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Gone to war: have deployments increased divorces?

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Abstract Owing to the armed conflicts in Iraq and Afghanistan, members of the US military have experienced very high rates of deployment overseas. Because military personnel have little to no control over their deployments, the military setting offers a unique opportunity to study the causal effect of major disruptions on marital dissolution. In this paper, we use longitudinal individual-level administrative data from 1999 to 2008 and find that an additional month in deployment increases the divorce hazard of military families, with females being more affected. A standard conceptual framework of marital formation and dissolution predicts a differential effect of these types of shocks depending on the degree to which they are anticipated when a couple gets married. Consistent with this prediction, we find a larger effect for couples married before 9/11, who clearly expected a lower risk of deployment than what they faced post 9/11.

Keywords Divorce · Work-related absences · Unanticipated deployment shocks

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1 Introduction

The US national security environment changed dramatically after 9/11. The frequency, length, and dangers of deployments increased in comparison to the pre-9/11 period. This paper measures the impact of US military operations on the marital stability of military families, with a focus on the post 9/11 period. It considers the effect of post 9/11 deployments on marriages formed after 9/11, as well as their effect on marriages formed before 9/11 and for which the large post 9/11 increase in deployments may have come as a surprise relative to expectations at wedding time. The study contributes information about the effect of deployment on marital stability and provides new estimates of the effect of surprises on marital stability.

Theory predicts that the expected gains from marriage motivate marriage formation, while ex post unanticipated shocks can alter the couple's actual gains from marriage and may cause divorce (Becker 1973, 1974; Becker et al. 1977). This is difficult to test because conventional datasets rarely offer exogenous shocks that could lead to marital dissolution. Empirical studies on this question focus on changes in income (Becker et al. 1977; Weiss and Willis 1997), deployments, viewed as work-related absences (Angrist and Johnson 2000), and job displacements and disability (Charles and Stephens 2004; Doiron and Mendolia 2012) to estimate their impact on the divorce hazard. However, some of these papers do not use explicit measures of shocks, while, in others, the "surprise" is not entirely unanticipated for some population groups. We use longitudinal individual data from military administrative sources and exploit the unanticipated shock of 9/11 as well as other sources of exogenous variation to identify the effects of deployment on the divorce probability of military families.

A deployment represents the movement of an individual service member or a military unit to an overseas location to accomplish a task or mission. Such overseas missions include routine training as well as participation in armed conflicts. More than 2.1 million US troops have been deployed to Iraq and Afghanistan since 9/11. Hosek and Martorell (2009) show that by the end of 2007, service members deployed to such hostile areas were away 1 in 3 years of service, with many experiencing more than one deployment. Longer and more dangerous deployments likely pose increased challenges to military families. Tanielian and Jaycox (2008) find that the incidence of symptoms of post traumatic stress disorder (PTSD) and depression after deployment was as high as 20 %, while Cesur et al. (2013) identify a strong causal effect of combat exposure on mental health problems. Family separation, day-to-day stress from limited information and inability to help from a distance, as well as consequences such as injury and PTSD, may ultimately increase the rate of marital dissolution.

Military families can form prior expectations about the deployment experience and, based on those expectations, can take precautionary measures to lessen or cope with adverse consequences. But just as the attacks of 9/11 were not anticipated, the ensuing change in the type and number of post 9/11 deployments was a major unanticipated shock. This unique source of variation represents a structural shift away from the previously anticipated deployment regime and provides an opportunity to identify the effect of a regime change on the stability of military families.

Moreover, our identification strategy yields valid estimates of the effect of deployments even apart from the post 9/11 shock. This is because, although families can anticipate a certain number and type of deployments, the actual realization of deployments is outside of the family's control; the military service, not the service member, determines whether and when the service member is deployed and for how long. The military service also determines the location of the deployment as well as other deployment-specific conditions (Hosek et al. 2006; Lyle 2006; Engel et al. 2010). As a result, to the extent that the actual deployment experience is different from what the couple previously anticipated, the family's marital stability is affected. This is the same as the marital shocks in Becker's theory of divorce.

Not all service members deploy at the same time, and the difference in timing of deployment provides valuable variation in "treatment". We estimate that among families formed before 9/11, those who experienced a post 9/11 deployment of 12 months had a 28 % higher divorce probability after 3 years of marriage than families who experienced a 12-month deployment before 9/11. In general, we find that cumulative months of prior deployment increases the divorce hazard of military families, regardless of the period when the family formed or the period when the deployment occurred. When we distinguish by type of deployment, we find that, in some periods, the effect is stronger for hostile deployments relative to nonhostile deployments. Also, compared to males, female service members are always more likely to divorce as a result of time in deployment. This differential effect by gender is in line with the findings of Angrist and Johnson (2000) who use cross-sectional survey data from the first Gulf War period and find that deployments increase the divorce rates of female service members, but have virtually no effect on those of males.[1]

2 Conceptual framework

The conceptual framework that guides our interpretation of the family's response to deployment shocks is based on the theory developed by Becker (1973, 1974) and Becker et al. (1977), according to which the probability of marital dissolution increases when unanticipated shocks decrease the spouses' expected gains from marriage. If the ex post realization of an event experienced by the family is consistent with the couple's expectations from the time of marriage, the marital gains remain unchanged, and the couple's marital stability is unaffected. But if the event is unanticipated and negative, the gains from marriage decline, and the probability of divorce increases. We consider the randomness of deployments, the heterogeneity of

[1] Karney and Crown (2007) find that time spent in deployment decreased the probability of divorce among military families, concluding that military couples are resilient and that the benefits deployed service members receive might have compensated for the negative aspects of deployment for both spouses. However, their time frame is limited, as they only focus on individuals who entered the military between 2002 and 2005, married and deployed while married. Given that over this period the average time between military enlistment and first marriage was about 2 years, and deployments were about a year in many cases, the time over which service members are at the risk of divorce may be too short for the estimation of a deployment effect.

the deployment experience, and the unanticipated change in the nature of post 9/11 deployments to identify the effect of deployment shocks on marital stability.

The length, conditions, and risks of the deployment are sources of shocks to the value of military marriages (Hosek et al. 2006). If deployments are longer and more dangerous than expected, the revision is likely to be downward, increasing the probability of divorce. Furthermore, the downward revision is likely to be greater if the new regime of deployments is expected to persist.[2]

As mentioned, deployments create stress within the family and create serious health consequences. In addition, military spouses take on increased household responsibilities, allocating more time to family finances, housework, and child care (Savych 2008), and their children may become anxious or have emotional or behavioral issues (Chandra et al. 2011). Savych (2008) finds that, more recently, military spouses have had lower civilian labor force participation before, during, and soon after the deployment of their spouse. Castro (2008) documents a substantial decline in self-reported marital satisfaction among those who have returned from Iraq deployments.

Conversely, positive aspects of deployments might increase the marital surplus. By applying skills acquired in training, service members may have a fulfilled sense of duty (Hattiangadi et al. 2004; Hosek et al. 2006), which nonetheless tends to dissipate as deployment time increases (Hosek et al. 2006). Deployment-related pays, which increase pre-tax earnings by $800 to $1,000 a month, can help to compensate for the intangible negatives of deployment and for costs such as more purchased meals and child care. Angrist and Johnson (2000) note that family income remained constant during the First Gulf War deployments as deployment-related pay offset a drop in military spouses' labor force participation and hours worked. Appendix A in the Electronic Supplementary Material (ESM) develops a formal matching model of the formation and dissolution of military families and the role of deployments.

3 Empirical strategy

An important assumption relevant to identifying the effect of deployments on marital turnover is the exogeneity of deployments. Over our period of analysis, individual deployments in the active components were strongly tied to unit deployments, and unit deployments were not related to the preferences for deployment of individual unit members. Within a service and controlling for occupational specialty, deployment depends on higher-level decisions regarding which unit to deploy and when. It is the military service, not the service member, who determines whether a service member is deployed and for how long. Other studies have shown that unit deployment decisions are made at the division or brigade level (Lyle 2006; Savych 2008;

[2]It may be the case that when the gains of the military couple decrease, service members leave the military and become civilians in order to avoid divorce. We do not model explicitly this possibility. However, we find empirical evidence to the contrary, that is, individuals who reenlist in the military are more stable than the overall population of enlistees (see Section 6 and Appendix B in the ESM).

Engel et al. 2010).[3] Also, Cesur et al. (2013) use the randomness in deployment assignments to identify the mental health effects of combat experiences.

Theory predicts a differential effect of deployments depending on the degree to which they are anticipated when a couple gets married. In our analysis, the change in the nature of post 9/11 deployments was an unanticipated shock to couples formed before 9/11. In contrast, couples formed after 9/11 might have anticipated that deployments would be more frequent and more dangerous than those before 9/11, but for all couples, the realization of deployments was exogenous to the individual service member and family.

We specify a discrete hazard model in which the divorce hazard is a function of cumulative time deployed measured in quarters and other fixed and time-varying variables.[4] Some individuals have multiple deployments, and the hazard model evaluates the impact on the divorce hazard in period t of deployment time accumulated up to period t. If the service member is deployed again after t, cumulative time deployed is updated to include that deployment time. This approach (a) controls for the underlying change in the couples' risk of dissolution with time in marriage (Bergstrom 1997) and (b) deals naturally with the censoring induced by marriages that are intact at the end of the observation period.

The divorce hazard in quarter t, $D_{i,t}$, is a function of time spent by member i in deployment up to quarter t, $\text{Depl}_{i,t}$; the number of months member i was married up to time t, $M_{i,t}$; calendar quarter dummies, Q_t, and other observed characteristics, X_t, are described as follows:

$$\begin{aligned} D_{i,t} \;=\; & \gamma_1 \text{Depl}_{i,t} + \gamma_2 \text{Depl}_{\text{Post911}_{i,t}} + \gamma_3 m_{\text{Post911}} \cdot \text{Depl}_{\text{Post911}_{i,t}} \\ & + \gamma_4 m_{\text{Post911}} + \tau M_{i,t} + X_t'\beta + Q_t'\delta + \varepsilon_{i,t} \end{aligned} \tag{1}$$

The variable $\text{Depl}_{\text{Post911}_{i,t}}$ represents the cumulative deployment time up to period t, starting after 9/11. Inclusion of this term in Eq. (1) allows for the identification of a differential post 9/11 deployment effect on the divorce hazard, in addition to the "baseline" effect of pre 9/11 deployments. We also include squared terms for $\text{Depl}_{i,t}$ and $\text{Depl}_{\text{Post911}_{i,t}}$ for possible nonlinearity in their effect.

To test whether the effect of post 9/11 deployments differs by whether the marriage formed before or after 9/11, we include an interaction term between cumulative time deployed after 9/11, $\text{Depl}_{\text{Post911}_{i,t}}$, and an indicator of whether the marriage formed after 9/11, m_{Post911}. We also include the m_{Post911} indicator separately to control for the effect of factors other than deployments on the divorce hazard of couples married after 9/11. In this specification, the coefficients on $\text{Depl}_{\text{Post911}_{i,t}}$ and its squared term measure the additional effect of post 9/11 deployment shocks on the divorce risk of military couples formed before 9/11, relative to the effect of pre-9/11 deployments. Finally, γ_3 measures the differential effect of post 9/11 deployments on families formed after 9/11, relative to families formed before 9/11.

[3] Using unit deployment as an instrument for individual deployment, Lyle (2006) and Savych (2008) conduct a Hausman test, which rejects the hypothesis that the individual-level deployment is not orthogonal to the error.

[4] An extensive treatment of this framework is provided by Singer and Willett (1993) and Willett and Singer (1995).

The marriage duration variable, $M_{i,t}$, is a running count of months married up to quarter t. Inclusion of the square of $M_{i,t}$ allows for a potentially concave relationship between marriage duration and the divorce hazard. The quarter dummies Q_t represent period baselines for the divorce hazard and account for time-varying unobserved factors such as variation in national-level military family policies and possible seasonal patterns in divorces.

If higher aptitude individuals are better at problem solving, they may have a lower likelihood of divorce (Holley et al. 2006). To capture the stabilizing effect of ability and higher education on marriage, the model includes Armed Forces Qualification Test scores and indicators for education level at the time of enlistment. To control for differences in the timing of divorces in the post-deployment period, we include linear and quadratic terms of the time elapsed between the end of the last deployment and the current quarter. We also include age at marriage, current age and age squared, an interaction between cumulative time deployed and age, and a dummy for whether both spouses are military service members (i.e., the couple is "dual"). A variant of Eq. (1) interacts the dual indicator with the deployment variables.

In addition to their direct effect, the tenure, rank and occupation variables are highly predictive of military pay and therefore we control for their effect on the divorce hazard. The military occupation variables were constructed as one-digit occupational codes (Department of Defense 1997) for infantry, gun crews, and seamanship; electronic equipment repairers; communication and intelligence; medical and dental specialists; other technical and allied specialists; functional support and administration; electrical/mechanical equipment repairers; craftsmen; service and supply handlers; and unknown. Finally, there are indicators for branch of service (i.e., Army, Navy, Air Force, and Marine Corps).

4 Data overview

The Defense Manpower Data Center's Proxy Perstempo (personnel tempo) file is the main source of data. This longitudinal file, updated quarterly, has individual-level records on active-duty service members including information on time deployed, military occupation, education, pay grade, and AFQT score category. Information for both hostile and nonhostile deployments is inferred from administrative pay records. The Defense Enrollment Eligibility Reporting System (DEERS), a database of military service members and their families, has information on the marital status of service members.[5] We include all military personnel who entered military service and married in the military between March 1999 and June 2008.[6] We observe each indi-

[5] All military members have strong incentives to update their family status in DEERS online or in paper form, as their updated status determines the conditions under which they have access to military health care (TRICARE) and other military family benefits.

[6] To ensure that we include only couples that could form expectations regarding military service at the time of marriage formation, we exclude individuals already married at the time of enlistment.

vidual's entire history of deployments after their first marriage. The sample includes 462,444 enlisted service members.

Figure 1 shows the incidence of deployments over our time frame, calculated as the percentage of active-duty personnel deployed at some time in a year relative to the total number of enlisted personnel serving in that year. Hostile deployments are determined via the receipt of "hostile fire/imminent danger pay," which is paid in combat zones such as Iraq and Afghanistan.[7]

The incidence of deployments is relatively low through 2001, but increases from 2002 onward. In 2003, the year of engagement with Saddam Hussein's forces in Iraq, it is 50.4 %, up from its pre-9/11 value of 35 %. It reaches new maxima in more recent years. The incidence of hostile deployments was very low before 9/11 and much higher afterwards, providing clear evidence that military families were exposed to a much higher level of dangerous deployments after 9/11.

Figure 1 also displays the annual divorce rate among enlisted personnel (the number of divorces in a given year relative to the number of intact marriages at the start of the year). This rate decreased from 3.1 in 2000 to 2.7 % in 2001, but then increased to 3.5 % in 2002 as deployments became more frequent and dangerous. The pace of deployments is highest between 2003 and 2007; however, the annual divorce rate is relatively constant over this period. Perhaps this is because couples selecting into marriage after 9/11 form accurate expectations of the high pace of deployment they will face, and because some couples married before 9/11 and surprised by the higher expected pace of deployment have already divorced by 2003 or 2004.

Table 1 provides descriptive statistics of the sample. The distribution by military service mirrors the actual profile of the armed forces, with the highest fraction of service members being concentrated in the Army and the Navy.

The average cumulative time deployed, calculated as the mean of individual means over the observation period, is about 4 months. The average of "months deployed at exit," which represents the total months of deployment as of the individual's last period in the sample, is about 8 months. The average of time deployed after 9/11 is comparable at 3.65 months, while the corresponding at-exit measure is 7.63 months (not shown in the table). The average number of years in military service, calculated as the mean of individual averages over the entire time frame, is about 4 years, while the average number of years married in our data is about 2 years. The at-exit time in service and the at-exit married time are 6 and 3.5 years, respectively.

Consistent with findings by Angrist and Johnson (2000), most divorces in our data (97 %) occur after a return from deployment, and very few occur during a

[7]The list of hostile-fire pay areas as of March 2008 included Afghanistan, Algeria, certain areas of the Arabian Peninsula and adjacent sea areas, Azerbaijan, Bahrain, Burundi, Chad, Colombia, Cote d'Ivoire, Cuba (Guantanamo), Democratic Republic of Congo, Djibouti, East Timor, Egypt, Eritrea, Ethiopia, certain areas of Greece, Haiti, Indonesia, Iran, Iraq, Israel, Jordan, Kenya, Kosovo, Kuwait, Kyrgyzstan, Lebanon, Liberia, Malaysia, Montenegro, Oman, Pakistan, Philippines, Qatar, Rwanda, Saudi Arabia, Serbia, Somalia, Sudan, Syria, Tajikistan, certain areas of Turkey, Uganda, United Arab Emirates, Uzbekistan, and Yemen (Office of the Under Secretary of Defense [Comptroller] (2009), cited in Hosek and Martorell, 2009).

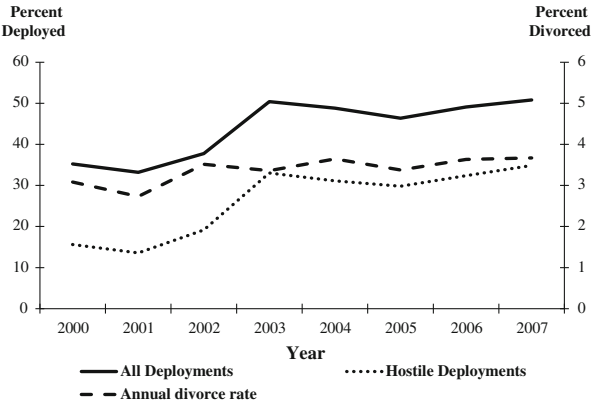

Fig. 1 Incidence of deployments and annual divorce rates

deployment. We therefore exclude from estimation the observations corresponding to quarters when the service member is deployed.[8] The fraction of enlisted personnel that divorce over the observation period is 6.8 %. This fraction is calculated as the ratio between the total number of first-marriage divorces recorded in our sample among the enlisted (31,587) and the total number of individuals in the sample (462,444 service members). Female service members divorce at a higher rate—12.8 %.

The fraction of married enlisted personnel deployed at any time in our time frame is 82 %. The second column of Table 1 provides an overview of the subsample of service members that married between 1999 and September 2001. Marriage duration and overall time in deployment are longer within this subsample than in the overall sample, as the observation period for those cohorts is longer. The fraction of divorcees, 15.3 %, is much higher than in the main sample, 6.8 %. We will test whether this results in part from a higher hazard of divorce from post versus pre-9/11 deployments.

In Table 2, we break down the summary statistics from Table 1 by gender. Females and males have similar characteristics in terms of educational attainment and age at first marriage, but tend to differ by racial composition. Females are less likely to deploy, accumulate less time in deployments, and spend more time in service outside deployments.

5 Effect of deployments on marital stability

We present our main estimated coefficients in Table 3. The first column shows the overall impact of deployments (in log odds) on the divorce hazard, regardless of when the deployments occurred or the marriage formed. The next column splits the

[8] As a result, we also exclude those individuals for whom all available observations correspond to deployment time. This is particularly the case for more recent entrants.

Table 1 Means of the main covariates

	Full sample	Married before 9/11	Married after 9/11
Female	0.20	0.20	0.20
Age at first marriage	22.05	21.27	22.20
High school	0.93	0.92	0.94
Some college	0.03	0.04	0.03
College	0.02	0.02	0.02
White	0.61	0.59	0.61
Black	0.17	0.18	0.17
Hispanic	0.10	0.12	0.10
Army	0.29	0.28	0.29
Navy	0.28	0.25	0.29
Air Force	0.27	0.30	0.26
Marine Corps	0.16	0.17	0.16
Years in Military	4.02	3.68	4.08
Years married	1.75	2.70	1.57
Deployed	0.82	0.84	0.82
Months deployed	3.88	5.03	3.67
Months deployed - hostile	2.01	2.03	2.00
Months deployed (at exit)	7.89	10.88	7.32
Months deployed hostile (at exit)	4.57	5.42	4.41
Months since last deployment	17.55	23.02	16.52
Number	462,444	40,041	422,403

The numbers in the above table are averages of means across individual longitudinal observations

overall deployment effect by deployment period. The impact of pre-9/11 deployments remains positive and strongly significant (γ_1) and, as hypothesized, post 9/11 deployments increase the divorce hazard relative to pre-9/11 deployments (γ_2). The increase in the effect of deployment on divorce after 9/11 versus before 9/11 for couples married before 9/11 suggests that the nature of deployments had become more adverse—more wearing on their relationship—than expected when they formed their union. Breaking down the effect of post 9/11 deployments by time of marriage formation (column 3), we find that couples married after 9/11 have a slight decrease in the divorce hazard relative to those married before 9/11, as shown by the estimate of γ_3. However, when we include the "married post 911" dummy in column 4, this difference in the effect of deployment on divorce becomes zero. Finding the same effect of post 9/11 deployments on divorce for couples married before 9/11 as for couples married after 9/11 suggests that the couples perceived and were affected by post 9/11 deployments similarly. Nonetheless, the coefficient on the "married post 911" dummy, γ_4, indicates that couples married after 9/11 are selected by unobserved characteristics that in turn decrease their divorce hazard.

Finally, column 5 presents our preferred model, which allows us to distinguish the deployment effects of dual couples from the deployment effects on nondual couples.

Table 2 Means of the main covariates by gender

	Females			Males		
	All	Married pre 9/11	Married post 9/11	All	Married pre 9/11	Married post 9/11
Age at first marriage	21.47	20.78	21.6	22.2	21.39	22.35
High school	0.93	0.92	0.93	0.94	0.93	0.94
Some college	0.04	0.05	0.04	0.02	0.03	0.02
College	0.03	0.02	0.03	0.02	0.02	0.02
White	0.54	0.54	0.53	0.62	0.60	0.63
Black	0.23	0.24	0.23	0.16	0.16	0.15
Hispanic	0.10	0.11	0.10	0.10	0.12	0.10
Army	0.28	0.3	0.28	0.29	0.28	0.29
Navy	0.27	0.22	0.28	0.28	0.26	0.29
Air Force	0.37	0.41	0.36	0.24	0.27	0.24
Marine Corps	0.08	0.08	0.08	0.18	0.19	0.18
Years in Military	3.73	3.41	3.79	4.09	3.75	4.16
Years married	1.61	2.30	1.47	1.79	2.81	1.60
Deployed	0.65	0.66	0.65	0.87	0.88	0.87
Months deployed	1.85	2.15	1.79	4.39	5.77	4.13
Months deployed – hostile	0.95	0.89	0.96	2.27	2.32	2.26
Months deployed (at exit)	4.06	5.30	3.83	8.84	12.30	8.19
Months deployed – hostile (at exit)	2.34	2.67	2.28	5.08	6.12	4.94
Months since last deployment	15.60	20.31	14.70	12.56	16.50	11.82
Number	86,164	8,936	77,278	376,264	31,092	345,172

The effect of deployments on dual couples is higher than on nondual couples, but it does not vary by time of marriage or period when deployment occurs. The estimated effect for dual couples in each period and time of marriage formation is obtained by combining the main coefficients on the deployment variables with the coefficients on the interaction terms between the dual dummy and the deployment variables.

Table 4 presents coefficient estimates for female and male subsamples for the majority of variables included in the models. The effect of deployments is higher for females throughout the entire period, and, for both genders, the differential impact of post 9/11 deployments is positive and significant.[9]

[9]We also estimated full sample models in which we interacted the deployment time variables with a female dummy variable. The predicted divorce hazards and cumulative divorce hazards that we generated for males and females using the estimates from this model are very similar to the ones presented in Fig. 5 below.

Table 3 Building of the empirical model

	(1)	(2)	(3)	(4)	(5)
Months deployed (γ_1)	0.065** (0.008)	0.046** (0.011)	0.047** (0.011)	0.035** (0.011)	0.022* (0.011)
Months deployed post 9/11 (γ_2)		0.022** (0.008)	0.026** (0.008)	0.031** (0.008)	0.039** (0.009)
Months deployed post 9/11 × Marr post 9/11 (γ_3)			−0.006**(0.002)	0.004 (0.003)	0.003 (0.003)
Months deployed squared	−0.001**(0.000)	0.000* (0.000)	0.000 (0.000)	0.001* (0.000)	0.001** (0.000)
Months deployed post 9/11 squared		−0.001**(0.000)	−0.001**(0.000)	−0.001**(0.000)	−0.001**(0.000)
Married post 9/11 (γ_4)				−0.183**(0.028)	−0.181**(0.028)
Dual	0.516** (0.015)	0.516**(0.015)	0.516** (0.015)	0.519** (0.015)	0.475** (0.018)
Months deployed × dual					0.040** (0.010)
Months deployed post 9/11 × dual					−0.034**(0.012)
Months deployed post 9/11 × Marr post × dual					0.001 (0.004)
Observations	3,212,298	3,212,298	3,212,298	3,212,298	3,212,298

All models include the set of controls described in Section 3. Clustered standard errors (by individual identifier) in parentheses

*$p < 0.05$; **$p < 0.01$

Table 4 Deployment effects on the divorce hazard, by gender

	All couples	Females	Males
Months deployed	0.022**	0.043*	0.026**
	(0.011)	(0.024)	(0.013)
Months deployed post 9/11	0.039***	0.060***	0.027***
	(0.009)	(0.021)	(0.010)
Months deployed post 9/11	0.003	0.011	0.005
× Marr post 9/11	(0.003)	(0.008)	(0.003)
Months deployed squared	0.001***	0.000	0.001**
	(0.000)	(0.001)	(0.000)
Months deployed	−0.001***	−0.003***	−0.001***
post 9/11 squared	(0.000)	(0.001)	(0.000)
Married post 9/11	−0.181***	−0.126***	−0.206***
	(0.028)	(0.042)	(0.037)
Dual	0.475***	0.047*	0.861***
	(0.018)	(0.026)	(0.021)
Months deployed × dual	0.040***	0.032*	0.016
	(0.010)	(0.019)	(0.013)
Months deployed	−0.034***	−0.036	−0.023
post 9/11 × dual	(0.012)	(0.023)	(0.015)
Months deployed post 9/11	0.001	−0.011	−0.004
× Marr post 9/11 × dual	(0.004)	(0.009)	(0.005)
Female	0.608***	–	–
	(0.017)		
Black	−0.124***	0.217***	−0.121***
	(0.016)	(0.026)	(0.021)
Hispanic	−0.110***	−0.098***	−0.132***
	(0.020)	(0.033)	(0.025)
Age at first marriage	−0.229***	−0.098***	−0.290***
	(0.014)	(0.023)	(0.017)
Age	0.149***	0.010	0.222***
	(0.025)	(0.045)	(0.032)
Age squared	0.001***	0.001*	0.001**
	(0.000)	(0.001)	(0.001)
Months deployed × age	−0.001***	−0.002**	−0.001***
	(0.000)	(0.001)	(0.000)
High school dropout	−0.022	0.246**	−0.079
	(0.054)	(0.115)	(0.062)
Some college	−0.144***	−0.153***	−0.115**
	(0.034)	(0.052)	(0.045)
College	−0.197***	−0.240***	−0.178***
	(0.048)	(0.076)	(0.063)

Table 4 (continued)

	All couples	Females	Males
AFQT Cat I	−0.011	−0.128**	0.010
	(0.031)	(0.064)	(0.036)
AFQT Cat III	0.007	−0.023	0.030*
	(0.013)	(0.023)	(0.016)
AFQT Cat IV	0.097	0.114	0.123*
	(0.064)	(0.127)	(0.074)
Time in marriage (quarters)	0.198***	0.300***	0.153***
	(0.006)	(0.011)	(0.007)
Time in marriage squared	−0.008***	−0.010***	−0.007***
	(0.000)	(0.000)	(0.000)
Time since last deployment (quarters)	0.026***	−0.011	0.042***
	(0.005)	(0.008)	(0.006)
Time since last deployment squared	−0.002***	−0.000	−0.002***
	(0.000)	(0.000)	(0.000)
Time in service (months)	−0.002***	−0.007***	0.000
	(0.000)	(0.001)	(0.001)
Rank E1 to E3	0.008	0.059*	−0.036
	(0.019)	(0.030)	(0.024)
Rank E5	−0.051***	0.050*	−0.083***
	(0.016)	(0.028)	(0.019)
Rank E6	−0.064*	0.185**	−0.127***
	(0.035)	(0.073)	(0.040)
Rank E7 to E9	0.176	0.796**	−0.046
	(0.196)	(0.382)	(0.234)
Infantry	−0.148***	0.023	−0.175***
	(0.022)	(0.045)	(0.027)
Electronic	−0.057**	−0.009	−0.085***
	(0.024)	(0.044)	(0.030)
Communications and Intelligence	−0.086***	−0.049	−0.127***
	(0.023)	(0.035)	(0.031)
Medical and dental	−0.079***	−0.063**	−0.065*
	(0.023)	(0.031)	(0.035)
Other technical	−0.081**	−0.061	−0.128***
	(0.036)	(0.057)	(0.046)
Mechanical equipment	−0.084***	0.054	−0.132***
	(0.019)	(0.035)	(0.024)
Craftsmen	−0.059*	0.001	−0.104***
	(0.033)	(0.072)	(0.039)
Services and supply	−0.034	−0.021	−0.068**
	(0.023)	(0.035)	(0.030)

Table 4 (continued)

Unknown	−0.116**	−0.306***	−0.049
	(0.053)	(0.095)	(0.064)
Navy	−0.019	−0.162***	0.045**
	(0.017)	(0.030)	(0.021)
Air Force	0.156***	0.086***	0.168***
	(0.017)	(0.027)	(0.022)
Marine Corps	−0.038*	−0.036	0.016
	(0.020)	(0.040)	(0.023)
Observations	3,212,298	639,609	2,572,409

Clustered standard errors (by individual identifier) are in parentheses. For race, education, AFQT score, rank, occupation, and service, the excluded categories are, in order, as follows: white, high school diploma, category II, E4, administration, and Army. The AFQT scores range from 0 to 100 and are grouped in category I (scores above 93), category II (scores 65 to 92), category III (scores 31 to 64), category IV (scores 10 to 15), and category V (score 0 to 9)

$^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$

In line with previous work (e.g., Weiss and Willis 1997), estimates in Table 4 indicate that marital stability increases with spouses' education and age at marriage. Also, the risk of divorce is lower for Black and Hispanic couples.[10] The risk of divorce increases steeply in the first years of marriage, but declines in later years, as indicated by the negative sign on marriage duration squared. A longer tenure in the military decreases the divorce hazard, which may indicate the development of skills to cope with the stress of deployment and the selective retention of those less stressed and those more adept at coping.[11]

Following Greene (2010), we put the magnitude of our estimates in context and provide an interpretation of our results by building divorce hazard and cumulative divorce hazard predictions for various deployment lengths and family cohorts. We start in Fig. 2 with families formed before 9/11 that experience post 9/11 deployments and plot the predicted (quarterly) divorce hazard for different deployment durations in the first 5 years of marriage. Since the predictions in Fig. 2 are plotted against time married, each point on the divorce hazard profiles is calculated for successive values

[10] Given that marriage markets are largely confined to one's race (e.g., Qian 1997, 1998), and that marriage and divorce patterns may therefore vary by race, we also estimate our main empirical specification on subsamples of Whites, Blacks, and Hispanics, respectively (estimates not reported). Over our time frame, we find no differential pattern in the effect of deployment shocks by race.

[11] We investigated whether our main deployment effects are robust to alternative measures of tenure and rank in the military. This is a valid concern, because tenure and rank variables may subsume some of the impacts of deployments. Using tenure and rank at the time of marriage generates the same estimates as in Tables 3 and 4. Finally, the positive sign on the variable measuring time elapsed since last deployment and the negative sign on its squared term indicate that divorce is more likely to occur sooner after a return from deployment than later.

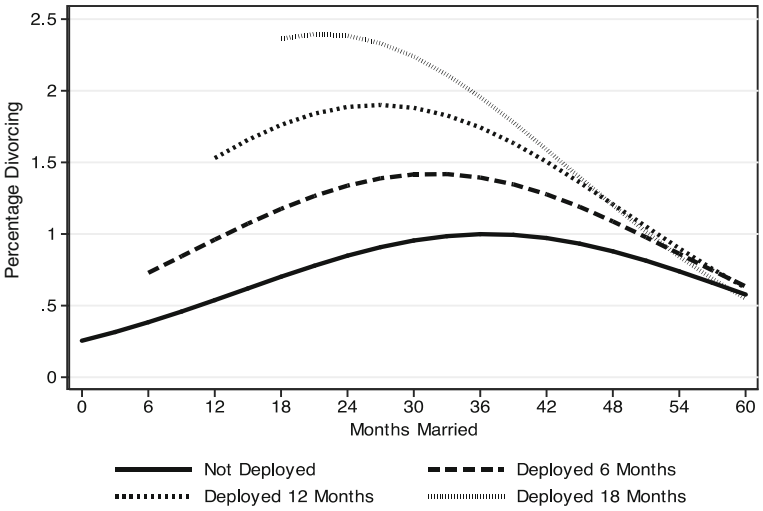

Fig. 2 Predicted divorce hazard by time deployed after 9/11 for families formed before 9/11

of time married and time elapsed since last deployment, at the means of the data for all other covariates.[12]

In Fig. 2, the divorce hazard of nondeploying individuals increases from 0.3 % to about 1.0 % in the first 3 years of marriage and then declines to 0.5 % by the fifth year of marriage.[13] For married couples that experienced a 6-month deployment, by the end of the second year in marriage, the predicted divorce hazard is 1.4 %, or 58 % higher than that of nondeployers. Longer-duration deployments further increase the divorce hazard across all values of time in marriage. Before reaching 2 years of marriage, an individual returning from a 12-month deployment faces a divorce hazard between 1.5 and 1.8 % in each post-deployment quarter, while a service member returning from an 18-month deployment faces an even higher risk of divorce (above 2 %) in the post-deployment periods.

Using the information from Fig. 2, we plot in Fig. 3 the cumulative divorce hazard, which represents the probability of getting divorced between the date of the union and the current period t.[14] The predicted divorce probability after 3 years in marriage of

[12]The divorce hazard, also known as the "instantaneous" divorce probability, is defined as the probability of a couple to get divorced in the current period conditional on not having divorced in any of the previous periods.

[13]In order to offer a simple comparison across the divorce hazards of nondeploying individuals and individuals deploying for various durations, for Fig. 2, we assume that the deployment episode starts immediately after the service member gets married. We nevertheless experimented with other scenarios, in which individuals deploy some time later in their marriage. For the same value of time married and deployment duration, the postdeployment divorce hazard of an individual deploying later in marriage is very similar to the postdeployment divorce hazard of somebody who deploys immediately after marriage.

[14]The cumulative divorce hazard is calculated using the following formula: $H_t = 1 - \prod_{s=1}^{t} (1 - h_s)$, where h_s represents the divorce hazard in period s after marriage. As all predicted divorce hazards shown in Fig. 2 have a concave profile, the cumulative divorce hazards have higher growth rates in the first few post-deployment periods and lower growth rates over the time married when the divorce hazard declines.

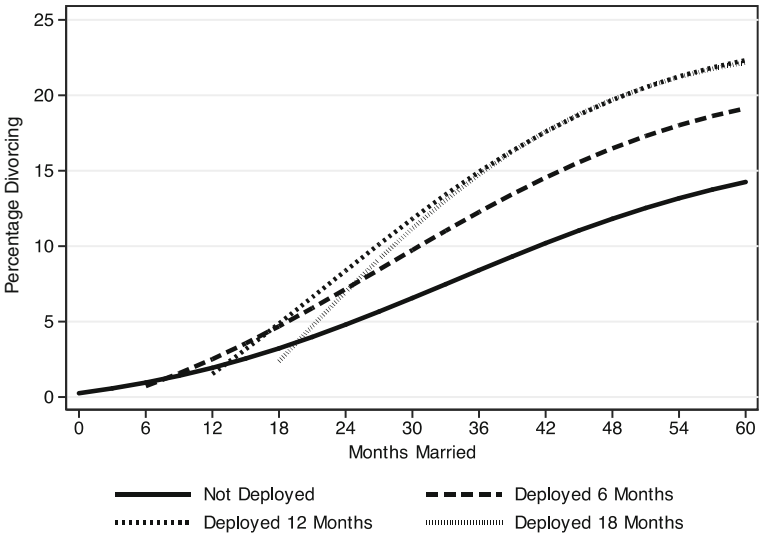

Fig. 3 Predicted cumulative divorce hazard by time deployed after 9/11 for families formed before 9/11

individuals who never deploy is 8.4 %. In contrast, for service members who deploy for 6 months in their first 3 years of marriage, the predicted divorce probability is 12.4 %, 46 % higher than the divorce probability of non-deployers.

Figure 4 shows the divorce probability for a service member who married before 9/11 and deployed 12 months before 9/11 (solid line) and the corresponding profile for a post 9/11 deployment of 12 months (dashed line). The predicted divorce probability after 3 years in marriage and a 12-month post 9/11 deployment is 14.9 %, or about 28 % higher than the divorce probability of a service member who married before 9/11 and deployed 12 months before 9/11 (11.6 %).[15]

Also in Fig. 4, the predicted divorce probability after 3 years of marriage for a service member married after 9/11 (13.1 %) is lower than that of a service member who married before 9/11 and experienced a post 9/11 deployment (14.9 %). As mentioned, we interpret this finding as evidence of selection, as couples who married after 9/11 have a significantly lower divorce probability than couples married before 9/11 who experience post 9/11 deployments.

To further explore the gender differences in Table 4, we plot in Fig. 5 the predicted divorce probability by time in marriage of nondeploying males and females who married before 9/11, along with the predicted divorce probability of males and females who married before 9/11 and deployed 6 months after 9/11. The cumulative divorce hazard after 3 years in marriage for nondeploying males (7.3 %) is much lower than that of nondeploying females (16.8 %). This indicates that the underlying conditions leading to divorce are radically different in families where the military

[15] All predictions presented in this paper are generated for nondual couples.

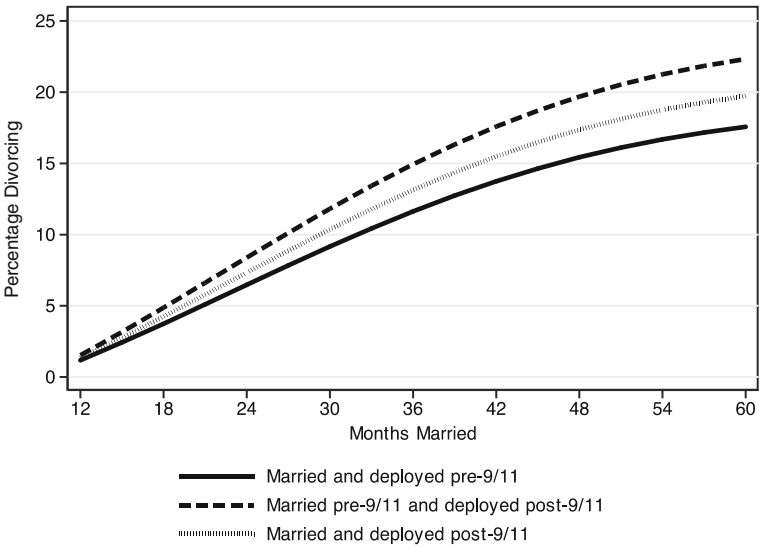

Fig. 4 Predicted cumulative divorce hazard after a 12-month deployment by time of marriage formation

member is the wife. Regarding the large difference in the deployment effects by gender, one explanation may be that couples of military women expect at the time of marriage a lower probability of deployment and form different expectations regarding the deployment experience, given that, historically, the role of women in the military has been different from that of males.[16,17]

6 Additional results and robustness checks

Table 5 compares the effect of nonhostile and hostile deployments. These predictions are generated from a regression model that includes variables for both types of deployment time. Before 9/11, we observe an important difference between the divorce probabilities associated with hostile and nonhostile deployments. The predicted divorce probability of individuals who experience a 12-month hostile deployment in their first 3 years of marriage is 14.7 %, an increase of 35.3 % relative to the divorce probability of a corresponding nonhostile deployment (column 1). After 9/11, the difference between the divorce probabilities of hostile and nonhostile deployments drops to 5.4 % for families formed before 9/11 and to 6.1 % for families formed after 9/11 (column 2). While the smaller difference between the effects of hostile and nonhostile deployments may be surprising at first, it is driven by the substantial increase in the effect of nonhostile deployments after 9/11 relative to pre-9/11 level deployments. Using survey and focus group data, Hosek et al. (2006)

[16] For instance, only as of February 2013 were women allowed to be involved in direct combat.

[17] As our predictions are generated only for nondual couples, the gender difference in the effect of deployment is not driven by the fact that some families are dual military couples.

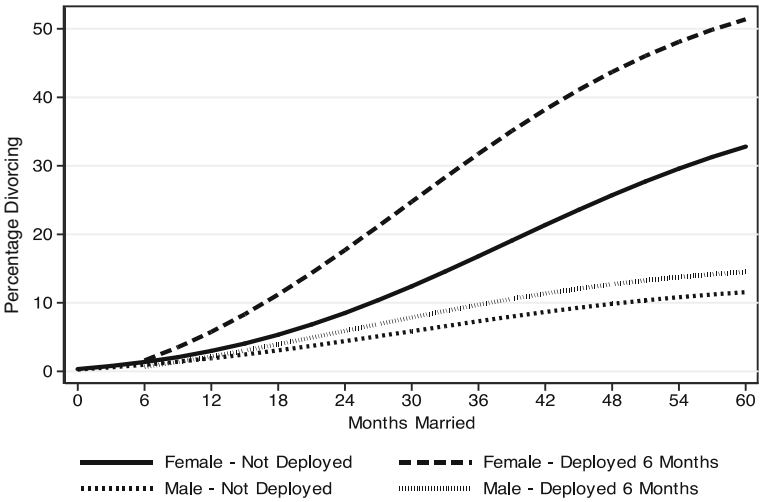

Fig. 5 Predicted cumulative divorce hazard by time deployed after 9/11 for families formed before 9/11, by gender

find that, in the first years after 9/11, deployed and non-deployed personnel alike faced an increased operating tempo with longer work hours and self-reported higher-than-usual work-related stress. It is likely that even non-hostile deployments after 9/11 were much more strenuous, uncertain, and associated with a much higher work pace than the pre-9/11 non-hostile deployments. The additional burden associated with the post 9/11 non-hostile deployments is likely to have been responsible for the marked increase in the divorce risk among couples married before 9/11. The finding that hostile and nonhostile deployments have a similar (and large) effect after 9/11 seems to indicate that it is not only direct combat exposure and combat-related activities that increase the risk of marital dissolution, but also the long separation from the family, increased work burden, and ubiquitous stress from high-pace deployments.

One potential concern in our estimation framework is that while unit deployments are independent of the individual's own preferences, assignment to the different unit branches or military occupations are not necessarily random. For instance, if unit assignment within an occupation is to some extent endogenous, the estimates of the deployment effect could be biased. However, to allocate service members to units, the Army uses an automated system, called the Enlisted Distribution Target Model, to create "enlisted distribution targets by MOS, grade, and unit identification code (UIC). The model fills each UIC reflected in the Personnel Manning Authorization Document (PMAD) with projected available inventory from a system called MOS Level System (MOSLS), according to the Deputy Chief of Staff for Personnel distribution policy" (Army Regulation doc. 614-200, 2013). It follows that the automated allocation of soldiers to units should take care of the potential selection of soldiers into unit types. As a robustness check, we estimated Army models in which we controlled for unit branch and clustered the standard errors by individual unit. The coefficients in the models with unit branch controls (with or without clustering at

Table 5 Predicted percentage of divorce in the third year of marriage after a 12-month deployment

	Deployed pre 9/11 (1)	Deployed post 9/11 (2)
Married pre 9/11		
Nonhostile	10.9	14.2
Hostile	14.7	15.0
Married post 9/11		
Nonhostile	–	12.5
Hostile	–	13.3

the unit level) are practically identical to those from the model without unit branch controls and unit clustering.[18]

Another concern may come from the fact that assignment of entrants to military occupations might be nonrandom. This allocation typically occurs at enlistment, and it depends on the service's openings in occupations and on the aptitudes and preferences of the entrant. For instance, the Army employs the MOSLS to project the numbers for the various MOSs needed, using the number of authorizations for new personnel by skill and grade (stipulated in PMAD), the current stock of skills and grades (from the Total Army Personnel Database-Active Enlisted), and the projected accessions (from the Active Army Military Manpower Program). The inputs from the MOSLS are, in turn, linked to the Recruiting and Training Reservation System (REQUEST) to ensure that the necessary number of new enlistees is recruited for each MOS (How the Army works handbook 2011). New enlistees are shown a set of MOSs generated by an algorithm seeking to match spaces to faces, as well as a set of hard-to-fill MOSs. Enlistees may have preferences for occupations, but these relate not only to occupational type (e.g., combat, logistics, medical, administrative, etc.), but also to the bonus and educational benefit kickers they may be offered by military recruiters for the hard-to-fill MOSs. Also, occupation preferences might not be well informed and might be subject to persuasion by the occupation counselor. This milieu contributes to the likelihood that the allocation of soldiers by occupation is, in fact, random for our purposes.

Nonetheless, the allocation by occupation may at least in part be a function of the entrant's characteristics that are unobservable to the researcher, but observable to the military recruiter. If the counselor can make a match between the occupations offered and the occupations preferred by the entrant, the Army and the entrant will both be well satisfied. Moreover, those unobservable characteristics that make a recruit more likely to be in a certain occupation could make the individual more (or less) likely to divorce even in the absence of deployments. One possibility is that entrants who prefer certain occupations (whichever they are) are inherently more likely to divorce.

[18]The unit branches are Airborne Division/Brigade, Armor Cavalry, Army Corps, Aviation, Chaplain, Chemical, Civil Affairs, Composite Service, Engineers, Field Artillery, Finance, General, Heavy Division/Brigade, Infantry, Judge Advocate, Military Police, Military Intelligence, Ordnance, Psychological Operations, Public Information, Quartermaster, Security, Signal, Special Operations, Transportation and Training Division.

Another possibility is that entrants assigned to an occupation that is acceptable but not near their first choice are more likely to divorce; in this case, the occupation assignment system could be a cause of divorce. However, even if the individual chooses his or her or occupation, we cannot know without additional information whether those who enter a combat service support occupation, such as administration or personnel, are less or more likely to deploy and divorce than those who enter a combat occupation such as infantry or artillery. Controlling for occupation in the regression models, as we do in all models shown in Tables 3 and 4, we eliminate a possible omitted variable bias that could affect the deployment coefficients. While we cannot rule out the possibility of an occupation-related selection effect, our argument is that assignment to an occupation is governed by the service's objective of matching recruits to manning targets.

We also estimated the main specification for each one-digit DoD military occupation category (Table 6) (Department of Defense 1997). Notably, soldiers who married before 9/11 and in occupations like electronic, communications and intelligence, mechanical equipment, craftsmen, and service supply faced an increased divorce hazard when experiencing post 9/11 deployments, relative to pre 9/11 deployments. This is consistent with our theory, as those soldiers could not have anticipated the change in the nature of post 9/11 deployments. At the same time, we found that the divorce risk of infantry soldiers increases as a result of deployments, but the change in the nature of post 9/11 deployments did not have an additional impact on their deployment-related divorce probability. So although infantry soldiers also could not have anticipated the change in the nature of deployments, their relationship between deployment and divorce was unaffected by this change. Similarly, soldiers who married before 9/11 that are grouped in unit branches like aviation, engineers, field artillery and composite service have a much higher divorce risk when confronted with post 9/11 deployments, a finding that is also in line with our theoretical prediction that the effect of deployments on marital stability depends on the degree with which such events are anticipated at the time of marriage (estimates not shown).

Another issue may come from the fact that we do not observe our subjects after they decide to separate from military service. If the decision to reenlist after a first term in the military is correlated with the decision to divorce, it may be that reenlistees are a selected sample of initial entrants.[19] If service members who reenlist are more likely to divorce than the initial sample of entrants, then our estimate of the effect of deployment on divorce is likely overstated. We test this hypothesis with a Heckman selection model with two outcomes—reenlistment and divorce—modeled as probits. This framework does not exploit the panel feature of the data, so we choose a single observation point—the date of the first-term reenlistment decision. We use our main sample of individuals who made their first-term reenlistment decision before March 2008.[20] We find a small negative correlation between the unobservable characteristics associated with the reenlistment decision and the unobservables underlying the divorce decision. Hence, those who reenlist are, on average,

[19] First terms are usually 4-year contracts.

[20] In this estimation, "divorce" indicates that the service member divorced during the first term prior to the reenlistment decision date.

Table 6 Effect of deployment by 1-digit DoD occupations

	(1) Infantry	(2) Electronics	(3) Communications	(4) Medical	(5) Other tech	(6) Administration	(7) Mechanical equipment	(8) Craftsmen	(9) Service supply	(10) Unknown
Months deployed	0.077**	−0.033	−0.002	0.073*	0.002	0.033	−0.017	−0.011	0.010	0.086
	(0.031)	(0.028)	(0.036)	(0.044)	(0.089)	(0.026)	(0.022)	(0.048)	(0.038)	(0.098)
Months deployed post 9/11	0.004	0.048*	0.067**	0.009	0.079	0.030	0.068***	0.112***	0.063*	−0.050
	(0.023)	(0.027)	(0.031)	(0.034)	(0.072)	(0.022)	(0.017)	(0.040)	(0.033)	(0.064)
Months post 9/11 × Marr 9/11	0.010	0.010	−0.007	0.005	0.006	0.002	0.001	−0.013	0.000	0.042
	(0.008)	(0.009)	(0.009)	(0.012)	(0.023)	(0.008)	(0.006)	(0.016)	(0.009)	(0.029)
Months deployed squared	0.000	0.003***	0.001*	0.000	0.002	−0.000	0.001	0.001	0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.000)	(0.001)	(0.001)	(0.002)
Months deployed post 9/11 squared	−0.001	−0.003***	−0.002**	−0.001	−0.003	−0.001	−0.001***	−0.003**	−0.001	−0.002
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Married post 9/11	−0.140	−0.093	−0.133	−0.138*	−0.187	−0.150**	−0.204***	−0.119	−0.193**	−0.205
	(0.091)	(0.092)	(0.087)	(0.079)	(0.169)	(0.059)	(0.062)	(0.155)	(0.096)	(0.245)
Observations	495,141	303,526	306,759	251,239	95,602	477,754	756,393	123,215	320,833	74,695

All models include the set of controls described in Section 3. Clustered standard errors (by individual identifier) in parentheses

$^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$

less likely to divorce than all married personnel reaching the end of their first term, suggesting that our hazard model estimates in Tables 3 and 4 are conservative, and the correlation between divorce and reenlistment is unlikely to be problematic in our hazard models.[21]

Finally, our results are robust to the inclusion of children. When we estimate the main model by including number of children at each *t*, along with an interaction term between time deployed and number of children as additional covariates, we find, as expected, that the number of children decreases the divorce probability of Army families. We also estimate a negative, statistically significant coefficient on the interaction between the number of children and months deployed, of −0.005, indicating that deployments have a slightly lower effect on families with children. However, the estimates of the deployment effects are similar across models with or without children included (estimates not reported).

7 Conclusions

Our analysis of deployment and divorce has led to several findings consistent with economic models of marriage stability. First, the hazard of divorce increases as a function of cumulative time deployed. This is true for overall time deployed and for time deployed in both hostile and nonhostile deployments. We interpret this finding in a theoretical context that assumes that a couple forms expectations about the value of the match at the time of marriage, and if subsequent realizations conform to expectations, they should not affect marital stability. The fact that deployment realizations, regardless of whether they occurred before or after 9/11, do affect marital stability implies that the experience of coping with actual deployment and the prospect of more such deployments in the future acts on average to decrease the ex ante expected gains from marriage. An in-depth analysis of the specific causes of this result is beyond the scope of this paper. Our findings are consistent with potential causes for the decline in marital surplus, like long separation from the family and increased work burden during deployments. Other proximate causes, like psychological and health-related problems, represent fertile ground for new research.

Second, the heightened pace and danger of post 9/11 deployments relative to pre-9/11 deployments caused a statistically significant increase in the divorce hazard of couples married before 9/11 compared to those married after 9/11. We interpret the change in deployments as a large shock entirely exogenous to the family, and, given heterogeneous preferences regarding deployment, this shock might have increased the gains from marriage in some families, but decreased them in others. But the predominant effect was negative, judging by the increase in divorce

[21] The estimates of the hazard model, as well as those from the Heckman probit model predict a similar effect on the cumulative probability of divorce. In the sample-selection probit model, one additional month in deployment during the first term increases the probability of divorce by 0.75 %. This translates into a cumulative probability of divorce of 11.8 % for an enlisted service member who deployed for 6 months. Similarly, the discrete hazard model estimates predict that the cumulative probability of divorce for service members that experience 6-month deployments during the last 3 years of their first term is slightly smaller (10.8 %), but of the same order of magnitude.

hazard. One might wonder whether a family's response to this shock could have been to separate from the military and not divorce, but military retention throughout the past decade was fairly stable, supported in part by the extensive use of reenlistment bonuses and, for a short time, by a stop-loss policy that prevented exit until after the return from deployment. Related to this, enlisted service members serve under contracts that in most cases last from 3 to 6 years. Given that the contract cannot be unilaterally terminated, families might have chosen divorce rather than exit. Our findings provide evidence that surprises matter for marital stability in the same way that Weiss and Willis (1997) find that unexpected changes in the earnings capacity of each spouse change the divorce hazard, and Charles and Stephens (2004) find that the divorce probability increases after a spouse's job displacement.

Third, the empirical analysis supports the notion that marriages occurring after 9/11 were based on expectations adjusted to the new reality of deployments. Although post 9/11 deployments were more frequent and more dangerous than pre-9/11 deployments, the effect of post 9/11 deployment time on the divorce hazard of pre-9/11 couples was the same as the effect of post 9/11 deployment time on the divorce hazard of post 9/11 couples.

Fourth, we find a larger effect of deployment on the divorce hazard of female service members. This suggests an asymmetry in the capability or willingness to adapt to deployment of couples where the service member is female in comparison with families where the service member is male. We also find a larger effect of deployment on the divorce hazard of service members in dual families (military member married to military member). In dual families, both spouses are under a military regime that perhaps leaves less opportunity for handling stress related to deployment, and both spouses are not at liberty to leave the military.

Finally, when we distinguish between types of deployments, we find some evidence that hostile deployments have a stronger effect on the risk of divorce than nonhostile deployments. However, nonhostile deployments, which seem more similar to civilian absences, also have a significant impact on marital stability. Since the military is the largest employer in the US and is similar in many respects to other large employers, our estimates of the impact of deployments on military families may provide insights into the effect of shocks in spousal absences due to work requirements on the marital stability of the civilian workforce.

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