Russian Rearmament: An Assessment of Defence-Industrial Performance

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Introduction

At the end of 2010, the Russian President -- at that time Dmitri Medvedev -- approved a new ten-year state armaments programme (*gosudarstvennaia programma vooruzheniia*, hereafter the GPV-2020) that envisaged the partial re-equipment and modernization of the Russian armed forces by 2020. This programme was without precedent in the post-Soviet period. Previous state armaments programmes had been underfunded and unfulfilled (Zatsepin, 2012; Cooper, 2013a). This left the domestic defence industrial-complex (*oboronno-promyshlennyi kompleks*, or OPK) dependent on arms exports to survive (Cooper, 2013a). As well as providing funds for rearming Russia's military forces, the GPV-2020 was also intended to revitalize the Russian defence industry through investment in the modernisation of the industry's fixed capital. As such, the GPV-2020 is an attempt to reinvigorate *both* the Russian armed forces and the Russian OPK.

That the military and the OPK were deemed to be worthy recipients of such financial largesse was due to a combination of social, economic, political and military factors. Socially, the OPK accounts for a large share of employment in Russia. At around 2.5 million, it accounts for nearly 3% of total employment in Russia, with many cities and regions built around defence output (Cooper, 2013a; authors' calculations based on data from Rosstat, 2016).[1] Economically, the OPK is one of the few technology-intensive areas of the economy that has proven to be globally competitive. Indeed, Vladimir Putin declared the OPK to have the potential to "serve as fuel to feed the engines of modernization in [Russia's] economy" (Putin, 2012a; see also Putin, 2012b). Politically, the wider and more traditional security concerns of the geographically large and geopolitically isolated Russia demand capable and independent armed forces (Kotkin, 2016). This sentiment was succinctly expressed recently by the Prime Minister, Dmitri Medvedev, who declared "if we do not have effective armed forces we will simply have no country" (Medvedev, 2016). In military terms, Russia's poor performance in the Georgia war of 2008 created an urgent realization that re-equipment was necessary if the military were to be transformed into a modern and effective fighting force (Bukkvoll, 2009; McDermott, 2009; Renz and Thornton, 2012; Trenin, 2016). For all these reasons, the OPK is a leading sector of the Russian economy, even if not afforded the immense support it received in the Soviet period when the economy was 'hyper-militarized' (Bradshaw and Connolly, 2016).

This article addresses two related questions associated with Russia's rearmament programme. First, how has the OPK performed in the first five years of the rearmament programme? Specifically, what can be said about the quantity and quality of new arms procurement in Russia? Have modern new weapons been delivered to the Russian armed forces on time and in sufficient quantities to meet the objective of modernising the armed forces? Second, which factors explain the nature of OPK performance over the past five years? Is any improvement in performance simply due

[1] From an active labour force of c.76.5 million.

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to the increase in extra financial resources allocated to defence procurement? Or have other structural or institutional factors shaped defence-industrial performance?

The answers to these questions are important not simply because of what they reveal about the state of Russia's defence industry, but also because of the implications that rearmament has for Russia's role in the world. After Russia's recent military involvement in Ukraine and Syria, and against a backdrop of rising geopolitical tensions between Russia and the West, a sober appreciation of the capabilities of the Russian defence industry is essential to understanding what role it might play in Russia's future.

In order to answer the questions posed above, this article is organised as follows. The first section provides an outline of the objectives of the GPV-2020 and an overview of progress in delivering new weapon systems up to the end of 2015. A second section considers several factors that help explain Russian defence-industrial performance over the past years, including: the role of increased federal government spending; the influence of existing capabilities in providing a platform for expanded production over 2011-2015; the capabilities in the area of R&D and defence innovation; and, finally, the impact of industrial restructuring and institutional reorganisation on defence-industrial performance. A final section concludes.

The GPV-2020: objectives and performance

The objectives of GPV-2020

The GPV-2020 is a 10-year programme that envisages the large-scale procurement of a wide range of weapon systems to equip and modernise the Russian armed forces. It was envisaged that at least 70% of the armed forces' equipment would be modern by the time the GPV was completed.[2] In 2010, the share of modern equipment was said to be just 15%.

This rearmament plan moved the OPK back to the forefront of the Russian economy. During the Soviet period the OPK was one of the - if not *the* – highest priority sectors in the Soviet economy (Shlykov, 1995 and 2004). It enjoyed preferential access to resources – financial, physical and human - and was politically powerful (Gaddy, 1996; Cooper, 2013a). However, the OPK saw its privileged status decline over the course of the 1990s as spending cuts saw arms procurement drastically reduced. As a result, the OPK shrank considerably, with only arms exports to the likes of China and India keeping many enterprises afloat (Cooper, 2013a). After several underfunded and

[2] The precise share of modern equipment envisaged for each branch of the armed forces varies. As well as new or recently-developed weapon systems, this includes 'modernised' equipment from the Soviet era. For example, modernised MiG-31BM fighter and Tu-160 strategic bomber aircraft were all developed during the 1980s, while the Tu-22M3 and MS aircraft were developed even earlier. Therefore, while the modernised weapon systems are undoubtedly capable, it is important to realize that 'modern' weapon systems do not refer exclusively, or even primarily, to genuinely new weapon systems that were developed in the last decade. Moreover, because the Russian government does not provide clear and consistent data on force inventories, it is unclear what the precise aggregate number of weapon systems is. In conjunction with the fact that the official definition of what constitutes a 'modern' weapon system is classified, there are serious difficulties in interpreting official statements on the share of modernized weapon systems in service with the armed forces.

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unsuccessful state armaments programmes, the Russian leadership expressed the hope that the GPV-2020 would restore the OPK to a position of strength.[3]

A total of RUB 20.7 trillion (or c. USD 700 billion at the average 2011 exchange rate) was allocated to fund the procurement of modern equipment, as well as the development of future weapon systems and the modernisation of the wider defence-industrial base (Falichev, 2011).[4] It should be noted that spending was from the outset intended to be back-loaded, so that around one third of the total spending would take place before 2016, with the remaining two-thirds spent thereafter (Barabanov et al, 2013).[5] It was also expected that the GPV-2020 would be superseded by a new state armaments programme in 2016 (GPV-2025), although this has been postponed until 2018, at least in part due to the protracted recession that began at the end of 2014 (Butrin and Safronov, 2015).[6]

The total funds allocated to the Ministry of Defence for rearmament can be disaggregated by service (CAST, 2015, p.23). The Navy was assigned the largest share of funds (RUB 5 trillion; or 25% of total spending), which was intended to cover the costs of procuring over two dozen modern submarines and 51 surface combat ships. The air force was scheduled to receive the next highest share (RUB 4.7 trillion; 24%) to help deliver over 600 modern fixed-wing aircraft and around 1100 helicopters. Space and air defence forces were allocated RUB 3.4 trillion (17%) to purchase over 100 divisional units of surface to air missiles (SAMs) and over 100 spacecraft, while the army (ground troops and airborne troops) were allocated RUB 2.6 trillion (15%) to procure around 2300 main battle tanks (MBTs), 17,000 armoured vehicles and 2000 artillery systems. Strategic nuclear forces were allocated RUB 1 trillion (5%) to order nearly 300 intercontinental ballistic missiles (ICBMs). A further RUB 2.7 trillion (14%) was allocated to the procurement of other equipment, such as communications and control systems.[7] Additional funding through a variety of Federal Targeted Programmes (FTsP, or *federalnye tselevye programmy*) supplements procurement spending. The FTsP for the development of the defence industrial complex, 2011-2020 is the largest of these programmes.[8]

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[3] For instance, the first Russian GPV covered the period 1996–2005, but was recognized as a failure as soon as 1997. The program was based on excessively optimistic macroeconomic assumptions, and envisaged annual military spending of over 5% of GDP. The Russian MoD later estimated that procurement and R&D reached just 23% of what was initially planned in GPV-2005 (Cooper 2006, pp.441).

[4] According to the IMF, the average USD-RUB exchange rate in 2011 was 29.33 RUB per USD. In an interview, the then-First Deputy Defence Minister, Alexander Sukhorukov, described the funding mechanisms for the GPV-2020 (Falichev 2011). As described in Cooper (2016, pp.43-44), the eventual sum allocated to the GPV-2020 was considerably lower than the initial amount of RUB 55 trillion considered by the Ministry of Defence.

[5] This figure was also expressed in nominal terms, meaning that any inflation over the period of the GPV would erode the real value of the increase in defence procurement spending.

[6] On the sources and nature of the recession, see Zamaraev et al (2013), Mau (2013, 2014), Kudrin and Gurvich (2015), and Connolly (2015).

[7] This totals RUB 19.4 trillion, although Cooper (2016a, p.13) suggests that the figure is in fact closer to RUB 19 trillion.

[8] Details for this and other FTsPs can be found at: http://fcp.economy.gov.ru/cgi-bin/cis/fcp.cgi/Fcp/GosProgram/View/2014

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OPK performance, 2011-2015

The principal measure of military modernization is the share of modern weapon systems and other equipment in the inventory of the armed forces. There is some ambiguity over whether the denominator in this calculation refers to the total stock of equipment in the armed forces, including stored equipment, or whether it refers to equipment used in active service units.[9] In any case, the targets for modernization of military equipment used by the MoD are summarized in Table 1.

Table 1. Ministry of Defence targets for share of modern military equipment in total equipment for selected categories of weapon system, per cent

Type of weapon system	2013	2015	2020
Submarines	47	51	71
Surface ships	41	44	71
Aircraft	23	37	71
Helicopters	39	63	85
Ground missile systems	27	64	100
Artillery	51	53	79
Armoured vehicles	20	37	82
Multi-role vehicles	40	48	72

Source: Ministry of Defence of the Russian Federation, 'Plan deyatel'nosti na 2013-2020 gg' [Action Plan for 2013-2020], Moscow: Ministry of Defence, available at: http://mil.ru/mod_activity_plan/constr/vvst/plan.htm.

By the end of 2015, Russian officials noted that considerable progress had been made in meeting these objectives. Speaking at the MoD Collegium in December 2015, the Defence Minister, Sergey Shoygu, stated that many of the targets for 2015 had been exceeded (Shoygu, 2015). For instance, Shoygu claimed that modern armaments accounted for 52% of the equipment in the air force, 55% of strategic forces, 35% of ground troops' equipment, and 39% for the navy. Later, the Prime Minister, Dmitri Medvedev, reiterated Shoygu's claim that 47% of all armaments were classed as modern by the end of 2015 (TASS, 2016b). These figures indicate that rearmament is moving faster than originally envisaged in some areas, but slower in others, suggesting that the overall improvement in the share of modernized equipment in service in the Russian armed forces conceals significant variation in performance across different categories of weapon systems. In the remainder of this section we examine this variation in performance across several broad sub-sectors of the OPK to identify any trends in performance.[10] We examine deliveries of new (i.e. not

[9] Cooper (2016a, p.19) cites a speech by Dmitri Medvedev from May 2010 in which he refers to "units of permanent readiness." Because of this ambiguity, there is scope for manipulation on the part of the Russian authorities to ensure that the share of modern equipment rises. For instance, by withdrawing from service, say, 1000 older tanks, the share of modern equipment in the total tank park will rise, regardless of whether any modern tanks were delivered.

[10] For a detailed breakdown of deliveries across all categories of weapon systems, see Cooper (2016a) and Frolov (various).

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refurbished or upgraded versions of existing systems) fixed-wing aircraft, strategic missiles, naval vessels, and equipment for the ground forces from 2011 onwards.[11]

Fixed-wing aircraft

In 2011, the original schedule envisaged the procurement of around 700 new aircraft, comprising 70 new fifth generation multi-role fighter aircraft T-50 (PAK-FA, or Perspektivnyi aviatsionnyi kompleks frontovoi aviatsii), around 180 advanced fourth generation (4++) fighter aircraft, over 100 Su-34 strike aircraft, 120 new trainer aircraft (Yak-130), and over 150 cargo aircraft (Frolov and Barabanov, 2012). These numbers have, however, subsequently been adjusted, so that a greater number of fourth generation fighters are now scheduled to be delivered (now over 250), while the number of fifth generation fighters is expected to be closer to a dozen than to the 70 that were initially planned (TASS, 2015c). By the end of 2015, a total of more than 310 aircraft had been delivered.

At first glance, deliveries of new fixed-wing aircraft appear to be on schedule. However, closer inspection reveals that procurement of some types of aircraft have encountered difficulties. In Table 2, we outline the original GPV-2020 objectives for each type of weapon system and show how many aircraft had been delivered by the end of 2015. It is clear that Russia has enjoyed some success in acquiring aircraft developed in the 1990s or in systems based on upgrading older designs. Thus, the aircraft based on the established MiG-29 and Su-27 'Flanker' models – including the Su-30, Su-34 and Su-35 – have all been delivered largely to plan. The delivery of large quantities of Yak-130 trainer aircraft was also proceeding on schedule.[12] It is noteworthy that production of these systems had already begun before 2011. As a result, production lines were ready to expand production based on tried and tested models.

However, the development of newer models – the PAK-FA and the MiG 35 – where production lines were not already in place has proven more difficult. The Russian MoD has postponed the original plans to order over 30 MiG-35S until at least 2018 due to persistent technical and industrial obstacles (RIA Novosti, 2013; RIA Novosti, 2016b). As a replacement, 16 MiG-29SMT aircraft were ordered, a model that was developed in the 1990s (Lenta.ru, 2014). The high profile PAK-FA programme has also encountered problems. In late 2014 the MoD revised down plans to procure 70 aircraft by 2020, suggesting instead that 55 units was a more realistic number, and by March 2015, local media reported that this number might not exceed 12 aircraft (Sarkisyants and Khazbiev, 2016; Kommersant, 2015). Instead, the Ministry of Defence may purchase extra Su-30 and Su-35 aircraft to fill the gap until the PAK-FA reaches serial production (Zgirovskaya, 2016). Delays were not only encountered in the production of brand new weapon systems. Even the updated Su-25 UBM, an advanced version of the widely-used Su-25 airframe that was originally developed in

[11] All data are estimates supplied by the Centre for the Analysis of Strategic Technologies (CAST), a Moscow-based think tank that has worked alongside the authors on this project.

[12] The AI-222-25 engine used in the Yak-130 was jointly developed in Russia (by Salut) and Ukraine (by Motor Sich). After defence industry ties between the countries were largely severed after the annexation of Crimea in March 2014, it was suggested that deliveries of the Yak-130 might be interrupted. By 2015, however, it became apparent that Salut was able to produce the engine independently. See http://ria.ru/maks/20150825/1206390087.html

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the 1970s, has not yet been delivered due to development problems (Oko Planeti, 2011).

Table 2. GPV-2020 objectives and deliveries to end of 2015: Fixed-wing aircraft

Type	Developed[13]	GPV-2020 goal	Delivered by end of 2015
Strike aircraft		**100**	**66**
- Su-34	1990-2008	100	66
Fighters		**328**	**155**[15]
- PAK-FA (T-50)	2002-present	70	5[16]
- Su-30M2	1997–2009	16	16
- Su-30SM	1996–2012	60	53
- Su-35S	1993–2014	96	48
- Su-27SM3	2002–2011	8	8
- MiG-29K/KUB	1988–2009	26	26
- MiG-29SMT	1997–2004	0[14]	4
- MiG-35S	2005–2018	48	0
Trainer aircraft		**120**	**63**
- Yak-130	1990-2010	120	63
Close air support aircraft		**16**	**0**
- Su-25UBM	1999–2012	16	0
Passenger and transport planes		**235**	**35**
- An-140(-100)	1993–2004	9	11
- An-70	1986–2014	60 (0)	0
- An-124	1982–1986	40 (0)	0
- L-410	1966–1970	4	18
- Il-112	1994–2019	62	0
- Il-476	2007–2014 (late 60's–1974)	50(39)	0
- Tu-154M	1966–1971 (2007 upgrade)	0	6
- Tu-214	1996–2001	10	0

Source: Frolov (2011) for GPV-2020 objectives, and CAST (various years) for deliveries.

In addition to the procurement of new combat aircraft, a programme for the modernisation of Russia's existing fleet of strategic bomber aircraft is also underway. Between 2011 and 2015, small numbers (i.e. up to half a dozen) of Tu-95MSs and

[13] Development periods taken from Jane's IHS.
[14] Order placed for 16 aircraft in 2014 after original GPV-2020 targets had been adjusted.
[15] Not including prototype PAK-FA (T-50) deliveries.
[16] Serial production has not yet begun. The aircraft delivered to date have been prototype aircraft. Additional prototype aircraft are scheduled for delivery in 2016. See http://rg.ru/2015/05/28/pak-fa-site.html

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Tu-160s were modernised each year (TASS, 2015e). Initially, there were plans to replace the Tu-95MS and Tu-160 with a new generation of strategic bomber (the PAK-DA, or *Perspektivnyi aviatsionnyi kompleks dal'ney aviatsii*; see Sputnik 2014). However, delays in the development of this new model have led the Ministry of Defence to revise its plans so that production of a new, modernised version of the Tu-160 (the Tu-160M2) will be restarted with the aim of ensuring delivery of around 50 new bombers over the next decade (TASS, 2015b). Work on upgrading the facilities to revive production of the modernised Tu-160 was well underway by the end of 2015 (BMPD, 2016; Defence.ru, 2016 and Oruzhiye Rossii, 2016).

While deliveries of combat and trainer aircraft have accounted for the vast majority of fixed-wing aircraft deliveries, the procurement of modern passenger and transport planes has been more problematic. In 2011, it was envisaged that around 175 new aircraft would be delivered by 2020, although this objective has subsequently been revised up to nearly 300 (VPK, 2013). A fleet of modern cargo aircraft is essential if Russia's armed forces are to be capable of rapid deployment both within and outside its borders. However, by the end of 2015, only 35 new aircraft had been delivered.

While most fixed-wing combat aircraft are produced in Russia, transport aircraft were previously developed and produced in conjunction with Ukrainian enterprises, a legacy of the Soviet-era allocation of production facilities. For instance, Russia had planned to procure An-70 (jointly developed), An-124 and An-140 aircraft from the Ukraine-based aircraft producer Antonov, with deliveries initially scheduled to commence in 2015. However, the breakdown in defence industry cooperation between the two countries has caused the cancellation of orders for Ukrainian aircraft, which has in turn disrupted the procurement of military cargo aircraft. To date, orders for Russian-produced aircraft, such as the Ilyushin Il-476 heavy-lift transporters, have been revised downwards, rather than upwards, due to problems encountered in raising production capacity (Vzglyad, 2015). Plans to develop a brand new transport aircraft (the PAK-TA, or *Perspektivnyi aviatsionnyi kompleks transportnoi aviatsii*) have also been postponed (Mail.ru News, 2014), again illustrating that the OPK has proven more adept at producing established weapon systems than in developing new ones.

Although it is clear that OPK performance varies across aerial weapon systems, Russian strengths should not be underestimated. In 2015 alone, over 63 new combat aircraft were delivered to the Russian armed forces (not to mention the number delivered to export customers). This compares favourably with, for example, China, which was projected to produce around 50 combat aircraft in the same year (Jane's, 2015). Moreover, while the development of new weapon systems has proven challenging, it is also true that many other countries – including Russia's defence industry competitors in the USA, UK, Germany and China -- have experienced similar problems in developing extremely complex new weapon systems. Indeed, despite delays in the development of the PAK-FA and in producing transport aircraft, production under the GPV-2020 has already resulted a significant increase in the share of modern equipment in the air force, with Defence Minister, Sergei Shoygu, declaring in late 2015 that 52% of the equipment in the air force could be classified as modern, well in excess of the original target of 37% by this point in the programme (Shoygu, 2015).

Naval systems

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The navy was allocated the highest share of funding under GPV-2020. This expansion of production was intended to modernise both Russia's strategic missile submarine fleet, as well as the modernisation of submarines and surface vessels deployed in all of Russia's four principal fleets.[17] As well as producing new weapon systems, GPV-2020 also envisaged the refurbishment of dozens of existing vessels. However, delays in the development of newer models, the imposition of Western sanctions in the aftermath of Russia's annexation of Crimea in 2014, and the breakdown of ties between Russian and Ukrainian enterprises, which performed a vital role in the production of important components used in military ship-building, have all contributed to a slower pace of modernisation in the navy than in the other branches of the armed forces.

Submarines

In order to modernize Russia's strategic missile submarine (SSBN) fleet, the GPV-2020 envisaged the procurement of a total of eight Borei-class (Project 955/A) SSBNs by 2020. Two new Borei-class (Project 955/A) SSBNs are already in service, one is built and due to enter service soon, and an additional four are at various stages of construction.[18] An eighth and final boat (the 'Kniaz Pozharsky') is due to be laid down in 2016 (Lenta.ru 2015a). Although the 'Borei' production programme has encountered delays, which mean that delivery of all eight boats will likely not take place until after 2020, it is nevertheless the case that the modernization of the Russian SSBN fleet is progressing well.

Table 3. GPV-2020 objectives and deliveries to end of 2015: Submarines

Type	**Developed**[19]	**GPV-2020 goal**	**Delivered by end of 2015**
SSBN - Borei-class (Project 955/A)	 1997-2013	 8	 3
Nuclear multirole - Yasen-class (Project 885/M)	 1993-2015	 7	 1
Diesel-electric submarines - Lada-class (Project 677) - Varshavyanka-class (Project 636/636.3)	 1997-2010 2010-2014	**9-13** 3 6(10)	**5** 1[20] 4

Source: Frolov (2011) for GPV-2020 objectives, and CAST (various years) for deliveries

Production of new nuclear multi-role and diesel-electric submarines has been much slower. Only one of the Yasen-class (Project 885) submarines has been delivered to date, and that is still undertaking sea trials (VPK, 2016c). The original objective of

[17] These are the Baltic Fleet, the Northern Fleet, the Black Sea Fleet, and the Pacific Fleet. There is also a smaller Caspian Flotilla.
[18] The first 'Borei', the Yuri Dolgoruki (K-535), is based at Yagelnaya in the Northern Fleet. The second, the Alexander Nevsky (K-550), is based near Petropavlovsk, and entered service in September 2015. A third 'Borei', the Vladimir Monomakh (K-551), is scheduled to enter service in 2016.
[19] Development periods taken from www.russianships.info.
[20] Active only as a test boat.

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acquiring seven Yasen-class submarines will almost certainly not be met. Indeed, such has been the scale of challenges encountered in the production of the Yasen-class that it has been reported that serial production will be shelved in favour of a new, smaller and cheaper model (Lenta.ru, 2016).

As a result, much of the improvements in the submarine fleet that have taken place to the end of 2015 have come from the delivery of refurbished older models, such as variants of the Shchuka-class (Project 971 M & U), and production of the Varshavyanka-class (Project 636.6, or 'Improved Kilo' using the NATO designation) submarines that are based on well-established technology and production techniques. The development of the newer Lada-class (Project 677), which began in the late-1990s, has also been beset by problems. In 2011, the first of its type failed to pass sea trials due to problems with its propulsion systems, computer systems and sensors (Tel'manov, 2011). Although construction of a new, redesigned model, equipped with a new engine, resumed in 2015, these delays will almost certainly ensure that the original GPV-2020 objectives of producing up to ten new submarines will not be met (TASS, 2015a).

Surface vessels

The modernisation of the Russian surface fleet has taken place on two levels. First, the older, and often larger, ships that were built in the late Soviet period have been refitted and modernised. Second, brand new types of ships have been procured.

The refurbishment of the existing fleet has been relatively successful, and has extended the service life of Russia's largest surface ships, such as the aircraft-carrying cruiser, the 'Admiral Kuznetsov', the cruisers of the Slava- (Project 1164) and Kirov-classes (Project 1144), and the large destroyers of the Sovremennyi-class (Project 956). This has not always proven to be a smooth process. For instance, the Sovremennyi-class ships have experienced persistent problems with their propulsion systems, while doubts remain about the combat effectiveness of even a modernised Admiral Kuznetsov (Khodarenok, 2012).

Procurement of new surface vessels has proceeded slowly (Table 4). Larger ships, such as the Admiral Gorshkov-class (Project 22350) and Admiral Grigorovich-class (Project 11356R) frigates have not been delivered on schedule. The Ministry of Defence originally planned to acquire six of each type. However, the gas turbine engines that were used for both types of ship were produced in Ukraine by Zorya-Mashproekt. The outbreak of conflict in 2014 led to an end to the supply of these power systems (VPK, 2014), which in turn delayed production of the vessels.[21] No ships of either class had been delivered by the end of 2015, although one Admiral Gorshkov-class and two Admiral Grigorovich-class vessels were delivered in 2016.

Sanctions have also affected the supply of German-made engines for the Gremyashchy-class corvettes (Project 20835), which were intended to form the backbone of a modernised corvette fleet (VPK, 2015). As a result of sanctions, the Ministry of Defence has initiated a programme of import substitution to produce the

[21] For a discussion of the integration of Ukrainian and Russian defence industries, as well as an overview of the sanctions regime imposed on Russia in the aftermath of the annexation of Crimea, see Davis (2016).

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engines in Russia, and has also increased orders of the Steregushchiy-class (Project 20380) to make up for these delays (VPK, 2016b). Sanctions also led to the cancellation of the purchase of French-made 'Mistral' landing ships. As a result, the deputy defence minister, Yuri Borisov, indicated that a replacement ship would be built in Russia during the next GPV (2018-2025; VPK, 2016e) Smaller landing, artillery, minesweeping, intelligence and other auxiliary ships have been delivered in greater quantities (Defence-Industrial Commission College, 2016).

Table 4. GPV-2020 objectives and deliveries to end of 2015: Surface vessels

Type	Developed [22]	GPV-2020 goal	Delivered by end of 2015
Frigates		**15**	**0**
- Gorshkov-class (Project 22350)	2006–2015	6	0
- Grigorovich-class (Project 11356R)	2010–2015	6	0
Corvettes		**35 (36)**	**3**
- Gremyashchy-class (Project 20385)	2011–n.d.	16 (2)	0
- Steregushchiy-class (Project 20380)	2001–2007	12 (20)	3
Small artillery ships		**8-10**	**6**
- Buian-class (Project 21630)	2004–2006	0	1
- Buian-M-class (Project 21631)	2008- 2012	8-10	5
Guard ships		**1**	**1**
- Gepard-class (Project 1166.1/K)	1991–2002	1	1
Landing craft		**6-?**	**7**
- Serna-class (Project 11770)	1993–1994	-	2
- Ivan Gren-class (Project 11711)	2004–2016	2	0
- Diugon-class (Project 21820)	2006–2010	-	5
- Mistral-class		4	0
Minesweepers and auxiliary vessels		**97**	**94**

Source: Frolov (2011) for GPV-2020 objectives, and CAST (various years) for deliveries

Overall, procurement has followed a similar pattern to that exhibited in other weapon system categories. The OPK has been more proficient in building new ships where there are already well-established production lines. The development of newer models has been less successful, with the construction of a new Lider-class destroyer another system that will not take place until at least 2018-19 (TASS, 2015d). Indeed, as well as proving less able to develop new systems, ship-building has also highlighted the difficulties that Russian ship-building has in producing surface vessels larger than corvette size (Ministry of Defence of the Russian Federation, 2016b). These smaller vessels, alongside modernised larger vessels from the Soviet era, are still capable. Equipped with, inter alia, the advanced Kalibr cruise missile system, these ships are

[22] Development periods taken from www.russianships.info.

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undoubtedly capable. However, it is clear that Russia is not, at least for now producing ships that are needed to make a 'blue water' navy. Instead, Russia's OPK is better suited to equipping a navy that is capable of undertaking operations closer to Russia's shores (Gorenburg, 2016).

Ground forces

Russia's ground forces were allocated a relatively small proportion of total spending under GPV-2020, with only 15% of the RUB 19 trillion assigned to the procurement of new weapons systems for the army and airborne forces. The modernization programme envisaged the purchase of new command and control systems, modern infantry combat systems (the 'Ratnik'), thousands of new armoured vehicles, tens of thousands of trucks and automobiles, new artillery systems, and 'Iskander' tactical missile systems. As illustrated in Table 5, there remains some ambiguity over precise objectives for procurement of armoured vehicles for the ground forces. While the target of 2300 MBTs is clearly defined, it is less clear how many light tanks and infantry vehicles are scheduled for delivery.

Table 5. GPV-2020 objectives and deliveries to end of 2015: Armoured vehicles

Type	**Developed**[23]	**GPV-2020 goal**	**Delivered by end of 2015**
Main Battle Tanks		**2300+**	
- T-14 (Armata)	2009–present	2300	20[24]
Light Tanks/ Tank destroyer			
- BMD-3 (Sprut SD)	1995–present	-	- 10
Infantry Fighting Vehicle (IFV)			
- T-15 (Armata)	–present	-	- 0
- Kurganets IFV (BMP-4)	2008–present	-	- 0
- BMD-3 (RKhM-5)	1995–present	-	- 3
Light Multirole Vehicle		**3000**	**765**
- Iveco LMV M65 'Rys'			- 364
- Tigr-M	2000–2004	-	- 166
- BMP-3	–1990	-	- 235
Armoured Personnel Carrier (APC)		**-**	**1109**
- BTR-80(A)	–1994	-	- 150
- BTR-82(A)	2008–2013	-	- 819
- BMD-3 (BTR-MDM)	–2015	-	- 25
- BMD-4M	–2014	-	- 25
- Typhoon (light)	2007–2013	-	- 80
- Bumerang (medium)	2010–present	-	- 0
- Kurganets APC (medium)	2010–present	2000	- 10[25]

[23] Development periods taken from Jane's IHS.
[24] Only prototype vehicles delivered by end of 2015.
[25] Only prototype vehicles delivered by end of 2015.

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Vehicles/ Trucks		**50000**	**13060**
- Urals trucks	Various		- 4820
- KAMAZ	Various		- 1600
- Other	Various		- 6640

Source: Frolov (2011) for GPV-2020 objectives, and CAST (various years) for deliveries

By end of 2015, the Russian armed forces have only acquired prototype versions of the new T-14 'Armata' MBT, although around 30 further prototypes of the T-14 and other 'Armata' based vehicles are scheduled for delivery in 2016, suggesting that serial production at the Uralvagonzavod plant in Nizhny Tagil may begin in 2017-2018 (TASS, 2016c).[26] This is later than initially planned, and is likely to result in the failure to meet the 2020 objective of 2300 deliveries. While delays have affected the procurement of the T-14, several hundred modernised T-90 tanks have been delivered since 2011, as well as hundreds of upgraded and refurbished variants of the T-72 and T-80.

More success has been registered in producing systems based on older models of multirole vehicles, such as the BMP-3, and armoured personnel carriers (APCs), such as the BTR-82A, which started serial production in 2013 (Lenta.ru, 2013). Russia is also developing new types of armoured vehicles, including the 'Kurganets-25' tracked IFV and APC variants, and the 'Bumerang' wheeled APC. While neither has yet to enter serial production, it has been reported that the 'Kurganets' may enter serial production in 2016 (Zvezda, n.d.). The production and delivery of over 12,000 lighter vehicles has also proceeded according to schedule.

The overall picture for procurement of armoured vehicles is similar to that observed in other categories of weapon system in that the OPK has proven able to deliver large quantities of established weapon systems, usually developed or refined in the 1990s and 2000s, and less successful in initiating serial production of newer models. Although this means that it is highly unlikely that the Russian armed forces will meet the ambitious objectives defined in the original GPV-2020, if serial production of systems like the 'Armata' and 'Kurganets' does begin by 2017-2018, those objectives may be met in the early part of the next decade. Moreover, along with the delivery of tens of thousands of 'Ratnik' infantry combat systems, hundreds of new artillery systems, and dozens of 'Iskander' tactical missile systems, the procurement of weapons systems for Russia's ground forces has already resulted in a sharp modernisation of force inventories, with modern equipment accounting for 25% of the total number of MBTs and around 70% of other vehicles (TASS, 2015f; Shoygu, 2015).

Strategic missiles

The political importance attached to maintaining Russia's position as a nuclear superpower has meant that the defence industry maintained significant research and development (R&D) and production capabilities in the field of strategic missiles, even during the 1990s and early 2000s when defence procurement spending was at a historically low level. This helps explain why deliveries of strategic missiles under the GPV-2020 have largely been carried out to schedule. The R&D and testing phases for

[26] The Armata will also serve as a chassis for other models of IFV (the T-15), artillery systems (BM-2), and other weapon systems.

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the Topol-M (RS-12M) ICBM, RS-24 'Yars' ICBM, and R-20 'Bulava' submarine-launched ballistic missile (SLBM) began under previous state armament programmes. Although all these programmes encountered difficulties during the development phases, these were largely overcome by the time that deliveries were scheduled under GPV-2020 (RIA Novosti, 2011; see Table 2). Consequently, around 130 ICBM and SLBMs were delivered before the end of 2015, contributing to a significant modernisation of Russia's strategic nuclear forces (Kristensen and Norris, 2016a). By the end of 2015, the Defence Minister stated that over half of Russia's strategic missile forces were classified as modern (Shoygu, 2015).

Table 6. GPV-2020 objectives and deliveries to end of 2015: Strategic ballistic missiles

Type	**Developed**[27]	**GPV-2020 goal**	**Delivered by end of 2015**
ICBM		**c.150**	**70**
- RS-12M (Topol-M)	late 80's–2005		12
- RS-24 Yars	2004–2010		58
- RS-26 Rubezh	2006–present		0
- RS-28 Sarmat	2005–2020		0
SLBM		**c.190**	**92-98**
- SS-NX-30 Bulava	1998–2010	150	41-47
- Sineva & Lainer	2011–2012 (1983–1989)	40	51

Source: Frolov (2011) for GPV-2020 objectives, and CAST (various years) for deliveries

The development of additional strategic weapon systems continues. The first deliveries of the solid-fuelled RS-26 'Rubezh' are expected in 2017, while the liquid-fuelled heavy ICBM, the RS-28 'Sarmat', which is intended to replace the RS-20V after 2016 (Podvig, 2008), has also made good progress. Although a 'pop-up' test (where a launch without full engine ignition takes place) scheduled for 2015 was postponed, deliveries of a system that reportedly will carry new warheads designed to penetrate anti-ballistic missile systems are still expected to take place from 2018 onwards (Karakayev and Falichev, 2016). There are also plans to develop the Barguzin rail-based launcher system intended to carry the 'Yars' missile. However, reports suggested that development of this system may be delayed or cancelled due to a shortage of funds (Lenta.ru, 2015b). However, subsequent reports indicated that work continues on the development of the system (Interfax, 2016; VPK, 2016d). Whether the Barguzin continues or not, it is clear that the OPK has performed well in supplying strategic missiles to the Russian armed forces. In doing so, it is likely that Russia will maintain the world's second most capable strategic nuclear forces and a domestic production system that is equal in capacity to the United States.[28]

Summary

Several broad patterns can be discerned from the four brief outlines of OPK performance across different categories of weapon system given above. First, the OPK has proven capable of producing established weapon systems in large quantities

[27] Development periods taken from Jane's IHS.
[28] On US missile production, see Kristensen and Norris (2016b).

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and largely to schedule. Second, it has proven less adept at producing newer, more sophisticated weapon systems. Third, the acquisition of weapon systems where linkages with foreign partners were high, especially with Ukrainian enterprises, has also encountered obstacles. Taken together, these trends suggest that the GPV-2020 has not, to date, generated a wide-scale breakthrough in defence-industrial capabilities. These tendencies are also evident in other categories of weapon systems, such as surface-to-air missiles (SAMs), unmanned aerial vehicles (UAVs), and helicopters (see Cooper, 2016b for a detailed breakdown).

Factors explaining OPK performance

In this section we consider several factors that explain the patterns of OPK performance described in the first section. They include: (1) the expansion of funding for defence procurement under GPV-2020; (2) the variation in defence-industrial capabilities across sub-sectors of the OPK at the beginning of the GPV-2020; (3) the nature of the Russian innovation system in the OPK; and (4) the influence of industrial restructuring that preceded the GPV-2020. We consider each of these factors in turn.

Increased funding: the expansion of defence procurement

The first and most obvious explanation for the improvement in defence-industrial performance is the unprecedented (in post-Soviet times) increase in funding allocated to defence procurement. After rearmament moved to the top of the political agenda in the aftermath of the Georgia war, total Russian military expenditure grew from 3.8% of GDP in 2010 to 5.5% in 2015. [29] This figure, of course, includes military expenditure beyond procurement, such as expenditure on military wages, pensions, housing, training and exercises, and operational expenditure.

Figure 1. Annual state defence order (GOZ), including state guaranteed credits, 2010-2015 (RUB billion, current prices, left axis; % of GDP, right axis)

[29] The share of GDP devoted to military expenditure is higher than for any NATO country, as well as China, India and Japan (SIPRI, 2016).

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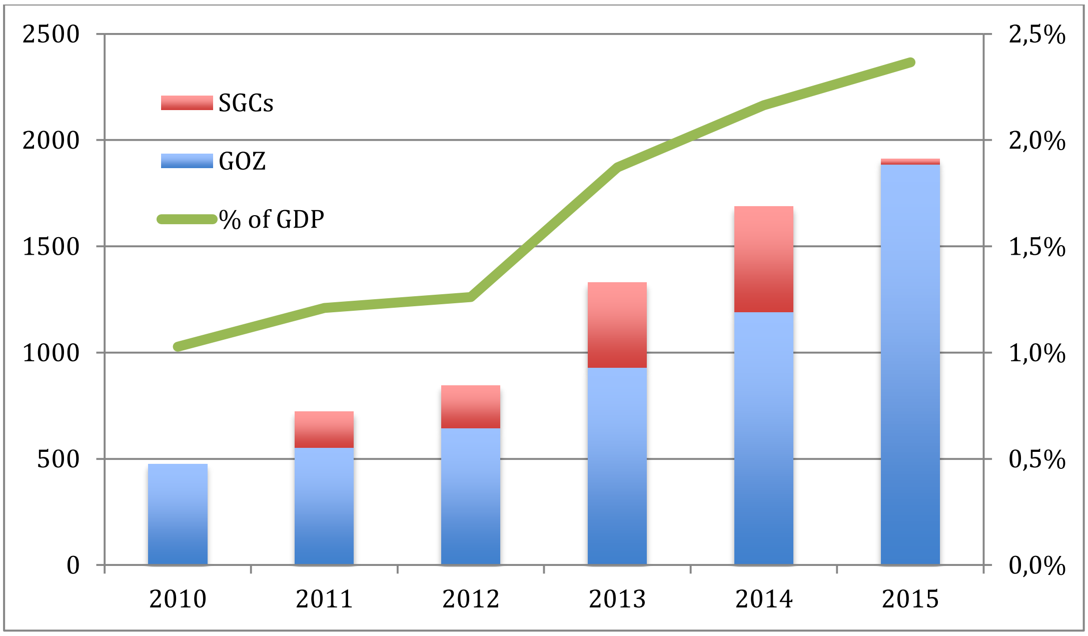

Sources: 2010-2013, TS-VPK; 2014-2015, Cooper (2016a); GDP data, Rosstat (2016); author's calculations

The volume of spending devoted to defence procurement rose especially sharply, rising from 1% of GDP in 2010 to 2.4% of GDP in 2015 (Figure 1). The amount allocated to the annual state defence order (*Gosudarstevennyi oboronnyi zakaz*, or GOZ) was supplemented with state guaranteed credits (SGCs), as well as funding channelled through other ministries, such as the Ministry of Industry and Trade, that included military components that supported defence research or production (Nikolsky, 2015).[30] This caused a significant reorientation in the overall profile of government spending. In 2010, military expenditure as a share of total federal government spending was 15.9%, but by 2015 it had risen to 25.8%. In 2015, the GOZ (including SGCs) alone accounted for around 12% of federal government spending.[31]

The sums allocated to support the wider defence-industrial base, including those from the FTsP for the development of the defence-industrial complex, 2011-2020, have also helped upgrade significant swathes of the capital stock used in the production of armaments. In 2010, it was stated that 74% of the capital stock of the OPK was obsolete (Myasnikov, 2009). By 2015, the construction of numerous high-profile factories were completed, including Almaz-Antey's new factory in Nizhny Novgorod (RIA Novosti, 2016a) and the upgrade of the facilities at the Kuznetsov factory in Samara (Ministry of Defence, 2016a), which produces engines for Tu-160 strategic bombers. As a result, it is clear that the defence-industrial base has been significantly upgraded. This is likely to provide a firm basis for both meeting future domestic demand for weapons and also for ensuring that Russia will remain competitive in export markets in the future.[32]

[30] See MDB (2015, No.4) on other means of funding. The use of SGCs is discussed in Cooper (2013b).
[31] Total federal government spending of RUB 15.2 trillion was planned in the revised budget for 2015 (Ministry of Finance, 2015). GOZ spending amounted to c. RUB 1.9 trillion.
[32] Russia is the world's second largest exporter of armaments (SIPRI 2016).

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However, while the funding allocated to rearmament has been impressive, Russia's ambitious plans to reinvigorate its defence-industrial sector have encountered economic challenges.

First, the decline in oil prices from over $100 per barrel in the summer of 2014 to an average price of around $40 per barrel over 2015, and around $30 per barrel during the first half of 2016, exacerbated a pre-existing slowdown in economic growth (Connolly, 2015; Bradshaw and Connolly, 2016). This slowdown began at the end of 2012, and was likely caused by the exhaustion of the economic growth model that served Russia well between 1999 and 2008, when annual GDP growth averaged over 7%. In 2014, real GDP growth slowed to just 0.6%, down from 1.3% in 2013, and around 4% in 2012. This slowdown was likely caused by a combination of many factors, including a shrinking labour force, the slowdown in growth of government and consumer spending and, perhaps most importantly, a low and declining share of investment in economic activity (Connolly, 2011; Gaddy and Ickes, 2013). When oil prices collapsed, an economy buffeted by the combination of Western sanctions and a home-grown structural slowdown shrank by 3.7% in 2015.

The deep and so-far protracted recession has imposed constraints on federal government spending.[33] However, even though the share of spending assigned to other budget chapters, such as health and education, has declined, the share devoted to defence procurement (and wider military spending) grew. A graphic illustration of the prioritisation of defence over other areas of budget spending was made when the decision was made to revise the 2015 budget in April of that year due to the severe recession. As tax revenues diminished, several areas of federal government spending were reduced by over 15%. However, the allocated funds for 'national defence' were cut by just 4.8% per cent (Ministry of Finance of the Russian Federation, 2015). Furthermore, the funds allocated to defence procurement were not reduced (at least not in nominal terms).[34]

The Russian government's reluctance to cut spending on rearmament, even in the face of a long and serious recession, illustrates the political importance attached to rearmament. As a result, the rearmament programme received the scheduled funds for the 2012-2015 period. With the Russian military a key component of a more muscular foreign policy, this prioritisation of defence production may persist, even in the wake of a protracted economic slowdown. If substantial cuts are finally made to the rearmament programme, procurement may be spared, with cuts instead falling on areas where Russian industry has struggled to make progress (e.g. postponing production of advanced new weapon systems), or by reducing spending on military infrastructure (TASS, 2016a).

A second financial challenge encountered during the rearmament process was that of rapid price inflation for goods and services produced in the OPK, which has served to reduce the efficiency of defence spending (CAST 2015, pp.17-19). To be sure, this

[33] This is discussed in greater detail in Oxenstierna (2016).

[34] Defence procurement was further shielded from significant nominal cuts in 2016. The budget for 2016 stated that the direct government funding allocated to rearmament would be reduced by 10% (over 180 billion RUB, or $2.3bn at current exchange rates). However the provision of SGCs of RUB 209 bn ensured that the level of available funding remained the same. See http://www.i-mash.ru/news/nov_otrasl/79189-predprijatijam-opk-predostavjat-v-2016-godu-209.html

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was not a new problem. A rate of inflation higher than the national average producer and consumer prices indices was common even during the 1990s when procurement spending was relatively low (see Sanchez-Andres Sanchez, 2000). As a result, various measures to reduce costs, including the creation of the Federal Service for Defence Orders (Rosoboronzakaz) and the Federal Agency for the Procurement of Armaments, Military and Special Equipment and Logistical Resources (Rosoboronpostavka), were introduced.[35]

But these measures did not solve the problem. Instead, the low levels of transparency across the industry, along with a low intensity of competition, and a generally modest role for foreign suppliers, combined to fuel inflation.[36] As result, when the volume of funds allocated to each GOZ rose sharply, the problem of artificial price inflation worsened correspondingly. Although the government introduced several additional schemes to control prices, such as regulations to cap profits at 20-25% of suppliers' costs for 'core production', this has not proven successful to date. Perhaps as a sign of official unhappiness with the problem of rising costs, it was announced in September 2014 that Rosoboronzakaz and Rosoboronpostavka were to be abolished in January 2015 (RIA Novosti, 2014).

High levels of corruption have allegedly exacerbated the problem of rising costs, with some estimates suggested that as much as 20-40% of procurement funding has been lost (Aleshin and Elyushkin, 2013). However, while such estimates are often reported in the Russian press (with the most pessimistic estimates then reported in the Western press), it is difficult to gauge their accuracy. Whether the misallocation of resources in the Russian state and/or OPK – by corruption or other means – is an order of magnitude worse than other countries is, in the absence of any firm evidence, an open question. Indeed, recent research suggests that price growth for advanced technologies tends to outpace the average rate of price inflation, i.e. as recorded in consumer or producer price indices (Hartley and Solomon, 2016; Hove and Lillekvelland, 2016). In this respect higher-than-average price inflation in the Russian defence industry should be expected, especially given the focus in the GPV-2020 on the development on advanced new weapon systems.

It is for these reasons that President Putin's statement that productivity levels in the OPK had risen three-fold between 2011-2015 should be treated with caution (Putin, 2016). Although the increase in investment in reequipping defence plants should be expected to have boosted productivity, the rise in recorded output is likely to have been driven to a significant degree by price inflation (CAST 2015, p.18).

To sum up: the Russian rearmament programme was more or less fully funded between 2012-2015, despite the challenging macroeconomic conditions imposed by the long-running economic slowdown, and despite the failure to curb rising price inflation in the OPK that has eroded the real value of defence procurement spending. This commitment to rearmament could, if continued, further distort an economic structure that has become increasingly subordinated to serving Russian security and foreign policy objectives (Connolly, 2016b).

[35] The various instruments are described in Matyushkin (2016).

[36] Since 2011, procurement of goods relating to national security and defence applications (in addition to some machine tools) are required to be sourced from domestic producers unless they are unavailable. This has limited the role of foreign suppliers.

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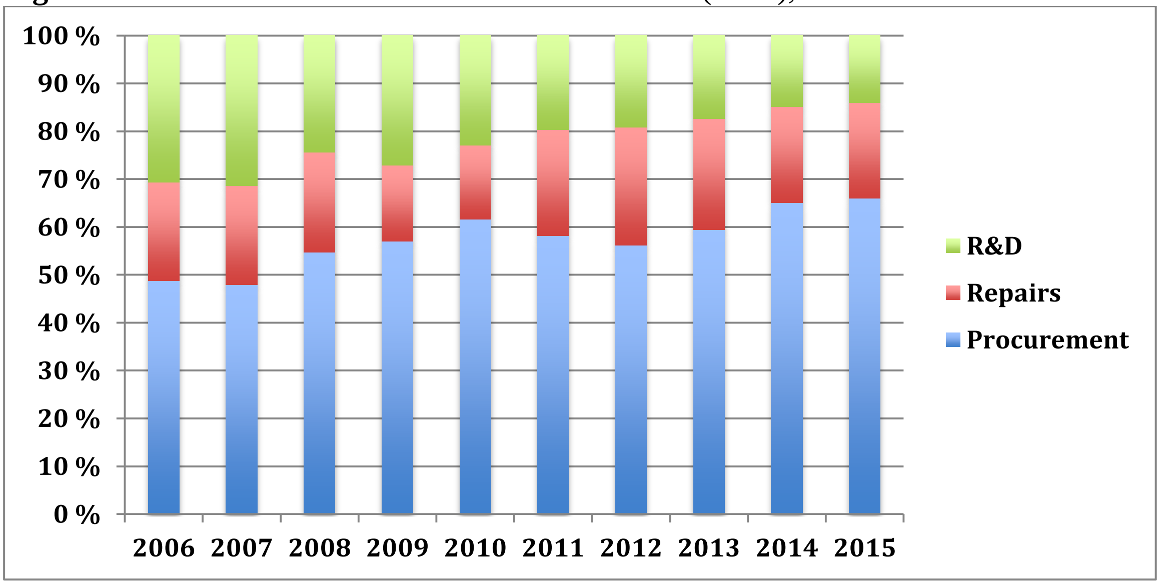
Initial conditions: the distribution of existing defence-industrial capabilities

A second factor that explains OPK performance during the GPV-2020 is the distribution of existing defence-industrial capabilities at the beginning of the programme. Put simply, in 2011 the OPK was proficient in the production of certain products, which became the areas of strong performance under GPV-2020. For instance, over the course of the previous state armament programme (GPV-2015), the OPK had supplied to the Russia armed forces a range of weapons systems, including automobiles, trucks, upgraded tanks (e.g. T-90) and armoured vehicles (e.g. BTR-80), artillery systems, Yak-130 trainer aircraft, Su-34 attack aircraft, Sineva SLBMs, and Topol-M/Yars (RS-24) ICBMs (see Cooper, 2011). In addition, between 2006-2011, the OPK also produced additional weapon systems for export, with aircraft accounting for 49% of all exports over this period (dominated by established aircraft designs, such as variations of the 'Flanker' series) and with missiles accounting for 19% (SIPRI, 2009). It is these same sub-sectors that performed well before 2011 that have performed best subsequently.

The OPK has also produced a greater quantity of products in those areas where resources for research and development (R&D) were allocated under the previous state armaments programme. As illustrated in Figure 2, a significant proportion of the annual defence order (GOZ) was allocated towards the development of new weapon systems that were intended to enter large-scale serial production under the GPV-2020 (Cooper, 2011). It was during this period that resources were committed to the development of, inter alia, the Bulava SLBM, the Su-35 fighter aircraft, Mil-28NM helicopter, and the BMD 3M and BMD 4 series of APCs. These systems subsequently began to enter large-scale production under GPV-2020.

Fig 2. Structure of Russian annual state defence order (GOZ), 2006-2013



Source: Data for 2006-2013 from Ts-VPK (2014); data for 2014-2015 from Frolov (2016, p.17)

By contrast, industrial performance in those sub-sectors of the OPK where production had been relatively limited prior to 2011, or where the development of new systems

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had been less successful, was markedly inferior to those where Russia already exhibited strength. Shipbuilding is a good example. With the exception of some submarines (e.g. the Project 636, which was produced for export during the 1990s and 2000s) and some smaller vessels, the shipbuilding industry has not developed or produced many new ships since the 1980s (Gorenburg, 2010). As a result, although some existing Soviet-era warships have been refurbished under the GPV-2020, the OPK has struggled to keep to schedule in the delivery of newly-designed ships.

This pattern suggests a certain path dependence that reflects the historical strengths and weaknesses of the OPK. The defence industry has performed best where established designs existed, or where serial production of newer designs had already begun before 2011. These sub-sectors of the OPK proved most able to absorb the massive expansion in defence procurement spending discussed above. Building new areas of comparative advantage in, for example, large warships or in fifth generation fighter aircraft may well require a prolonged injection of R&D funding before success is observed.

The quality and effectiveness of defence innovation

Another explanation for the relative difficulties observed in the development of newer weapon systems lies in the structure of the defence-industrial innovation system in Russia. These weaknesses can be traced to problems located specifically within the OPK (Roffey, 2013; Adamsky, 2014), and to problems with the wider national innovation system in Russia (OECD, 2011; Graham, 2013) that hampers the development of knowledge-intensive development more widely in Russia.

Table 7. Employment in selected Russian and foreign defence enterprises, 2014

Rank by total arms sales	Company	Country	Arms sales, $million	Total sales, $million	Arms sales as a % of total sales	Total employment	Total sales per worker, $
5	Northrop Grumman	USA	19,660	23,979	82	11,000	2,179,909
56	Korea Aerospace Industries	South Korea	1,660	2,198	76	3,230	680,495
2	Boeing	USA	28,300	90,762	31	165,500	548,411
21	Mitsubishi Heavy Industries	Japan	3,920	37,663	10	81,850	460,147
16	Rolls-Royce	UK	5,430	24,021	23	54,100	444,011
1	Lockheed Martin	USA	37,470	45,600	82	112,000	407,143
4	Raytheon	USA	21,370	22,826	94	61,000	374,197
9	Finmeccanica	Italy	10,540	19,455	54	54,380	357,760
60	Embraer	Brazil	1,470	6,388	23	19,170	333,229
3	BAE Systems	UK	25,730	27,395	94	83,400	328,477
31	Rheinmetall	Germany	2,970	6,220	48	20,170	308,379
12	Thales	France	8,600	17,207	50	61,710	278,836
89	Turkish Aerospace Industries	Turkey	850	1,001	85	6,030	166,003
23	Russian Helicopters	Russia	3,890	4,300	90	42,000	102,381
11	Almaz-Antey	Russia	8,840	9,208	96	98,100	93,863
67	Polish Armaments Group	Poland	1,270	1,270	100	17,500	72,571
39	High Precision Systems	Russia	2,350	2,351	100	45,000	52,244
45	KRET	Russia	2,240	2,731	82	54,000	50,574
15	United Shipbuilding Corp.	Russia	5,980	7,329	82	287,000	25,537
90	UkrOboronProm	Ukraine	840	881	95	122,000	7,221

Source: SIPRI, 2016d; author's calculations

Across the OPK, it is clear that the majority of enterprises are labor-intensive due to firms continuing the Soviet-era practice of employing large numbers of staff, many of

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whom do not have a high level of education. Table 7 compares the number of employees required to produce each dollar of output in selected large Russian defence enteprises with those from some high-profile Western comparators. As is evident, such a low capital-labour ratio is unusual in high-technology industries. Alongside ageing physical capital, an ageing R&D workforce, and weak linkages between higher education, R&D organisations and defence enterprises, the innovation environment within the OPK faces considerable challenges (Matyushkin, 2016; Roffey, 2013). These deficiencies are considered by some to have hampered the development of new weapon systems, and have the potential to prevent Russia from developing the next generation of weapon systems (Dvorkin, 2014; Frolov, 2015b).

Another weakness of the OPK is the declining influence of foreign participation in the development of weapon systems. In 2011, cooperation with foreign enterprises was considered to be a key component of the modernization process, despite a pre-existing preference for self-sufficiency among many in the military and OPK (Military Doctrine of the Russian Federation, 2010). As a result, between 2010 and 2012, the OPK experienced a brief opening to cooperation with foreign enterprises. Several high-profile deals, such as the acquisition of Italian IVECO light multirole vehicles and the French Mistral amphibious assault ships, were struck during this period. Imports from foreign suppliers were intended both to stimulate Russian producers by exposing them to greater competition, and also to fill technology gaps where Russian producers were found wanting. However, the conflict in Ukraine and the subsequent imposition of Western sanctions resulted in the severing of ties with Ukrainian enterprises and an embargo on dual-use and arms trade between Western countries and Russia (see Connolly, 2016c).

In response, the Russian government initiated a program of import substitution to ensure that proscribed products, especially those previously produced in Ukraine, could be made in Russia (Naberezhnov, 2014; Mukhin, 2015). Sanctions have only reinforced the apparent preference for self-sufficiency in arms production in Russia. While this may boost Russia’s autonomy and reduce its vulnerability to arms embargoes in the future, it also has the potential to reduce the scope for technological development in the OPK (VPK, 2016a).

Another source of innovation weakness in Russia is the relatively poor state of the wider national system of innovation. Russia inherited a national system of innovation from the Soviet Union that was ill-equipped for generating large-scale innovation in the modern global economy (Cooper, 2010). Innovation in Russia is hampered by a range of structural problems, including a state-dominated R&D system characterised by strong Soviet legacies (Dezhina and Saltykov, 2005), a low share of higher education institutions in R&D activity, aged and under-skilled researchers, a weak governance system that fails to prevent overlapping and top-down implementation strategies by different public entities (OECD 2011, p.16), weak linkages between sectors and regions, and within the science and technology community itself (Gokhberg and Roud, 2012).

Perhaps most importantly, Russia scores exceptionally poorly in measures of competition present within the economy (OECD, 2011). This is of fundamental importance because competition is viewed as a crucial ingredient of productivity growth. Higher levels of competition raise the incentive for enterprises to increase

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investment in capital (human or physical), or to engage in technological or organisational innovation (e.g. Aghion and Bessanova, 2006), either of which can help generate productivity growth. However, large and important sections of the Russian economy are dominated by uncompetitive enterprises that are often protected by either the federal or local government. Moreover, many of the most high-profile attempts in recent years to stimulate high-technology growth have been state-led, which has often exacerbated rather than solved these weaknesses. Efforts to stimulate the nanotechnology industry are a case in point (Connolly, 2013).

Weaknesses in the wider innovation system are of crucial importance to the development of innovation capabilities in the OPK because of the importance of 'spin ins' to defence-industrial innovation (e.g. Mowery and Langlois, 1996; Wong, 2012). In many Western countries, such as the UK and USA, innovation has often flowed from the civilian sector to military industrial production (Avadikyan, Cohendet and Dupouet, 2005). This has been especially prevalent in the last three decades as technologies used in advanced defence products have become increasingly complex. However, Russia does have strengths in certain areas of the knowledge-based economy. The software industry, for instance, has grown rapidly in recent years, with exports from the sector growing faster than in all the other high-tech sectors, at an average annual rate of around 28 per cent since 2003 (Russoft 2014, p.34). By 2014, it was comfortably Russia's second largest knowledge-intensive industry, with export sales greater than the combined value of the nuclear power and aerospace industries.

While there are obvious deficiencies with defence-industrial innovation in Russia, it is not clear that the weaknesses identified here are the sole source of the delays in developing new weapon systems. The sheer complexity of the modern systems being developed has caused many defence enterprises from across the world, not least in the United States and Western Europe, to experience similar difficulties when developing advanced weapons. The problems and delays experienced in the development of the US Seawolf-class attack submarine, the UK's Type-45 destroyer, and the Chinese J-20 fifth generation fighter all illustrate that the development of new weapon systems is an extremely demanding process that affects all defence industries across the world. Russia is no exception.

Industrial organization and control

After enjoying privileged status during the Soviet period, the OPK underwent a period of transformation and restructuring after the disintegration of the Soviet Union, reflecting the wider shift towards a market economy. As military spending by the newly independent Russian Federation was dramatically reduced, procurement and R&D expenditure shrank at an even faster rate. By 1997, the military output of the OPK had declined to a level less than one-tenth of its 1991 level (Cooper, 2013a). The savage reduction in financing for OPK production was accompanied, and exacerbated, by institutional and organizational fragmentation as the production associations and research-production associations that characterized the Soviet OPK were disbanded in anticipation of privatization. It was envisaged that privatization would result in a smaller number of leaner, more efficient enterprises. However, resistance by enterprise directors ensured that only a quarter of OPK enterprises were fully privatized by the end of the 1990s. As a result, the intended efficiency gains were not realized. Instead, by the end of the 1990s, an excessively large number of

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enterprises, many of which were loss-making, continued to characterize the defence industry.

After Vladimir Putin's accession to the Presidency in 2000, and with the resumption of rapid economic growth in the early 2000s, a concerted effort was made to bring order to the OPK. This was essentially focused on merging the numerous enterprises into so-called 'integrated structures' or holding companies. Consolidation, it was hoped, allow vertical management structures to generate greater efficiency and competitiveness to mixed bag of profit- and loss-producing enterprises. As a result, industrial behemoths such as United Aircraft Corporation (encompassing fix-wing aircraft production), United Shipbuilding Corporation (bringing together most of the country's shipyards), and Rostekh (overseeing 13 holding companies and nearly 700 enterprises in both military and civilian production) emerged from this initiative. By the end of 2013, it was estimated that around three-quarters of defence-industrial production took place within these structures (Karavaev, 2013).

However, this state-led restructuring initiative has not to date resulted in the desired outcome. Rather than causing greater efficiency, consolidation in many instances led to the softening of budget constraints for poorly-performing enterprises as the profits from the healthy components of holding structures were used to cross-subsidise the loss-producing components. Moreover, consolidation reduced competition within sub-sectors of the OPK, further suppressing the need for investment, restructuring and innovation at the firm level. Consolidation has also failed to reduce the large number of relatively small enterprises in the OPK, which pushes up costs as state resources are spread thinly across a large number of claimants. Such weaknesses have served to reduce the efficiency of defence procurement under GPV-2020, resulting in less bang for the Russian government's buck.

Conclusion

Russia's progress in modernizing its armed forces with advanced equipment under the GPV-2020 is progressing reasonably well. Although claims that the armed forces are over half way towards the stated objective of modernizing 70% of all equipment may be exaggerated and based on creative accounting, it is clear that considerable progress has been made. As a result, Russia's armed forces are undoubtedly more capable than they were just five years ago, enabling Russia to conduct a much more muscular foreign policy than at any other point since the disintegration of the USSR. While this increase in Russian capabilities is a source of anxiety for some Western observers, it is also possible that a Russia that feels more confident in its conventional capabilities may feel less inclined to emphasize the nuclear component of its military capabilities (Cooper, 2015).[37]

This is not to say that the Russian defence industry is not without its problems. It is clear, for example, that the expansion of public funding under the rearmament programme has not proven sufficient to revitalize the domestic shipbuilding industry that suffered so much over the 1990s. And, like many other countries, difficulties have been encountered in producing advanced weapon systems based on genuinely post-Soviet designs. There are also persistent structural problems across that OPK that

[37] See Oliker (2016) and Kristensen and Norris (2016a) for a discussion of Russian nuclear posture.

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may compromise its capacity to produce genuinely new and advanced weapon systems that are not iterations of Soviet-era systems. These structural problems include ageing human and physical capital in a labor-intensive industry, a need for further consolidation of smaller and numerous enterprises in some sub-sectors of the OPK, a decline in the degree of integration with foreign companies, and an innovation system that may prove unable to compete at the forefront of the defence-industrial technological frontier. The ongoing stagnation of the Russian economy also means that it will be difficult – although not impossible, at least in principle – to maintain the current defence procurement burden. Moreover, if and when defence procurement moderates, it is not clear that the OPK will be well-equipped to produce civilian products instead.[38]

Notwithstanding these problems, the quantity and quality of the new equipment delivered to the Russian armed forces since 2011 is impressive. Apart from the United States, it is difficult to see any other country being able to produce such a wide array of weapon systems – ranging from ICBMs and nuclear-powered attack submarines to corvettes and APCs – using largely indigenous capabilities. When Russia's position as the world's second largest producer of armaments is also taken into account, it is clear that for all its weaknesses, the Russian defence industry is now second only to that of the United States in its ability to produce large quantities of relatively high-quality weapon systems across the full spectrum of defence-industrial products.

Finally, it is also worth considering that although Russia may not yet be able to produce the types of advanced weaponry produced by the United States, its current productive capabilities do mean that it has an independent defence-industrial base that can produce weaponry that is of sufficient quality to support the Russian state in its pursuit of its strategic objectives, such as dominance of Russia's 'near abroad', an ability to engage in expeditionary warfare beyond Russia's immediate borders, and deterrence of other larger potential adversaries (e.g. NATO, China).[39] In this respect, the performance of the OPK during the GPV-2020 can be viewed as good enough to serve Russia's wider strategic purposes and, as a result, to have been successful.

[38] The President stated that the resources for procurement will peak in 2017 and that thereafter OPK enterprises should be capable of switching to civilian production (Lenta VPK, 2016).
[39] This point is made in greater detail by Renz (2015).

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