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Steampunk Settlement

Deploying Futuristic Technology to Achieve an Anachronistic Result

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DLT HAS GREAT POTENTIAL TO ENHANCE THE EXISTING SYSTEM BUT WILL STRUGGLE TO REPLACE IT FOR REASONS THAT ARE BOTH TECHNICAL AND CONCEPTUAL

$32B

IN NET SETTLEMENTS WERE SECURED WITH A MERE $8B IN COMMITMENTS, THANKS TO THE MULTILATERAL MARGINING AND RISK MANAGEMENT PROTOCOLS OF DTCC

Executive Summary

The credit crisis and the advent of distributed ledger technology have focused the mind on the future of clearing, but this future is best understood by looking first at the past. How did the current clearing arrangement come to pass? What problems were the designers of the current system trying to solve?

Once the existing system is fully contextualized, it is easier to look forward. Distributed ledger technology is going to have a profound effect on clearing and settlement in the future, but taken too far, it might actually turn the clock backward.

Introduction

Two developments in the past 10 years have made market participants think deeply about the future of clearing, something they once took for granted. The first was the global financial system's near-death experience as a result of complex multilateral clearing arrangements for credit default swaps. The second is the highly exalted arrival of distributed ledger technology (DLT). The excitement is partially justified—the technology really is extremely innovative, and the universe of possible use cases is only just beginning to be explored.

Exaltation can be taken too far, however, and a group of DLT maximalists have argued that it should supplant, not enhance, the existing clearing system. They contend that cryptographically enforced contracts can make secure settlement instantaneous and default impossible, thus obviating the need for posting collateral and the existing system altogether. In reality, the technology is evolutionary, not revolutionary, and attempting to replace the clearing infrastructure with this technology is to carry the system not into the future, but into the past. To fully understand this, it is necessary to examine that past, starting at the very beginning.

Part I – The Past

Ledger Accounting and the Birth of Credit (and Credit Risk)

In the beginning there was the ledger. It's difficult for us today, when Microsoft Excel® and 10-Q reports are taken for granted, to remember that when ledger accounting first appeared in Europe in the 14th century, it heralded a revolution. It separated each party in a transaction from the other in space and in time.

Before the ledger, merchants had to travel, gold in hand, to the place where goods might be bought and then transport the goods to where they might be sold, collect gold for them and begin the process again. Ledger accounting enabled this to be done with the stroke of a pen. Wool could be bought in Antwerp in March, woven into cloth in Florence in June and then the cloth sold in Constantinople in September—all of it recorded on the same day in the books at the home office in Venice, without the merchant banker leaving his chair.

Once ledger entries could be used by creditors as evidence in court to force debtors to pay, credits and debits for future payment themselves became a medium of exchange.

Francesco Guardi, (1766-1770), *Audience Granted by the Doge*, [oil on canvas], Musée du Louvre, Paris

Once ledger entries could be used by creditors as evidence in court to force debtors to pay, credits and debits for future payment themselves became a medium of exchange. This created a uniform system for moving money backward and forward through time. Payments expected in the future could be pledged today and vice versa, greatly expanding access to credit. This freed Europe from monetary constraints: The money supply of Europe was no longer limited by the physical amount of gold and silver circulating within it. This capacity for credit creation conferred enormous power on the keepers of ledgers. The benefits were not without costs. The complexity of the ledger system posed its own set of risks—risks that are with us to this very day.

The essence of the ledger system is trust. How certain can a creditor or a debtor be that a transaction that is recorded in the ledger will actually take place in the real world? Courts can force the reluctant to pay, but what of those unable to pay? To err is human, a corollary of which is that promises will be made that simply cannot be kept. What then? Venetian merchants were among the most aggressive, fueling their expansion using leverage created via ledger accounting. As a result, they were among the first to develop "systemically important" financial institutions and the first to watch in horror as speculative excesses lead to their implosion.

The First Banking Regulators

Implode they did. In 1584, the Venetian banking system collapsed entirely when the simultaneous bankruptcy of the Pisani and Tiepolo houses brought down every bank in the city, causing massive losses. This spectacular calamity provoked a fierce debate within the Venetian Senate, just as the mortgage crisis did in our own Congress. The Senators were furious. They had been prescient about the dangers of credit inherent in the ledger system and had been incrementally trying to reduce them for centuries. They instituted Renaissance-era Volcker Rules, prohibiting the use of ledger credit for trading volatile commodities like tin and honey or speculating on sea voyages. They installed inspectors within the merchant banks themselves, as the TARP would 500 years later, all to no avail.

When the wealth of Venice evaporated, so did the patience of the Senate. Now, they pushed a far more radical agenda: They outlawed private banking altogether. Instead, they set up a state bank, the Banco di Rialto, operated by government appointees. There would be no more bankers enriching themselves by creating credit at the stroke of a pen. The Rialto bank could only extend payment on cash that had been deposited in the bank—all accounts had to be fully collateralized.

In other words, they dissolved the banking system and replaced it with a payments system. The Senate soon discovered that it had solved one problem only to create another: It had made the credit crunch permanent by banning credit extension altogether. The volume of trade was reduced to merely what was secured by cash on hand, making it impossible for Venice to retain its commercial preeminence. Chastened, the Senate quickly reauthorized private banking and with it, the extension of credit via ledger entries. They discovered that credit risks can be mitigated, but they cannot be eliminated entirely without losing the benefits of credit creation.

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Reducing Confusion: The Invention of Clearing

Merchants themselves also sought to reduce risks inherent in the ledger system. They realized that using ledger entries as a medium of exchange created systemic risks simply through confusion. So many firms adopted the method, it became difficult to keep straight who owed what to whom and when. Merchants took it upon themselves to reduce the aggregate credit outstanding, and thus reduce the risks that brought Venice to grief, by periodically "clearing the books." These original clearing systems have their echoes in distributed ledger technologies: They were multilateral and deployed a series of sequential algorithms to net and clear transactions.

The first "clearing fairs" followed the market fairs that brought merchants from all over Europe to the Champagne region of France. The clearing fairs had a fixed set of steps that took just over a week to complete. First, all creditors would announce whether they required to be paid in cash and then announced all their debtors and their amounts owed. The debtors would then have to certify these records, a collective proof of work, if you will. Debtors and creditors with mutual obligations would pair off and net bilaterally, prior to the multilateral phase.

Anonymous 19th century engraving depicting the Champagne Fair in the 13th century (From Arthur Chandler, *Market, Fair, Festival and Exposition: Preludes to the National and International Expositions Held in Paris, 1798-1937*, [www.arthurchandler.com], fig. 7)

The multilateral segment was a series of recursive procedures in which participants searched for "clearing cycles" and "clearing chains." In a cycle, if A owed B, B owed C, and C owed A like amounts, then all these transactions could be resolved. Similarly, in a clearing chain, if A owed B, and B owed C, B could assign its obligation from A to C, taking itself out of the equation. Merchants sought out rings and chains until there were no more or until time ran out. Then all outstanding balances would be settled either in cash or in credits, to be resolved at the next fair in three months' time.

Contemporary academics have modeled this practice and have found it was remarkably efficient. Decentralized clearing was, therefore, very popular among the merchants, and many attempts to compel or cajole them to clear centrally via an official mechanism or a state bank failed. Merchants trusted one another more than they trusted the king. As the

financial system developed and exchanges were launched in Amsterdam and London, brokers used the decentralized chain and cycle methods pioneered in Champagne for clearing and settling exchange transactions.

An incremental step toward centralization was the creation of "clearing clubs." These clubs were formed within the wider milieu but could exclude members of doubtful credit, in contrast to the "open to all" ethos of Champagne fairs. This system proved its worth during the Dutch tulip mania, when the government refused to enforce contracts that were "obviously gambling," creating a wave of voluntary defaults among non-members. Members of clearing clubs were protected and suffered no losses from counterparty defaults.

Though led by the private sector rather than the state, centralization progressed. In 1775, British banks formed the London Clearing Club to clear intrabank debts. On the securities side, a Frankfurt exchange for trading government securities took a step that was to have significant consequences. In 1866, the Free City of Frankfurt was absorbed into the much larger Kingdom of Prussia, which brought a spike in trading volume on the exchange. Exchange volumes quickly outstripped the resources of the local banking system to fund them. To reduce this strain, the exchange compelled its entire membership to join a single clearing club. The exchange then ran clearing cycles among the members to net down the trades. Thus, only the residuals—10% of gross volume—needed to be funded.

Part II – The Present

Clearing Comes to the Stock Market

In America, it was through similar strains on the funding markets that clearing came to the equity markets. In the 19th century, every transaction on the New York Stock Exchange had to be paid for in full, with the shares delivered within one business day. This meant that every purchaser had to present a check to every seller, who, in exchange, would hand over his certificates. Messengers were dispatched throughout lower Manhattan to deliver the checks and certificates. If the buyer did not have cash in hand, he could secure a "call" or "day" loan of the purchase price, using the shares themselves as collateral. The key fact was that every single exchange of cash for shares had to be independently financed, via cash or secured loan, on a transaction-by-transaction basis.

Drawing of panicked stockbrokers, May 5, 1893, Frank Leslie's Illustrated Newspaper

This created extraordinary demands on New York funding markets. Indeed, the stock market developed in New York City because in 1853, New York City banks created the New York Clearing House—a more sophisticated version of the London Clearing Club. This greatly facilitated call loan financing by making it much easier to clear checks. So important were call loans to the stock market that it was possible to influence the stock market through operations in the money market. Speculators could conspire with bankers to "lock up" cash in vaults to starve buyers of the cash necessary to finance their purchases and, thus, force prices lower. The money market tail could be made to wag the stock market dog.

To reduce this strain on money markets, the NYSE implemented a Frankfurt-style solution in 1892. It created the New York Stock Exchange Clearing House, which netted down purchases and sales conducted on the exchange among members. It would present to them, on a member-by-member and security-by-security basis, the net requirements for cash and securities transfers among them. This was a significant improvement over the system based on individual transactions. It greatly reduced the need for funding, though the complex web of payments and securities transfers remained in place.

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A BRIEF HISTORY OF BANKING

11th Century	The first double entry ledgers used among the Jewish merchants of Cairo
1209	Merchants are granted safe conduct to and from the Champagne fairs by King Philip Augustus of France
1300	Florentine Merchants Adopt Ledger Accounting
1300s	Clearing technology of market fairs perfected, spreads from France to other fairs
1458	Ragusan economist Benedetto Cotrugli's treatise on double-entry bookkeeping
1583	Major banking crisis wipes out Venetian banking system
1584	Venice outlaws the private banking sector, establishes the Banco di Rialto
1586	Venice relegalizes private banking
1602	Amsterdam Stock Exchange created by the Dutch East India Company to facilitate trading in its shares
1636–1637	Dutch tulip mania drives home the importance of counterparty credit risk
1675	The Royal Exchange founded in London
1775	The London Clearing Club founded for clearing debts among bankers
1817	The New York Stock Exchange is founded
1853	The New York Clearing House is founded to facilitate debt clearing among bankers in New York
1867	The Frankfurt Chamber of Commerce forms a clearing club that includes all its members
1892	The New York Stock Exchange Clearing House is formed
1920	The Stock Clearing Corporation replaces the New York Stock Exchange Clearing House
1973	Depository Trust Corporation founded to immobilize and dematerialize securities
1976	U.S. equity exchange CCPs are merged into the NSCC
1999	DTCC formed

Source: Greenwich Associates 2019

There was no stopping the growth of the stock market. By 1920, two things had happened. First, the number of different securities traded had multiplied many times over, so netting merely on a security-by-security basis was no longer as effective. Second, the volume of trading and the number of members of the clearing house had grown to the point that an incredible number of checks and security transfers needed to be made, as well as a huge volume of day or call loans against delivery of securities—even after the Clearing House had performed its function. So, in 1920, the NYSE went a step further and created the Stock Clearing Corporation.

The Stock Clearing Corporation combined the clearing of both the securities balances as well as the loans that financed them. It was capitalized for this purpose with both its own capital and with reserves posted by the clearing members. As a result, rather than issuing checks

to all its counterparties, a firm could simply pay or receive money to the Clearing Corporation. This did away with call loans altogether by internalizing them within the corporation, and greatly reduced the demands of trading on the money market. But, while it reduced the scale of the securities transfers that needed to be effected, it did not reduce their complexity. Securities still needed to be moved from the vaults of the sellers to the vaults of the buyers. The messengers kept running.

DTCC is Born

Forty years later, in the 1960s, the complexity of the settlement system was overwhelmed by the increase in volume, which nearly brought the system to its knees. The securities industry, in partnership with the SEC, created the clearing and settlement system we know today. First, it created the Depository Trust Corporation (DTC). DTC is a central securities depository (CSD), a venue for storing stock certificates. All the share certificates were brought together in the CSD and then dematerialized—changed into electronic form to make processing transactions faster and simpler. This finally put an end to messengers running stock certificates up and down Wall Street, and the obvious operational risks inherent in that system.

DTC and NSCC were consolidated into DTCC so that U.S. equity clearing and settlement could take place in a single, vertically integrated entity.

Next, the NYSE's Stock Clearing Corporation merged with those of the AMEX and the Nasdaq into the National Securities Clearing Corporation. This consolidation enabled multilateral netting across the entire U.S. equity market, still further reducing the payments and transfers necessary. Finally, DTC and NSCC were consolidated into the Depository Trust and Clearing Corporation (DTCC) so that U.S. equity clearing and settlement could take place in a single, vertically integrated entity. As it was now possible to trade into a position on one exchange and out of it on another—with both trades clearing and settling via the same system—the entire equity market could be thought of as a national market system. This paved the way for the formalization of exchange competition via Reg NMS.

This system has proven itself under duress. In the most recent financial crisis, it was the decentralized, multilateral clearing system for CDS that put the system at risk. The centralized and adequately capitalized system of DTCC processed the extreme volumes and volatility during the crisis. It was also able to resolve the collapse of Lehman Brothers not only without any government intervention, but with hardly a ripple at all. It was so successful, in fact, that both the Congress and the Bank for International Settlements (BIS) have designed the post-crisis rule system to move as much OTC clearing onto central counterparties (CCPs) as possible.

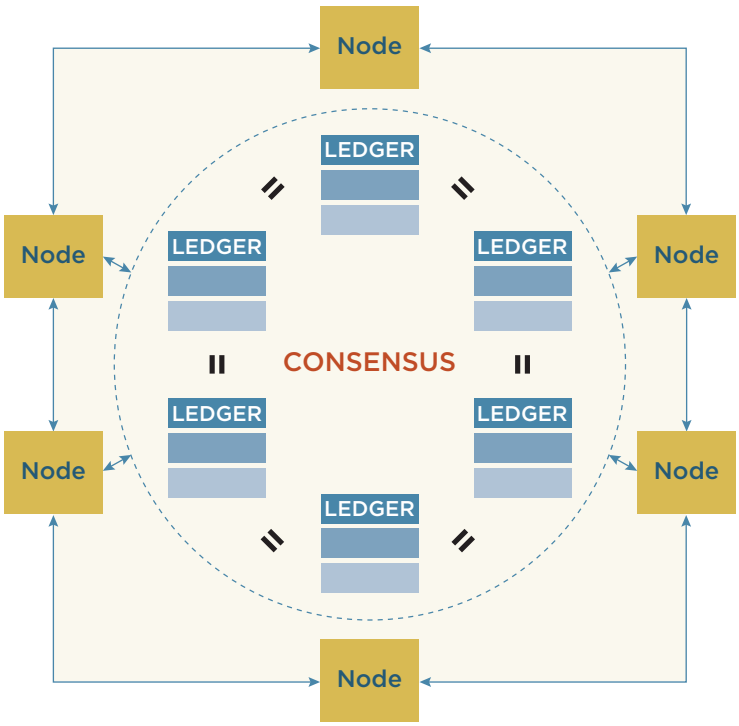
One would think that this triumph would be the last word in clearing. But, despite the model's proven success, some are declaring that the era of central clearing has passed and a new technology has made the entire system obsolete: the distributed ledger.

Part III – The Future

DLT: The Ledger Reborn

Distributed ledger technology is comprised of several elements that can be configured in a variety of ways to achieve different purposes, giving the technology extraordinary versatility. As with any clearing system, at the core is a ledger. The ledger can either contain a set of balances or, as in the case of a blockchain, a history of all transactions. What's more, thanks to the sophistication of the technology, the records in the ledger can include significantly more information than records of ownership. They can also include both contract terms as well as programmable instructions called "smart contracts." These can be used for payment of coupons or automatic enforcement of agreements within the ledger, subject to defined conditions.

LEDGERS DISTRIBUTED ACROSS MULTIPLE NODES



Source: Bank for International Settlements, "*Distributed ledger technology in payment clearing and settlement*," February 2017

How the ledger is updated and accessed is another unique feature of DLT. This is done by "nodes" that are assigned various rights and tasks for generating the consensus, which ultimately certifies the ledger. Nodes can be assigned one or more of the following tasks within the ledger: administrator, issuer, proposer, validator, and auditor. They can be permissioned to see various subsets of the ledger, such as only

the transactions to which they are a party. Because the ledger system and all the records are digital, the ledger and the permissions granted to the nodes are secured cryptographically. A related technology is "tokenization," the digital representation of real-world assets as tokens within a digital ledger, analogous to the dematerialization of share certificates within DTCC.

Many have hailed the emergence of DLT as a potential revolution in securities clearing. Rightly so, DLT is a major advance in books and records technology, as it permits ledgers to be shared collectively yet securely. By utilizing the nodal system, it's possible for the nodes representing parties to a transaction to certify the transaction as it is entered into the distributed ledger, reducing or eliminating the need for costly and time-consuming reconciliations. Nodal access permits the distributed ledger to be a golden data source for all the members, further reducing reconciliation to the individual books and records of the member firms, which in turn reduces expense and errors.

DLT is a major advance in books and records technology, as it permits ledgers to be shared collectively yet securely.

DLT has extraordinary potential to improve the quality and efficiency of existing clearing and settlement processes and exchanges, and clearing houses the world over have been working to take advantage of this. There is also the promise that some elements of the technology—smart contracts or the tokenization of real assets—might permit securities market structures to reduce friction in markets where they have never been practical.

How Sweeping is the Revolution?

Some DLT advocates, however, have taken this much further. They argue that the trust issues which have bedeviled the clearing process from the beginning can now be resolved technologically, and only technologically. They contend that the tokenization and cryptographically secured self-enforcing contracts obviate the need for both the centralization and the safeguards that are the hallmarks of central counterparties today. They believe that if DLT can be used to reduce settlement times to zero, it can do away with the need to post collateral altogether, thus freeing up capital that could be used for other purposes.

This is music to the ears of many in the financial services industry, who have been troubled by the amount of money they have had to post to secure their trades at CCPs. On a deeper level, some market participants fear that the regulatory push in favor of central clearing has simply shifted the locus of systemic risk from the banking system to the clearing system—without reducing it at all. A handful even believe these mandates have not merely shifted the locus but increased systemic risk altogether, and they look to DLT to resolve this. There is no doubt that DLT has an important role to play in improving the architecture of the financial system, but this maximalist view suffers from two serious, probably fatal, flaws. The first is technical, the second conceptual.

The technical issue is that while the dematerialization of securities is an accomplished fact, the digitization of cash is not. Although the recent mania for initial coin offerings (ICOs) may have outrun the SEC, from a technical perspective, it was merely verifying what DTCC established in the 1970s: It is possible to fully dematerialize assets and to electronically represent ownership.

In order to eliminate the need for collateral, however, the settlement has to be done in real time or at worst T+0. For this, DLT has outrun the Federal Reserve. It's true that Fedwire can instantaneously transfer cash and securities, but it is a closed system and not likely to be opened to a DLT securities system, which must itself be closed. Instructions and confirmations between Fedwire systems will not be instantaneous in a clearing context. The best existing option is ACH, which takes several business days. Undeterred, DLT proponents are pressing on with other solutions, such as settlement coins or other DLT solutions. Greenwich Associates has covered both of these extensively in prior research[1].

Developing a usable settlement coin is a non-trivial undertaking, but there are many companies that have made significant progress. Several large banks are working on settlement coins, either alone or as part of consortia. There are firms working on "stablecoins"—coins that are meant to represent fiat currency in digital form. The NYDFS has issued bank charters and authorized some companies to issue stablecoins, and they do, generally, perform as advertised. Stablecoins are kept stable because they represent cash on deposit in banks, and their holders believe their issuers will be able to redeem them for cash.

Yet for DLT maximalists to succeed, the existence of a stablecoin is merely a necessary, but not sufficient, condition. Replacing the existing system with DLT would require deep and liquid markets for borrowing and lending stablecoins in real time. That is because the conceptual Achilles' heel of the DLT maximalists is at the funding level.

DLT advocates claim that the need for posted collateral, as well as general reserve funds, can be eliminated entirely via DLT-enabled real-time settlement. This is true, as far as it goes. If settlement is instantaneous, then there is no need to post a reserve to secure it against default. In such a system, a default or even a settlement fail are theoretical and practical impossibilities. Fair enough, but this argument forgets entirely the credit extension role that the settlement process has come to embody, and how essential that credit extension is to the functioning of the securities markets.

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[1] https://www.greenwich.com/equities/security-tokens-how-regulated-icos-could-transform-market-structure

Back to the Future

From the standpoint of secure, accessible books and records, DLT represents an important step forward. From a funding perspective, it is a gigantic step backward. First, a real-time settlement system is, of necessity, a bilateral gross settlement system. Its bilateral nature precludes multilateral margining. So DLT maximalists are turning the clock back to 1919, before the Stock Clearing Corporation internalized the margining system on a multilateral basis. But this is not really far enough. Because real-time gross settlement also precludes netting, it requires funding all transactions in the market on a transaction-by-transaction basis. That's actually turning the clock back to 1891 and the era before the New York Stock Exchange Clearing House enabled marketwide net settlement.

But even this does not go far enough. In 1891, an investor could secure a call loan against shares during the day it took to settle them, using the transaction receipt as collateral. With instantaneous settlement, it's not possible to secure funding with shares you have yet to transact. This means you need to prefund the trade, but you must prefund it on an unsecured basis. So, it's really turning the clock back to the brief period in 1584 when the Venetian Senate required prefunding of all trading done via the Banco di Rialto. Therefore, DLT advocates arguing for the replacement of the current system are really arguing for the expensive deployment of futuristic technology in order to achieve a medieval result.

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The advocates of DLT might counter that instantaneous settlement means that the benefits of multilateral settlement are unnecessary because the moment you have sold your shares, you have the cash instantaneously and you can redeploy it with another purchase elsewhere. This might be a valid argument in a marketplace composed entirely of end users, but, as anyone familiar with the U.S. equity market can tell you, it is by no means composed entirely of end users. In fact, the U.S. equity markets rely for a great deal of their liquidity on market makers, who, in turn, rely on the extension of credit within the clearing and settlement cycle and system. This is not typically well understood, but data from DTCC can shed some light on it.

Over a 28-day sample in the volatile months of November and December 2018, the average gross settlement balance was $326 billion, and the net was $32 billion, 90% of the funding needs were eliminated via netting—about what the Frankfurt exchange achieved in 1867. What's more, thanks to the multilateral margining and risk management protocols of DTCC, these $32 billion in net settlements were secured with a mere $8.2 billion in commitments to the reserve fund from market participants. This is made possible by the risk management techniques utilized by NSCC and supplemented by reserves provided by NSCC itself, as well as additional advantages derived from its legal structure. Looked at another

way, the benefits of netting and risk margining enabled $326 billion in transactions to be financed with $8 billion in capital, meaning each dollar of capital from market participants secured $40 worth of gross transactions.

Conclusion

By any measure, this is an extraordinarily efficient system. While it's true that this efficiency would not be wiped out entirely with a real-time gross settlement, it is not an exaggeration to say that it would save $8 billion in reserve funds at the cost of requiring hundreds of billions in prefunding, creating a burden on money markets that participants have spent over a century developing systems to alleviate.

This is precisely the lesson the Venetian Senate learned in 1584 in a strikingly similar way: By substituting a payment system for a credit system, they sucked liquidity out of the economy. Unlike the Venetians, who really did blaze a new path, we have the benefit of learning from history, and this is its lesson: DLT has a big role to play in improving the quality of the settlement infrastructure, but it cannot replace it entirely without imposing the very costs it was designed to reduce.

Cover Illustration: © iStockphoto/MartaJonina

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