\ SEK/USD$. This equals the expectations about $t = 2$ spot rates shown in Figure 7. Again, because of the symmetric shocks of $+1$ or -1, the actual realizations of the $t = 2$ spot exchange rates differ. Specifically, Figure 7 shows that there are four different possible realizations with probability one-quarter each, which are 10.32, 8.32, 8.49 and 6.49 SEK/USD.

[10] See, for example, Dimson et al. (2012) for a discussion of empirical evidence.

Figure 7. Spot exchange rates and expectations with FX risk only



Note. Prob. stands for probability. Exchange rate shocks in red.

FX hedging strategies

We consider the following investment strategies for the asset manager:

1. **Long-term**: Invest in the foreign asset and seek a long-term FX hedging arrangement.

2. **Short-term**: Invest in the foreign asset and seek two short-term FX hedging arrangements (for example from $t = 0$ to $t = 1$ and from $t = 1$ to $t = 2$).[11]

3. **No FX hedge**: Invest in the foreign asset without a hedging arrangement.

Strategy: Long-term

Suppose that the Swedish asset manager pursues a long-term FX hedging strategy. We will show that the asset manager can then fully eliminate FX risk in the described environment and achieve a return of 21% for the foreign dollar denominated asset, which equals the return of the domestic asset.

The long-term FX hedging strategy works as follows: At $t = 0$, the AM sells $SEK\ 10$ on the FX spot market at the rate $S_0 = 10\ SEK/USD$ and obtains $USD\ 1$, which she invests in the dollar denominated foreign asset. To insure the FX risk, the AM enters a contract with the BANK, where the BANK agrees to deliver $F_{02} \times USD\ r_2^* = (1 + i_{02})/(1 + i_{02}^*) \times S_0 \times USD\ r_2^* = SEK\ 8.40 \times r_2^*$ in exchange for $USD\ r_2^*$ at $t = 2$. At $t = 0$, the foreign asset payoff is realized and the forward contract is settled.

As a result, the AM's rate of return at $t = 2$ for the domestic investment is

[11] The two FX hedges may be provided either by two different protection sellers or by the same protection seller who agrees to roll over the hedge.

$$r_2 - 1 \equiv \frac{SEK\ r_2 - SEK\ 10}{SEK\ 10} = 21\%$$

and the rate of return for the foreign investment is

$$R^{LT} \equiv \frac{F_{02} \times USD\ r_2^* - S_0\ USD}{S_0\ USD} = 21\%,$$

where the gross rate of return is computed as the forward rate times the foreign asset return in USD divided by the initial investment of $SEK\ 10$. Subtracting one gives the net rate of return of 21%.

Due to the assumption of no-arbitrage, the returns on the domestic and the foreign investment are identical. Moreover, the AM is *fully insured* against both an appreciation or depreciation of the krona relative to the $t = 0$ expectation given by $E[\tilde{S}_2] = 8.40\ SEK/USD$; the realization of the spot exchange rates at $t = 1,2$ does not matter.

Strategy: Short-term

Next, suppose that the Swedish asset manager pursues a short-term FX hedging strategy, and enters a one-period hedging arrangement at $t = 0$ and then a second arrangement at $t = 1$.[12] We will show that the asset manager can fully eliminate FX risk in the described environment if the first FX hedge is calibrated to the right amount. In this case, the expected return of the foreign dollar denominated asset is always identical at 21%.

The short-term FX hedging strategy works as follows: At $t = 0$, the AM sells $SEK\ 10$ on the FX spot market at the rate $S_0 = 10\ SEK/USD$ and obtains $USD\ 1$, which is invested in the dollar denominated foreign asset. To insure the AM's FX risk; the BANK agrees to deliver $F_{01} \times USD\ x = \frac{1+i_{01}}{1+i_{01}^*} \times S_0 \times USD\ x = SEK\ 9.17 \times\ x$ in exchange for $USD\ x$ at $t = 1$. At the beginning of $t = 1$, the realization of the spot exchange rate becomes known. It is either $S_1 = 10.17\ SEK/USD$ or $S_1 = 8.17\ SEK/USD$. We start with the former case.

First, the AM has to deliver $USD\ x$ to the counterparty of the first forward contract and receives $SEK\ 9.17 \times x$, meaning that she faces a hedging loss of $SEK\ x$, as the true exchange rate is $10.17\ SEK/USD$. Second, the AM seeks a new FX hedge with another BANK, which involves a promise to deliver $USD\ r_2^*$ at $t = 2$ to the BANK in exchange for $F_{12} \times USD\ r_2^* = (1 + i_{12})/(1 + i_{12}^*) \times 10.17\ SEK/USD \times USD\ r_2^* = SEK\ 13.42$. The hedging loss necessitates that the AM borrows $SEK\ x$ domestically at the interest rate $i_{12} = 10\%$ in order to meet the $t = 1$ payment obligation from the first forward contract. At $t = 2$, the foreign asset payoff is realized, the second forward contract is settled and the debt is repaid with interest.

[12] The protection seller may be the same or a different BANK. We discuss the case when the new protection seller is another BANK. The outcome is identical if the same BANK is used for a roll-over of the forward contract, which requires to account for hedging gains and losses, as to make the BANK indifferent about whether or not to roll over the forward contract.

This time the result differs. If $S_1 = 10.17\ SEK/USD$, the AM's rate of return on the foreign investment at $t = 2$ is

$$R_A^{ST}(x) \equiv \frac{F_{12} \times USD\ r_2^* - S_0\ USD - (1+i_{12}) \times SEK\ x}{S_0\ USD} = 34.2\% - \frac{(1+i_{12}) \times SEK\ x}{SEK\ 10}.$$

Similar to before we compute the gross rate of return as the forward rate times the foreign asset return in USD divided by the initial investment of $SEK\ 10$. However, we now also need to correct for the $t = 2$ value of the hedging loss. Note that the outcome of the short-term FX hedging strategy is *only identical* to the outcome of the long-term FX hedging strategy if the first FX hedge is over the amount $x = 1.2$, that is, *the discounted* $t = 2$ *return of the foreign asset*. Formally, $R_A^{ST}(x = 1.2) = 21\%$. The intuition for this result is that the lower cost for the second FX hedging contract has to be exactly off-set by the hedging loss.

We next look at the case where the realization of the spot exchange rate is $S_1 = 8.17\ SEK/USD$. At $t = 1$ the AM seeks to roll over the expiring forward contract. First, the AM has to deliver $USD\ x$ to the counterparty of the first forward contract and receives $SEK\ 9.17 \times x$, meaning that she faces a hedging gain of $SEK\ x$. The AM seeks a new FX hedge with another BANK, which involves a promise to deliver $USD\ r_2^*$ at $t = 2$ to the BANK in exchange for $F_{12} \times USD\ r_2^* = SEK\ 10.78$.

The AM's rate of return on the foreign investment at $t = 2$ then is

$$R_B^{ST}(x) \equiv \frac{F_{12} \times USD\ r_2^* - S_0 USD + (1+i_{12}) \times SEK\ x}{S_0\ USD} = 7.8\% + \frac{(1+i_{12}) \times SEK\ x}{SEK\ 10}.$$

Relative to the previous case, the cost for the second FX hedging contract is higher, which shows up as a reduction in the first term. However, we now have to account for a hedging gain in the second term. Again the outcome of the short-term FX hedging strategy is *only identical* to the outcome of the long-term hedging strategy if $x = 1.2$.

In sum, we find that the asset manager's payoff is constant (that is, the payoff variance is zero) if $x = 1.2$. Otherwise, the payoff variance is positive.

Strategy: No hedge

Now suppose that the Swedish asset manager pursues no FX hedging. It can be shown that in the described environment the expected return is the same as for the previous strategies, that is, $E[\tilde{R}^N] = 21\%$. However, the payoffs under the different exchange rate realizations are associated with substantial risk.

Specifically, without FX hedging, the return on the foreign investment at $t = 2$ depends on which of the four equally likely realizations of the spot exchange rate S_2 prevails (recall Figure 7).

We have now set the stage to address some of our questions and to identify variations in the economic environment that help us to gain additional insights.

Can the FX risk be fully eliminated under the short-term FX hedging strategy?

Yes, as shown above, the short-term FX hedging strategy can replicate the outcome of the long-term FX hedging strategy in the described environment. This is, however, only the case if the first forward contract targets the discounted cash-flow of the foreign currency denominated asset, that is, if $x = 1.2$. A wrongly calibrated first forward contract yields *the same expected return* of 21% as the long-run strategy, *but exposes* the Swedish asset manager to some risk. To see this, suppose that the first forward contract targets the non-discounted cash-flow of the foreign asset, that is, if $x = 1.44$, then the short-term FX hedging strategy has a risky return of $R_A^{ST} = 18.36\%$ with probability one-half and $R_B^{ST} = 23.64\%$ with probability one-half.

Importantly, the short-term hedging strategy is associated with gains or losses. These gains or losses occur because the FX hedge becomes either cheaper if the Swedish krona appreciates or more expensive if it depreciates. Only if $x = 1.2$ will the gains and losses exactly offset the variability in the cost of the second FX hedging contract. As a result, the first forward contract needs to be carefully calibrated.

What are the challenges in calibrating the first forward contract?

In our simple example, not only the cash-flow is known, but also the future foreign interest rate. In practice, both variables are likely to be uncertain. In fact, we show in Section 3.1.2 that the equivalence result breaks down if we consider a scenario with interest rate risk. Specifically, we show that discounting with the expected future foreign interest rate inevitably generates payoff variability, making the short-term FX hedging strategy risky.

Why is it that short-term FX hedging arrangements are used much more frequently in practice?

One aspect that can draw a wedge between the outcomes of the long- and short-term FX hedging strategies is related to the insurance premia. Specifically, the comparison of the two strategies is influenced by insurance premia if $\tau_{01} + \tau_{12} \neq \tau_{02}$. Consistent with the prevalent use of short-term FX hedging strategies, it is possible that longer-term hedges are, at least for certain maturities, more expensive due to a less liquid market. In fact, market surveys reveal that the most liquid segment of the FX swap market is typically concentrated over maturities of a few months. For the Swedish krona, the outstanding nominal amounts of FX swaps with maturities over 6 months are very small compared to shorter maturities, as illustrated in Figure 2. It is an interesting empirical question to understand how much of this outcome can be explained by demand and supply factors.

Investors may also choose to use short-term hedging strategies if demand and supply are more misaligned for longer maturities. Specifically, supply shortages for longer maturities can imply that the short-term FX strategy has a more favorable expected return. Formally, this can be captured in our model as $\tau_{01} + \tau_{12} < \tau_{02}$. Conceptually, there are a number of possible reasons for such a scenario. Important aspects have to do with institutional and regulatory factors. From the perspective of domestic banks, who are the dominant counterparties for Swedish asset managers, there is a desire to align the duration of the offered FX swaps with their desired FX funding profile. If

their own funding costs in foreign currency are more favorable at shorter maturities, banks will have an incentive to offer better terms to Swedish asset managers for short-term FX hedging arrangements with similar durations.

Another aspect that can draw a wedge between the outcomes of the long- and short-term FX hedging strategies is related to risk aversion. While risk aversion tends to favor long-term hedging strategies, it can interact with other factors that may induce asset managers to favor short-term FX hedging arrangements. These include the risk of over- and under-hedging, which we discuss in detail in Section 3.1.3, considerations that have to do with flexibility, which we discuss in Sections 3.4 and 3.5, and considerations related to domestic inflation risk, which we discuss in Section 3.6.

3.1.2 Shocks to the spot exchange rates and to the foreign interest rate

Next, we examine the role of uncertainty about foreign interest rates, which is one of the determinants of exchange rate risk. In the previous analysis, we modeled interest rates as deterministic variables and exchange rates as stochastic variables that are driven by a symmetric exogenous shock. Now we add a stochastic foreign interest rate, which is also driven by a symmetric exogenous shock. Specifically, we consider the following modified environment.

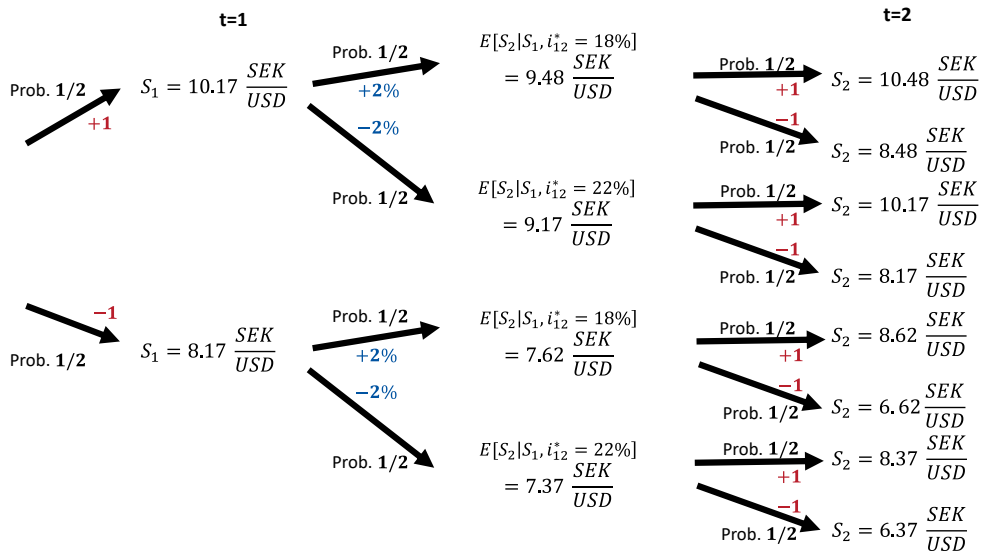
As before, the spot exchange rates at $t = 1, 2$ are assumed to be equally likely to strengthen or weaken by one unit. In contrast to Section 3.1.1, the foreign interest rate $\tilde{\imath}_{12}^{*}$ is now stochastic and becomes known at the beginning of $t = 1$. Consequently, the interest rate differential is now an additional driver of the spot exchange rate at $t = 2$ and of forward rates at $t = 1$.

We continue to assume that the short-term foreign interest rate in period $t = 0$ is given by $i_{01}^{*} = 20\%$. But the realization of the future short-term interest rate is equally likely to be $i_{12}^{*} = 18\%$ or $i_{12}^{*} = 22\%$, with an expected value of $E[\tilde{\imath}_{12}^{*}] = 20\%$. The long-term interest rate is unchanged at $i_{02}^{*} = 44\%$, and we assume that the domestic interest rates are unaltered with $i_{01} = i_{12} = 10\%$ and $i_{02} = 21\%$.

Assuming that CIP holds, the spot rate and implied forward exchange rate at $t = 0$ remain $S_0 = 10\ SEK/USD$ and $F_{01} = 9.17\ SEK/USD$. The implied forward exchange rate at $t = 1$ depends on both the realized spot exchange rate at $t = 1$ (which is either 10.17 or 8.17) and the realized short-term foreign interest rate (either 18% or 22%). As the forward rate at $t = 1$ is stochastic and given by $\tilde{F}_{12} = (1 + i_{12})/(1 + \tilde{\imath}_{12}^{*}) \times \tilde{S}_1$, there are four possible realizations: 9.48, 9.17, 7.62, or 7.37 SEK/USD, each of which occurs with equal probability of one-quarter. Figure 8 shows how the environment is modified at dates $t = 1,2$. We can see that there are eight possible realizations with probability one-eights each, which are 10.48, 8.48, 10.17, 8.17, 8.62, 6.62, 8.37 and 6.37 SEK/USD.

As in Section 3.1.1, the Swedish krona is expected to appreciate due to the interest rate differential, but the actual realization of the spot exchange rate can be either stronger or weaker than the expected value. We discuss the outcomes of the two FX hedging strategies in turn.

Figure 8. Spot exchange rates, foreign interest rate risk and expectations with FX and foreign interest rate risk



Note. Prob. stands for probability. Exchange rate shocks in red; foreign interest rate shocks in blue.

Strategy: Long-term

If the Swedish asset manager pursues a long-term FX hedging strategy, the analysis of Section 3.1.1 is unchanged. The long-term FX hedging strategy allows the asset manager to fully insure against either a depreciation or an appreciation of the Swedish krona. The spot exchange rate and the foreign interest rate realized at $t = 1$ do not matter since the contracting at $t = 0$ is based on the known (non-stochastic) long-term foreign interest rate $i_{02}^* = 0.44$ as in Section 3.1.1.

Strategy: Short-term

Next, suppose that the Swedish asset manager pursues a short-term FX hedging strategy. We then find that the strategy now delivers a risky payoff. The expected return is with 21% identical, but in contrast to Section 3.1.1, the hedging gains and losses are not fully offset.

As before, the AM sells $SEK\ 10$ at $t = 0$ on the FX spot market at the rate $S_0 = 10\ SEK/USD$ and obtains $USD\ 1$, which is invested in the dollar denominated foreign asset. To insure the AM's FX risk; the BANK agrees to deliver $F_{01} \times USD\ x = (1 + i_{01})/(1 + i_{01}^*) \times S_0 \times USD\ x = 9.17\ SEK/USD \times USD\ x$ in exchange for $USD\ x$ at $t = 1$. At the beginning of $t = 1$, the realization of the spot exchange rate and the foreign interest rate become known. As shown in Figure 8, we have to consider four different combinations of spot exchange rate and foreign interest rate realizations. Otherwise, the analysis is identical to Section 3.1.1 and we provide the derivations in Appendix A.

For the case where $S_1 = 10.17\ SEK/USD$ and $i_{12}^* = 18\%$, the AM's rate of return on the foreign investment at t =2 is $R_A^{STi} = 36.51\% - 1.1 \times SEK\ x/(S_0\ USD)$, for the

case $S_1 = 10.17\ SEK/USD$ and $i_{12}^* = 22\%$, it is $R_B^{STi} = 32.05\% - 1.1 \times SEK\ x/(S_0\ USD)$, for the case $S_1 = 8.17\ SEK/USD$ and $i_{12}^* = 18\%$, it is $R_C^{STi} = 9.67\% + 1.1 \times SEK\ x/(S_0\ USD)$, and for the case $S_1 = 8.17\ SEK/USD$ and $i_{12}^* = 22\%$, it is $R_D^{STi} = 6.08\% + 1.1 \times SEK\ x/(S_0\ USD)$.

Notably the expected return from the foreign currency denominated asset is still at 21%. However, different to Section 3.1.1, the short-term FX hedging strategy now delivers a volatile payoff. This is true even if the first FX hedging arrangement is tailored to the discounted cash-flow using the expected interest rate, that is, if $x = 1.2$, which leads to a small, but positive, payoff variance. In fact, exposure to some risk cannot be avoided. The reason is that the realized interest rate inevitably differs from the expected interest rate used to discount the future cash flow. Hence, the investment return is not fully hedged.[13]

What happens if short-term FX hedging is taken to the extreme, that is, if the asset manager engages in short-term FX hedging arrangements with an ultra-short duration?

From the discussion of our baseline model in Section 3.1.1, we know that the short- and long-term FX hedging strategies can deliver identical outcomes as long as we do not introduce additional elements such as interest rate risk. As a result, even FX hedging arrangements with an ultra-short duration, in some special cases, can yield the same outcome as a long-term FX hedging arrangement. However, this result is a special case and does not generalize.

The environment with foreign interest rate risk in Section 3.1.2 is a case in point. When adding additional periods, we can get an idea of the effect of shortening the duration of the FX hedges. Intuitively, a shorter duration exposes the asset manager to more risk of the type described above. Consequently, the short-term hedging strategy becomes increasingly less favorable when compared to the long-term strategy. In the extreme, when the duration of the short-term hedge becomes ultra-short, then the outcome of the short-term strategy starts to resemble more and more the outcome without any hedging at all. See Appendix B for a formal discussion.

3.1.3 Over- and under-hedging FX risk

So far, we have shown that a long-term currency hedge can perform very well in eliminating FX risk. This result changes when we introduce asset return risk. Specifically, we have so far assumed that the foreign asset return $\tilde{r}_2^*$ is constant. We next consider a modified environment with a stochastic foreign asset return.

[13] It is worth mentioning that from a theoretical viewpoint an ideal environment with complete markets would allow the asset manager to eliminate any risk even if using a short-term FX hedging strategy. This is because the asset manager could in such an ideal world construct a self-financing trading strategy that has a cash-flow identical to the long-term FX hedging arrangement. In practice, this outcome is, however, difficult to achieve. Even when instruments for the insurance of interest rate risk are available, it is arguably challenging to accomplish a full elimination of risk with short-term hedging strategies if the exchange rate and interest rate risks are intertwined, as it is the case in the environment we considered.

If the payoff in foreign currency is variable and uncertain, then the asset manager is unable to construct a hedge that fully eliminates the FX risk. Faced with such a scenario, the manager forms expectations about the payoffs and seeks FX risk protection accordingly. We find that in such an environment the asset manager will inevitably do some degree of over- or under-hedging from an ex-post perspective. If the asset manager receives new information over time which allows her to form better expectations about the payoffs, the strategy to roll over short-term FX hedges has the potential benefit that it can be more easily adjusted at each roll-over date to reduce the extend of over- or under-hedging.

To see this formally, consider a modification to the baseline model from Section 3.1.1. Specifically, we now assume that the asset manager receives information about the stochastic foreign asset return $\tilde{r}_2^*$ at $t = 1$, which reveals that the payoff will be higher or lower than the expected value. Specifically, the foreign asset return realizations are $r_2^* = 1.44 + \Gamma$ or $r_2^* = 1.44 - \Gamma$ with equal probability, where $0 < \Gamma < 1.44$.

To be precise, we define another time the actions for the long- and short-term FX hedging strategies for the context of risky foreign asset returns and label these strategies with a star * superscript to account for the modification.

1. **Long-term***: Invest in the foreign asset and seek a long-term FX hedging arrangement that does not leave room for adjustments to reduce over- and under-hedging.

2. **Short-term***: Invest in the foreign asset and seek two short-term FX hedging arrangements that allow for adjustments after one period to reduce over- and under-hedging. Moreover, use the domestic credit market for gains and losses from the currency hedges.

Note that the AM could, in principle, under the strategy Long-term*, seek additional short-term FX hedges after new information comes in, so as to make adjustments for the period from $t = 1$ to $t = 2$. For brevity, we abstract from this possibility and discuss after the analysis why this assumption is plausible.

Strategy: Long-term*

Suppose that the Swedish asset manager pursues a long-term FX hedging strategy. We show that the long-term FX hedging strategy does not allow the AM to fully insure against a depreciation or an appreciation of the Swedish krona anymore. Specifically, the rate of return of the AM on the foreign asset is

$$\tilde{\mathrm{R}}^{\mathrm{LT}*} \equiv \begin{cases} 21\% + \dfrac{\tilde{\mathrm{S}}_2}{\mathrm{S}_0} \times \Gamma & \text{with probability } 1/2 \\ 21\% - \dfrac{\tilde{\mathrm{S}}_2}{\mathrm{S}_0} \times \Gamma & \text{with probability } 1/2 \end{cases}$$

where $\tilde{\mathrm{S}}_2$ has four equally likely outcomes shown in Figure 7. Evidently, the rate of return is not constant anymore and depends on the realization of the asset return and

its interaction with the realization of the spot exchange rate at $t = 2$. As a result, the AM is either over- or under-hedged.

Strategy: Short-term*

Next, suppose that the Swedish asset manager pursues a short-term FX hedging strategy. We find that the short-term FX hedging strategy is typically superior if the realizations of the foreign asset return deviate a lot from its expected value (that is, if Γ is large), because it allows the Swedish asset manager to reduce risk relative to the long-term FX hedging strategy. The analysis of the asset manager's rate of return follows the same steps as before and derivations can be found in Appendix C. When comparing the short- and long-term FX hedging strategies, the average rate of return is identical and stands at 21%, but the return variability differs.

If $S_2 \approx S_1$, then the risks associated with both strategies are quite similar. Instead, if there is additional exchange rate risk between dates $t = 1$ and $t = 2$, as it is the case in our model, then the short-term strategy is typically superior if Γ is large. Analyzing the payoff variances associated with the two strategies reveals that the return variability associated with over- or under-hedging is higher for both, the larger is Γ. However, the effect is stronger for the long-term FX hedging strategy.

The critical insight is that the rolling FX hedge can be more effective in absorbing risk if better information about the returns of the dollar investment arrives over time. Whenever this aspect is important, for example if the asset return risk is high and if the asset manager expects to learn about it over time, then the short-term FX strategy is preferable.

One qualification is important to keep in mind. As mentioned earlier, the asset manager pursuing a long-term FX hedging strategy may seek additional short-term hedges for the period from $t = 1$ to $t = 2$ after receiving new information at the beginning of $t = 1$. There are, however, various practical reasons suggesting that the long-term FX hedging strategy is more difficult to adjust than the short-term strategy. First, the additional hedging arrangements are likely to involve additional costs that make the strategy Long-term* less favorable. Second, the unhedged returns are fairly small relative to the amounts rolled over under the strategy Short-term*, which can make it harder to obtain insurance at reasonable terms for additional FX hedges under the strategy Long-term*.

In practice, the model in Section 3.1.3 best captures a scenario where the underlying foreign currency denominated asset carries substantial risk, as it is the case for lower rated corporate bonds or equity. Instead, the benchmark in Section 3.1.1 best captures a scenario where the foreign asset is a riskless zero coupon bond, meaning that the future payoff in foreign currency is certain.

3.2 Price risk

We next discuss another type of risk, namely risk about the price of the foreign currency denominated asset at $t = 1$ and its effect if losses associated with the short-term FX hedging strategy need to be funded by asset sales. For this purpose, we

consider a slightly modified environment where we introduce asset-side adjustments to highlight the key insights.

Suppose that the Swedish asset manager pursues a short-term FX hedging strategy as in Section 3.1.1 with the difference that losses from the first period FX hedge are not funded by borrowing, but by selling a fraction of the foreign currency denominated asset at the price p_1^*. This modified strategy may, for instance, be justified by the asset manager's inability to borrow or to sell other assets at $t = 1$.

How do asset-side adjustments affect the outcome of the short-term FX hedging strategy?

We find that the liquidation price of the foreign currency denominated asset plays an important role for the outcomes. While a buy-and-hold investor (who owns the asset until maturity and uses a long-term FX hedging strategy) is unaffected by changes in the asset price over the duration of the hedging contract, this does not hold for an investor who uses a short-term hedging strategy.[14] Specifically, a depressed liquidation price results in a higher hedging loss due to costly asset liquidation. For the short-term FX hedging strategy, the associated risks remain unhedged. Consequently, short-term FX hedging exposes the AM to a combination of FX risk and price risk.[15]

How may such a situation arise? In practice, the foreign asset price may fluctuate over time due to changing liquidity conditions in the market at the point in time when the short-term FX hedge has to be rolled over or due to other factors such as adverse selection problems. Moreover, the asset price no-arbitrage condition may not always hold, which can give rise to deviations from the outcome described in Section 3.1.1.

3.3 Foreign exchange market distress

A third type of risk is foreign exchange market distress, which crystallizes as a challenge to roll over short-term FX hedges. This section is concerned with situations of financial market stress that can occur during a financial crisis episode or because of a large shock such as the COVID-19 pandemic. We are particularly interested in "insurance premium variability", which in our context refers to the FX hedging costs of Swedish asset managers, and in "market access risk", which is a more extreme manifestation of a spike in FX hedging costs that essentially renders the FX hedging market dysfunctional. Arguably, the type of events we have in mind are rare. Nevertheless, they are important and can have significant repercussions in the financial system.[16]

Both insurance premium variability and market access risk have important negative implications for the roll-over of short-term FX hedges. We use a slightly modified setting to highlight the key insights. Specifically, consider a version of the environment used in Section 3.1.1 where the asset manager only gets access to FX

[14] A buy-and-hold investor who does not hedge the FX risk is not exposed to price risk, but fully exposed to FX risk.

[15] See Appendix D for a numerical example.

[16] See Avdjiev et al. (2020) and Sveriges Riksbank (2020a,b) for a discussion of the financial market turmoil and FX markets in spring 2020 following the outbreak of the COVID-19 pandemic.

hedging instruments at the intermediate date $t = 1$ with probability q, where $0 < q < 1$. What we have in mind with this modelling tool is to capture major market dislocations during a financial crisis that temporarily impair the functioning of the FX market, thereby disrupting the roll-over of short-term FX hedges.

The outcome of the long-term FX hedging strategy is by definition unaffected by this disruption, but the outcome of the short-term FX hedging strategy is affected as follows. At the beginning of $t = 1$, the realization of the spot exchange rate becomes known. With probability $1 - q$, everything is identical to the short-term FX hedging strategy described in Section 3.1.1. With probability q, there is the FX market distress scenario. If the spot exchange rate is $S_1 = 10.17\ SEK/USD$, the Swedish asset manager faces a situation where she cannot roll over the FX hedge. As a result, her rate of return is now risky and given by $(SEK\ 10.32 \times 1.44 - SEK\ 10 - SEK\ 1.2 \times 1.1)/SEK\ 10 = 35.4\%$ or $(SEK\ 8.32 \times 1.44 - SEK\ 10 - SEK\ 1.2 \times 1.1)/SEK\ 10 = 6.6\%$ with probability one-half each. A similar result arises if the spot exchange rate is $S_1 = 8.17\ SEK/USD$. For this case, we can derive her rate of return as 35.4% or 6.6% with probability one-half each.

Interestingly, the expected rate of return is 21% as before. However, the asset manager's payoff now has a positive variance. Notably, the payoff variance increases in the magnitude of unhedged FX risks, which are positively associated with q, the probability of the FX market being dysfunctional.

Next, we consider a variant of the baseline model where the insurance premium is positive and potentially time-varying.[17] It shows that time-varying premia drive a wedge between the outcomes of the short- and long-term FX hedging strategies. An interesting case in point is a setting where the future premium is stochastic while the expected insurance premium payments are unaltered, that is, $\tilde{\tau}_{12}$ is stochastic with $\tau_{02} = \tau_{01} + E[\tilde{\tau}_{12}]$. In this scenario, the long-term hedging strategy is more effective not only in insuring against the previously discussed risks, but it also shields from fluctuations in the insurance premium. In practice, a source of such fluctuations could be a moderate degree of FX market distress at $t = 1$ that does not make the market dysfunctional, but merely causes a spike in hedging costs. Another relevant factor could be changes in the market power held by the small number of banks who act as the key sellers of FX risk protection.

Taken together, the roll-over of short-term FX hedges exposes the Swedish asset manager to both market access risk and insurance premium variability. While the average return of the Swedish asset manager may be unaltered, the possibility of FX market distress creates additional return volatility because of unhedged FX risks between dates $t = 1$ and $t = 2$.

[17] In Section 3.1.1, we assumed that $\tau_{01} = \tau_{12} = \tau_{02} = 0$. With a positive insurance premium, it evidently matters how the long-term premium τ_{02} relates to the short-term premia τ_{01} and τ_{12}. Only if $\tau_{02} = \tau_{01} + \tau_{12}$ do the results in Section 3.1 continue to hold.

3.4 Premature liquidation risk

In this section, we discuss the fourth risk category. While the previous three risk categories pointed to advantages of long-term FX hedging strategies, premature liquidation risk shows that short-term hedging arrangements offer some "flexibility" that can in certain scenarios be beneficial.

While some asset managers such as insurance companies are often buy-and-hold investors, there is a possibility that they may have to meet unexpected outflows and, therefore, need to sell a foreign currency denominated asset earlier than originally planned, that is, before it matures. In the context of our model, the FX risk may be fully eliminated with the help of a long-term hedging arrangement if the expected duration of the asset is perfectly matched with the duration of the currency hedge (see Section 3.1.1). This is, however, only true if the asset is held for the expected duration. Instead, if it is liquidated prematurely, then the investor has to unwind the long-term FX hedge, which can prove to be costly. In this scenario, the short-term FX hedging strategy can be advantageous, as it suffices not to roll over the FX hedge.

We can identify two relevant scenarios where the flexibility of the short-term FX hedging strategy has advantages. First, there may be additional insurance costs that arise from unwinding the long-term FX hedge, that is, if $\tau_{12} > 0$, which do not arise for the short-term FX hedging strategy. Second, the need to prematurely liquidate the foreign asset may be positively correlated with a foreign currency appreciation. In Appendix E, we formally compare the outcomes of the two FX hedging strategies for this scenario. We find that the expected return of the long-term FX hedging strategy can fall short of the expected return of the short-term strategy.

3.5 Counterparty risk

Next, we discuss the fifth risk category. Similar to Section 3.4, we find that also in an environment with counterparty risk short-term hedging arrangements offer some "flexibility" that can in certain scenarios be beneficial. Counterparty risk materializes when the seller of FX risk protection is for some reason unable to deliver on her promise. As a result, the forward contract signed at $t = 0$ may become worthless, leaving the Swedish asset manager fully exposed to FX risk. Short-term FX hedging contracts may help to mitigate this type of counterparty risk. More specifically, a short-term hedging arrangement can enable the asset manager to insure a substantial part of the FX risk, while allowing for a switch of counterparties at the roll-over stage (that is, at $t = 1$) if negative information about the current counterparties comes in. Differently, long-term FX hedging does not allow for this option.

The potential advantage of the short-term FX hedging arrangements being more flexible when unfavorable information about the counterparty comes in needs to be qualified. This is because it is common for the parties of a hedging arrangement to exchange collateral.[18] Notwithstanding, collateralization only works well if margin

[18] Major parties in the FX swap market exchange collateral in accordance with the so-called 'Credit Support Annex' (CSA) agreements. The CSA agreements are voluntary add-on agreements to the standard agreements to which operators undertake through membership of the International Swaps and Derivatives

calls can be met adequately to ensure that changes in the valuation of the collateral and changes in the counterparty risk are taken into account. As a result, a higher residual counterparty risk is likely to remain for long-term FX hedging arrangements relative to short-term FX hedging arrangements; especially when it comes to extreme market stress scenarios like a financial crisis. The same logic applies to credit default swaps, which could be used to hedge the counterparty risk.

3.6 Inflation risk

Finally, we examine the role of domestic inflation risk. In the previous analysis, the domestic and foreign interest rates reflect the real return in the respective currency. However, inflation and monetary policy are, in practice, important determinants of exchange rate developments, which tend to gradually restore relative purchasing power parity in the medium- to long-term (Dornbusch 1976; Taylor and Taylor 2004). At the same time, exchange rate movements also affect domestic inflation, especially in a small open economy like Sweden (Corbo and Di Casola 2020).[19]

To incorporate inflation risk in our stylized conceptual framework, we model inflation and exchange rates as exogenously determined stochastic variables and analyze implications for FX hedging. Specifically, we construct an example where we modify the baseline model by allowing for stochastic domestic inflation, $\tilde{\pi}_{01}$, $\tilde{\pi}_{12}$ and $\tilde{\pi}_{02}$, while fixing foreign inflation to zero, that is, $\pi^*_{01} = \pi^*_{12} = \pi^*_{02} = 0$. We denote real and nominal interest rates with the superscripts 'r' and 'n', respectively. Moreover, we assume that the expected real return of investing in the domestic and foreign credit market is identical to the baseline model; formally $i^r_{02} = E[(1 + i^n_{02})/(1 + \tilde{\pi}_{02})] - 1 = 21\%$ and $i^{r*}_{02} = E[(1 + i^{n*}_{02})/(1 + \tilde{\pi}^*_{02})] - 1 = 44\%$.

We assume that domestic inflation is either high or low and that it becomes publicly know at the beginning of date $t = 1$. Specifically, suppose that inflation risk is independently distributed with the shock hitting the economy between $t = 0$ and $t = 1$ so that domestic inflation is $i^n_{01} = 10\%$ in the first period with probability one-half and $i^n_{01} = -8.33\%$ otherwise. In the second period, domestic inflation is assumed to be zero so that the real interest rate in the first period is $i^r_{01} = 0\%$ with probability one-half and $i^r_{01} = 20\%$ otherwise, with the expected domestic real interest rate given by $E[\tilde{i}^r_{01}] = 10\%$ as in the baseline model in Section 3.1.1.

When analyzing the outcomes of the long-term and short-term FX hedging strategies in the modified environment with inflation risk, we find that the long-term FX hedging strategy is no longer able to fully eliminate FX risk. In fact, it performs considerably worse than the short-term FX hedging strategy if uninsurable domestic inflation risk is an important factor. The intuition for this result is that the long-term FX hedging

Association (ISDA). All major banks in Sweden, for example, are members of ISDA, as are all the large insurance companies.

[19] Empirically, exchange rates are impossible to forecast in the short-term, as document by Meese and Rogoff (1983), who show for major exchange rates that a random walk outperforms various time series and structural models of exchange rates (for a recent study of the Swedish krona see Askestad et al. 2019).

strategy goes *long in domestic inflation risk*. This effect matters more, the higher the exposure to uninsurable domestic inflation risk. Appendix F offers a formal analysis.

4 Discussion

In Sections 3.1–3.6, we have analyzed the outcomes of short- and long-term FX hedging strategies in different environments that allowed us to focus attention on six risk categories: FX risk, asset price risk, FX market distress, premature liquidation risk, counterparty risk and inflation risk. Based on our findings, we summarize in Table 2 potential advantages and disadvantages associated with the different strategies.

Generally, the outcomes associated with short- and long-term FX hedging strategies are not identical and depend on the nature of uncertainty and the informational environment. The overall picture is nuanced and a key take-away from this article is to carefully consider what types of risk are relevant for different types of asset managers and for the different asset classes they invest in.

As illustrated in Figure 1, Swedish insurance companies and pension funds have a substantial share of their investments in foreign currency denominated assets. They may seek protection against exchange rate risk because of risk management considerations or for other reasons, such as regulatory requirements. Figure 2 shows that Swedish insurance companies and pension funds primarily use FX hedging contracts with short durations (most frequently 3-4 months). Given the longer duration of the foreign currency denominated investments, a duration mismatch emerges which requires the short-term FX hedges to be repeatedly rolled over.

Based on our theoretical framework, a roll-over of short-term FX hedges can have benefits by reducing the risk of over- and under-hedging and by providing more flexibility in case of premature asset liquidation and new information about counterparty risk. Moreover, a short-term FX hedging strategy can help to reduce exposure to uninsurable domestic inflation risk. Notwithstanding, long-term FX hedging arrangements have clear advantages, especially in periods of financial distress when market functioning is impaired. While short-term FX hedging strategies create refinancing risks, long-term FX hedging strategies effectively shield against such risks.

It is an interesting empirical question to understand how much of the FX swap market concentration on maturities below half a year can be explained by demand and supply factors. In practice, Swedish insurance companies and asset managers are likely to carefully trade off the different risks, as well as the price and non-price attributes associated with different contracts. Still, it is possible that market failures stemming from financial frictions or market concentration create a wedge between the privately optimal and the social optimal choice of the appropriate FX hedging products. While it is beyond the scope of this article to draw normative implications, there are important aspects related to our analysis that deserve consideration.

Table 2. A comparison of long- and short-term FX hedging strategies

Risk category	Long-term FX hedge	Roll-over of short-term FX hedges	No FX hedge
(1) FX risk.	FX risk is fully eliminated to the extent that the future returns on the USD asset are known or can be insured; otherwise there can be some over- or under-hedging.	In some cases, all/most FX risk can be eliminated. FX hedges need to be carefully calibrated. It is difficult to hedge FX risk associated with foreign interest rate risk. Flexibility benefit: If the USD asset returns are uncertain, the short-term FX hedge can reduce risk, as it can be more easily tailored in response to incoming information.	Full exposure to FX risk.
(2) Price risk (i.e., changes in the USD asset price over investment duration).	No exposure to FX risk and to price risk for buy-and-hold investors (i.e., if USD asset is held until maturity).	If losses from short-term FX hedges are funded with asset-side adjustments, then an exposure to unhedged asset price risk arises (e.g. due to time-varying market liquidity or other factors).	No exposure to price risk for buy-and-hold investors; full exposure to FX risk.
(3) FX market distress (e.g. FX hedges cannot be rolled over at certain times).	No exposure to future FX market distress if there is no need to sell USD asset.	Exposure to market access / refinancing risk and to insurance premium variability (e.g. higher hedging costs when rolling over in times of financial distress).	No exposure to short-term market distress if there is no need to sell the USD asset; full exposure to FX risk.
(4) Premature asset liquidation risk / transaction date uncertainty (i.e., asset sale prior to expected investment duration).	Exposure to the risk of a costly unwinding of the long-term FX hedge if there is a need to sell USD asset.	Flexibility benefit: Limited exposure—especially if the next roll-over date of the short-term FX hedge is near the date of the unexpected premature asset liquidation.	Full exposure to FX risk also when USD asset is liquidated prematurely.
(5) Counterparty risk (i.e., default of the insurer; possibly in conjunction with an impairment of the collateral value).	Exposure to the same counterparty for FX hedging during the full investment duration.	Flexibility benefit: Possibility to limit exposure by changing counterparties at the next roll-over date in case of negative information about existing counterparty.	No exposure to counterparty risk; full exposure to FX risk.
(6) Risk of a high domestic inflation.	Long-term FX hedging has the disadvantage that it goes long in domestic inflation risk.	Short-term FX hedging offers the possibility to limit exposure to domestic inflation risk.	No exposure to domestic inflation risk; full exposure to FX risk.

First, the repercussions of individual FX hedging strategies are primarily felt in periods of financial distress. Consequently, an "over-reliance" on short-term FX hedges can pose a negative externality by creating additional market congestion in periods of financial distress. In practice, Swedish asset managers cannot rely on having market access at all times. Empirically, a typical crisis scenario features an appreciation of the dollar and at the same time a rise in the cost of FX risk protection. While long-term FX hedging arrangements are shielded against such a scenario, asset managers relying on short-term FX hedging arrangements experience a spike in the costs to roll over their FX hedges, as well as a further shortening of the duration of their hedges.

Second, a substantial part of the funding of Swedish banks is short-term and in foreign currency (see Bertsch and Molin 2016). At the same time, Swedish banks play a dominant role as sellers of FX risk protection to Swedish asset managers. Consequently, a stronger reliance on more short-term FX risk protection can have a disadvantageous financial stability effect in that it translates into a further increase in the short-term foreign currency funding reliance of Swedish banks.

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APPENDIX A – Derivations for the model with FX and foreign interest rate risk

This Appendix complements the discussion in Section 3.1.2. We first consider the case where $S_1 = 10.17\ SEK/USD$ and $i_{12}^* = 0.18$. As before, the AM seeks to roll over the expiring FX forward contract at $t = 1$. The protection seller may be the same BANK or a different BANK.[20] The payments associated with the first contract are settled and the AM faces a hedging loss of $SEK\ x$. She seeks a new FX hedge, which involves a promise to deliver $USD\ r_2^*$ at $t = 2$ in exchange for $SEK\ 9.48 \times 1.44$. The hedging loss necessitates that the AM borrows $SEK\ x$ domestically at the interest rate $i_{12} = 0.1$. The AM's rate of return on the foreign investment at t =2 is

$$R_A{}^{STi} \equiv \frac{9.48\frac{SEK}{USD} \times USD\ 1.44 - S_0\ USD - (1 + i_{12}) \times SEK\ x}{S_0\ USD}$$
$$= 36.51\% - \frac{1.1 \times SEK\ x}{S_0\ USD}.$$

Similar to before, we compute the gross rate of return as the forward rate times the foreign asset return in USD divided by the initial investment of $SEK\ 10$. Differently, however, the forward rate at $t = 1$ now depends on the realization of the foreign interest rate. Again, we need to correct for the $t = 2$ value of the hedging loss.

We next look at the case where $S_1 = 10.17\ SEK/USD$ and $i_{12}^* = 0.22$. Different to before, the new FX hedge now involves a promise to deliver $USD\ r_2^*$ at $t = 2$ in exchange for $SEK\ 9.17 \times 1.44$. The AM's rate of return on the foreign investment is

$$R_B{}^{STi} \equiv 32.05\% - \frac{1.1 \times SEK\ x}{S_0\ USD}.$$

Similarly, we can derive the AM's rate of return on the foreign investment for the case where $S_1 = 8.17\ SEK/USD$ and $i_{12}^* = 0.18$ as

$$R_C{}^{STi} \equiv 9.67\% + \frac{1.1 \times SEK\ x}{S_0\ USD}$$

and for the case where $S_1 = 8.17\frac{SEK}{USD}$ and $i_{12}^* = 0.22$ as

$$R_D{}^{STi} \equiv 6.08\% + \frac{1.1 \times SEK\ x}{S_0\ USD}.$$

The payoff variance for $x = 1.2$ is given by

$$Var^{STi}(x = 1.2) = \frac{\begin{pmatrix}(23.31\% - 21\%)^2 + (18.84\% - 21\%)^2 \\ +(22.87\% - 21\%)^2 + (19.28\% - 21\%)^2\end{pmatrix}}{4} = 7 * 10^{-6}.$$

[20] Without loss of generality, we focus on the case where the new protection seller is a different BANK. See discussion in Appendix A for the environment of Section 3.1.1.

APPENDIX B – Shortening the duration of FX hedges

This Appendix complements Section 3.1.2 by providing a formal discussion of potential implications when shortening the duration of FX hedging arrangements. We simplify the environment in Section 3.1.2 by setting expected domestic and foreign interest rates to zero. Formally, let $i_{01} = i_{12} = i_{02} = 0$ and let the foreign interest rate process be given by $i^*_{01} = i^*_{02} = 0 = r^*_2$ and

$$\tilde{\imath}^*_{12} = \begin{cases} -\varepsilon & with\ probability\ 1/2 \\ +\varepsilon & with\ probability\ 1/2 \end{cases}$$

with $E[1 + \tilde{\imath}^*_{12}] = 1$.

Assuming the CIP holds, the spot and implied forward rates at $t = 0$ are $S_0 = F_{01} = 10\ SEK/USD$. The $t = 0$ expectation about the $t = 1$ spot exchange rate is $E[\tilde{S}_1] = S_0$. We consider a generalized version of the environment in Section 3.1.2 with $\Delta \geq 0$

$$\tilde{S}_1 = \begin{cases} (10 + \Delta)\dfrac{SEK}{USD} & with\ probability\ 1/2 \\ (10 - \Delta)\dfrac{SEK}{USD} & with\ probability\ 1/2. \end{cases}$$

Assuming the CIP holds, expectations about implied forward exchange rates at $t = 1$ are now also influenced by the realization of $\tilde{\imath}^*_{12}$ and $\tilde{F}_{12}$ can be derived as

$$\tilde{F}_{12} = \begin{cases} \dfrac{10 + \Delta}{1 - \varepsilon}\dfrac{SEK}{USD} & with\ probability\ 1/4 \\ \dfrac{10 + \Delta}{1 + \varepsilon}\dfrac{SEK}{USD} & with\ probability\ 1/4 \\ \dfrac{10 - \Delta}{1 - \varepsilon}\dfrac{SEK}{USD} & with\ probability\ 1/4 \\ \dfrac{10 - \Delta}{1 + \varepsilon}\dfrac{SEK}{USD} & with\ probability\ 1/4. \end{cases}$$

The expectations about $t = 2$ spot exchange rates are $E[\tilde{S}_2 | S_1 = (10 + \Delta)\ SEK/USD, i^*_{12} = -\varepsilon] = (10 + \Delta)/(1 - \varepsilon)\ SEK/USD$, etc. and the actual realizations are

$$\tilde{S}_2 = \begin{cases} \left(\dfrac{10 + \Delta}{1 - \varepsilon} + \Delta\right)\dfrac{SEK}{USD} & with\ probability\ 1/8 \\ \left(\dfrac{10 + \Delta}{1 - \varepsilon} - \Delta\right)\dfrac{SEK}{USD} & with\ probability\ 1/8 \\ & etc. \end{cases}$$

A comparison with the payoff variance for short-term hedging yields for all $\varepsilon > 0$ that

$$Var^N(\Delta, \varepsilon) > Var^{STi}(\Delta, \varepsilon)$$
$$= \frac{\left(\dfrac{(10 - \Delta)\varepsilon}{1 - \varepsilon} - 0\%\right)^2 + \left(\dfrac{-(10 + \Delta)\varepsilon}{1 + \varepsilon}\right)^2 + \left(\dfrac{-(10 + \Delta)\varepsilon}{1 - \varepsilon}\right)^2 + \left(\dfrac{-(10 - \Delta)\varepsilon}{1 + \varepsilon}\right)^2}{4}.$$

Consistent with Section 3.1.1, we can see that absent interest rate risk, that is, if $\varepsilon \to 0$, the short-term FX hedging strategy eliminates all risk. For $\Delta = 1$ and $\varepsilon = 0.02$ as in Section 3.1.2 we have that $Var^{N}(1{,}0.02) = 0.0204 > Var^{STi}(1{,}0.02) = 0.0004$.

Notably, the short-term FX hedging strategy does just as badly as the no FX hedging strategy if $\Delta \to 0$ and $\varepsilon > 0$. Formally, $Var^{STi}(\Delta, \varepsilon) \to Var^{N}(\Delta, \varepsilon) > 0$ if $\Delta \to 0$. As a numerical example, consider the case where $\Delta = 0.5$ and $\varepsilon = 0.1$, where $Var^{N}(0.5{,}0.1) = 0.01538 > Var^{STi}(0.5{,}0.1) = 0.0103$.

We next study a modification of our model with an additional third period which also features interest rate risk and with implied forward exchange rates at $t = 2$ given by the eight possible combinations in

$$F_{23} = \frac{1}{1 \mp \varepsilon}\left(\frac{10 \mp \Delta}{1 - \varepsilon} \mp \Delta\right)\frac{SEK}{USD}$$

which occur with equal probability of one-eighths.

For $\Delta = 1$ and $\varepsilon = 0.02$, the payoff variance for the no FX hedging strategy is now given by $Var^{N}(0.02) = 0.0313$ and the payoff variance of the short-term FX hedging strategy is $Var^{STi}(0.02) = 0.0009$. Evidently, the short-term FX hedging strategy becomes more similar to the no FX hedging strategy when adding additional periods in this fashion. This effect shows up more prominently for a higher values of ε and smaller values of Δ. To see this, consider again the numerical example where $\Delta = 0.5$ and $\varepsilon = 0.1$. Now $Var^{N}(0.5{,}0.1) = 0.03582 > Var^{STi}(0.5{,}0.1) = 0.0277$.

APPENDIX C – Derivations for over- and under-hedging

This Appendix complements the discussion in Section 3.1.3. As before, the Swedish AM sells $SEK\ 10$ at $t = 0$ on the FX spot market at the rate $S_0 = 10\ SEK/USD$ and obtains $USD\ 1$, which is invested in the dollar denominated foreign asset. To insure the AM's FX risk; the BANK agrees to deliver $SEK\ 9.17 \times x$ in exchange for $USD\ x$ at $t = 1$.

We first look at the case when $S_1 = 10.17\ SEK/USD$ and $r_2^* + \Gamma$. At $t = 1$, the asset manager seeks to roll over the expiring forward contract. The hedging loss of $SEK\ x$ is funded at the interest rate $i_{12} = 0.1$. Moreover, the AM seeks a new protection which involves a promise to deliver $USD\ r_2^* + \Gamma$ at $t = 2$ to the BANK in exchange for $SEK\ 9.32 * (r_2^* + \Gamma)$. Taken together, the rate of return of the AM is

$$R_{1A}^{ST*} \equiv \frac{SEK\ 9.32 \times (r_2^* + \Gamma) - SEK\ 10 - SEK\ 1.1 \times x}{SEK\ 10}.$$

Next, we look at the case when $S_1 = 8.17\ SEK/USD$ and $r_2^* + \Gamma$. Now there is a hedging gain and the rate of return of the AM is

$$R_{1B}^{ST*} \equiv \frac{SEK\ 7.49 \times (r_2^* + \Gamma) - SEK\ 10 + SEK\ 1.1 \times x}{SEK\ 10}.$$

The third case is characterized by $S_1 = 10.17\ SEK/USD$ and $r_2^* - \Gamma$. The rate of return of the AM is

$$R_{2A}^{ST*} \equiv \frac{SEK\ 9.32 \times (r_2^* - \Gamma) - SEK\ 10 - SEK\ 1.1 \times x}{SEK10}.$$

Finally, the fourth case is characterized by $S_1 = 8.17\ SEK/USD$ and $r_2^* - \Gamma$, and the rate of return of the AM is

$$R_{2B}^{ST*} \equiv \frac{SEK\ 7.49 \times (r_2^* - \Gamma) - SEK\ 10 + SEK\ 1.1 \times x}{SEK\ 10}.$$

The respective payoff variances associated with the two strategies are

$$Var^{LT*}(\Gamma) \equiv \frac{\left(\frac{10.32}{10} \times \Gamma\right)^2 + \left(\frac{8.32}{10} \times \Gamma\right)^2 + \left(\frac{8.49}{10} \times \Gamma\right)^2 + \left(\frac{6.49}{10} \times \Gamma\right)^2}{4}$$

$$> Var^{ST*}(x = 1.2; \Gamma) = \frac{\left(\frac{9.32}{10} \times \Gamma\right)^2 + \left(\frac{7.49}{10} \times \Gamma\right)^2 + \left(\frac{9.32}{10} \times \Gamma\right)^2 + \left(\frac{7.49}{10} \times \Gamma\right)^2}{4}.$$

Analyzing the variance terms reveals that, for both strategies, the return variability associated with over- or under-hedging is higher, the higher Γ. However, the effect is stronger for the long-term FX hedging strategy, meaning that the differential payoff variance, $Var^{LT*}(\Gamma) - Var^{ST*}(x = 1.2, \Gamma)$, increases in Γ.

APPENDIX D – Derivations for price risk

This Appendix complements the discussion in Section 3.2. As before, the AM sells $SEK\ 10$ at $t = 0$ on the FX spot market at the rate $S_0 = 10\ SEK/USD$ and obtains $USD\ 1$, which is invested in the dollar denominated foreign asset. To insure the FX risk; the BANK agrees to deliver $SEK\ 9.17 \times x$ in exchange for $USD\ x$ at $t = 1$.

We first consider the case when $S_1 = 10.17\ SEK/USD$. The AM has to deliver $USD\ x$ and receives $SEK\ 9.17 \times x$. Since the AM lost from the appreciation of the dollar, a fraction of the foreign asset has to be liquidated, which we denote as $l > 0$. Moreover, the AM seeks a new FX risk protection, which involves a promise to deliver $USD\ (1 - l) \times x$ at $t = 2$ to the BANK in exchange for $F_{12} \times (1 - l) \times USD\ r_2^* = SEK\ 9.32 \times (1 - l) \times r_2^*$ where l can be derived as $l = x/(p_1{}^* \times 9.32)$.

The rate of return of the AM at $t = 2$ is

$$R_A^{STl} \equiv \frac{SEK\frac{p_1^* \times 9.32 - x}{p_1^*} \times r_2^* - SEK\ 10}{SEK\ 10}.$$

The foreign asset is fairly priced, that is, its return at $t = 1$ corresponds to the interest rate in the credit market, if $p_1^* = 1.31$. In this case, the AM can achieve a return of 21% and fully eliminate risk as in Section 3.1.1 by calibrating the first forward

contract in the same way, that is, $x = 1.2$. The reason is that the implicit funding cost $r_2^*/p_1^* - 1 = 0.1$ equals the domestic interest rate $i_{12} = 0.1$.

Instead, if the foreign asset is not fairly priced and trades at a price lower than $p_1^* = 1.31$, then the AM strictly prefers the domestic credit market (if accessible). Conversely, if the price is higher than $p_1^* = 1.31$, then the AM strictly prefers to sell the asset over borrowing in the domestic credit market.

We next consider the case when $S_1 = 8.17\ SEK/USD$. This time the AM enjoys a hedging gain and there is no need to sell a fraction of the foreign asset. If the asset price is lower than $p_1^* = 1.31$, the asset manager has no incentive to sell the asset and the outcome is the same as in Section 3.1.1.

Taken together, the main insight is that the liquidation price of the foreign currency denominated asset plays an important role for the outcomes. While a buy-and-hold investor (who owns the asset until maturity and uses a long-term FX hedging strategy) is unaffected by changes in the asset price over the duration of the hedging contract,[21] this does not hold for an investor who uses a short-term hedging strategy. Specifically, a depressed liquidation price, for example $p_1^* < 1.31$, results in a higher hedging loss due to costly asset liquidation. For the short-term FX hedging strategy, the associated risks remain unhedged.

To illustrate this point numerically, consider the outcome when the $t = 1$ asset price is $p_1^* = 1$, for example due to an adverse selection problem. In this situation, the asset manager suffers from an appreciation of the dollar. Hence, the rate of return of the AM at $t = 2$ falls short of the return achieved by the short-term FX hedging strategy in Section 3.1.1 since

$$R_A^{STl}(x = 1.2) = 16.92\% < R_A^{ST}(x = 1.2) = 21\%.$$

In sum, short-term hedging exposes the AM to a combination of FX risk and price risk.

APPENDIX E – Derivations for premature liquidation risk

This Appendix complements Section 3.4 by providing a formal discussion of potential implications of premature liquidation risk.

To make the argument, consider a modification to the baseline model where the AM has a need to liquidate the dollar investment at $t = 1$ with probability q', where $0 < q' < 1$. We discuss the outcome below using a modification of the environment in Section 3.1.1. As before, the AM can choose among three investment strategies.

We find that the strategy not to hedge FX risk performs poorly also in our modified environment and is associated with a considerably higher payoff variance than the short- and long-term FX hedging strategies. Moreover, we find that the outcomes of the short- and long-term FX hedging strategies can differ at the presence of

[21] A buy-and-hold investor who does not hedge the FX risk is not exposed to price risk, but fully exposed to FX risk.

premature asset liquidation risk. For the example with $p_1^* = 1.2$, and with a zero FX insurance premium, the two strategies deliver outcomes identical to those in Section 3.1.1. For $p_1^* \neq 1.2$, both strategies deliver risky payoffs. Notably, the expected return of the short- and long-term FX hedging strategy is equal. But the return is lower than 21% if $p_1^* < 1.2$ and larger than 21% if $p_1^* > 1.2$.

Next, we consider a variant of the previous model where the liquidation need and the foreign currency appreciation are perfectly correlated, with $\Pr\{S_1 = 10.17|q' = 1\} = 1$ and $\Pr\{q' = 1|S_1 = 10.17\} = q'' > 0$. Moreover, assume the foreign currency denominated asset has to be liquidated at a depressed price of $p_1^* = 1$. We discuss the outcomes of the long- and short-term FX hedging strategies in turn.

Strategy: Long-term

Everything remains the same if the spot exchange rate realization at $t = 1$ is $S_1 = 8.17$. Instead, if $S_1 = 10.17$, then the rate of return of the AM is $(11.19 \times p_1^* - 11.32)/10$. For $p_1^* = 1$ and $q'' = 1$, the ex-ante return can be derived as

$$R^{LT**}(q'' = 1) = \frac{21\% + (1-q'') \times 21\% + q'' \times \frac{11.19 \times p_1^* - 11.32}{10}}{2} = 9.85\%.$$

Strategy: Short-term

Again, everything stays the same if the spot exchange rate realization at $t = 1$ is $S_1 = 8.17$. Instead, if $S_1 = 10.17$, then the rate of return is $(4.53 + (p_1^* - r_2{}^*) \times 11.19)/10$. For $p_1^* = 1$ and $q'' = 1$, the ex-ante return can be derived as

$$R^{ST**}(q'' = 1) = \frac{23.64\% + (1-q'') \times 18.36\% + q'' \times \frac{4.53 + (p_1^* - r_2{}^*) \times 11.19}{10}}{2} = 13.79\%.$$

To conclude, the short-term FX hedging strategy may deliver a better-than-expected return if the asset manager considers it to be likely that the long-term asset needs premature liquidation with a risk that the cost of the unwinding of the long-term FX hedging arrangement cannot be covered.

APPENDIX F – Derivations for inflation risk

This Appendix complements Section 3.6 by providing a formal discussion of the environment with stochastic domestic inflation. We analyze the outcomes of the long- and short-term FX hedging strategies in turn.

Strategy: Long-term

Observe that the two-period forward rate at $t = 0$ remains the same as in Section 3.1.1, since $F_{02} = S_0 \times E[1 + i_{02}^r]/(1 + i_{02}^*) = 8.40\ SEK/USD$. The AM's expected rate of return at t=2 is also the same as in Section 3.1.1, that is, $E[\tilde{R}^{LT,r}] = 21\%$, but now payoffs vary across states due to the domestic inflation risk, which induces a mean-preserving spread. With probability one-half, the rate of return is given by $R^{LT,r} = 1.21/1.1 - 1 = 10\%$ and otherwise by $R^{LT,r} = 1.21/0.9167 - 1 = 32\%$.

Strategy: Short-term

Also, the one period forward rate at $t = 0$ remains the same as in Section 3.1.1, since $F_{01} = S_0 \times E[1 + \tilde{i}^r_{01}]/(1 + i^*_{01}) = 9.17\ SEK/USD$. The same is true for the $t = 1$ spot rates and one-period forward rates. While the AM's expected rate of return at $t = 2$ remains the same, that is, $E[\tilde{R}^{ST,r}] = 21\%$, we now have four cases to consider. We first look at the case where the spot exchange rate is $S_1 = 10.17\ SEK/USD$ and a domestic inflation of 10%, where the rate of return is

$$R_A^{ST,r}(x) = 31.10\% - \frac{(1 + i_{12}) \times \frac{x}{1 + i^*_{12}}}{10\left(1 + \pi_{02,1}\right)},$$

with $\pi_{02,1} = 10\%$ and $R_A^{ST,r}(1.2) = 21.10\%$. Instead, if the domestic inflation is -8.33% then the rate of return can be derived as

$$R_B^{ST,r}(x) = 37.32\% - \frac{(1 + i_{12}) \times \frac{x}{1 + i^*_{12}}}{10\left(1 + \pi_{02,2}\right)},$$

with $\pi_{02,2} = -8.33\%$ and $R_B^{ST,r}(1.2) = 25.32\%$. Using the same logic, we look at the case where the realization of the spot exchange rate is $S_1 = 8.17\ SEK/USD$. Now the rate of return is $R_C^{ST,r}(1.2) = 17.14\%$ if the domestic inflation is 10% and $R_D^{ST,r}(1.2) = 20.57\%$ if the domestic inflation is -8.33%.

Taken together, the results with domestic inflation risk differ drastically from our baseline model in Section 3.1.1. Both, the long- and short-term FX hedging strategies now deliver a risky payoff. Moreover, we can see that the introduction of domestic inflation risk is particularly harmful for the long-term FX hedging strategy, which now performs considerably worse than the short-term strategy.

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